



Government of **Western Australia**
Department of **Water and Environmental Regulation**

MURUJUGA ROCK ART STRATEGY

A monitoring, analysis and decision-making framework to protect Aboriginal rock art located on Murujuga (the Dampier Archipelago and Burrup Peninsula)

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Photo: Front cover, echidna engraving
Inside cover, turtle engraving
Back cover, engraving of two marine species



Contents

Executive summary	2	6.0 Management responses	43
1.0 Purpose	4	6.1 Management framework	43
2.0 Introduction	4	6.2 Joint management – Murujuga National Park	45
2.1 The petroglyphs on Murujuga	4	6.3 Dampier Archipelago island reserves	46
2.2 Industrial development on Murujuga	7	7.0 Governance	47
2.3 Existing legislative framework for protection of the rock art	9	8.0 Resourcing	49
2.4 Senate inquiry into the protection of Aboriginal rock art of the Burrup Peninsula	20	9.0 Stakeholders and consultation	50
2.5 World Heritage nomination	21	10.0 Custodian	51
3.0 Scope	23	11.0 Communication	51
4.0 Environmental Quality Management Framework	24	12.0 Evaluation and review of the strategy	51
4.1 Proposed approach	24	Appendix A	52
4.2 Environmental Quality Management Framework to protect the rock art on Murujuga	26	Murujuga Rock Art Stakeholder Reference Group – terms of reference	52
4.3 Review	29	References	55
5.0 Monitoring and analysis	30	Abbreviations	58
5.1 History of scientific studies and monitoring	30		
5.2 Opportunities for improvements	33		
5.3 The Murujuga Rock Art Monitoring Program	36		
5.4 Atmospheric deposition monitoring network	41		
5.5 Ambient air-quality monitoring network	41		

Executive summary



This strategy outlines a long-term framework to guide the protection of the Aboriginal rock art (petroglyphs) located on Murujuga (the Dampier Archipelago and Burrup Peninsula), 1300 kilometres north of Perth, Western Australia (WA). This area of the Pilbara has one of the largest collections of rock art anywhere in the world. The petroglyphs are of immense cultural and spiritual significance to Aboriginal people, and of significant state, national and international heritage value.

Murujuga is host to industry that contributes to the national, state and local economy and provides employment in the area. There has been public concern expressed that the rock art could be damaged by airborne emissions from industry. In response to these concerns, numerous scientific studies and monitoring have been undertaken since 2004. The conclusions of some of these studies and the monitoring have been contested. Recent independent reviews commissioned by the Department of Water and Environmental Regulation (DWER) have identified a number of improvements that could be made to provide robust, replicable and reliable results about the impact of emissions on the rock art in which stakeholders and the public can have confidence.

The Department of Water and Environmental Regulation recognises the Traditional Owners and custodians of Murujuga; the past, present and future generations of Ngarda-ngarli, and their ongoing connection to this sacred country.

Photo: Echidna engraving

This strategy builds on the previous work on Murujuga to deliver a scientifically rigorous approach to monitoring, analysis and management that will provide an appropriate level of protection to the rock art. It describes a risk-based approach for the management of impacts to the rock art that is consistent with the State Government's responsibilities under the *Environmental Protection Act 1986* (EP Act) and provides the monitoring and analysis to determine whether accelerated change is occurring to the petroglyphs. The principles and governance arrangements detailed in the strategy will ensure that the monitoring and analysis program and scientific studies are undertaken with rigour and that independent peer review processes are in place to provide assurance that the best scientific information is available to guide management actions.

DWER has primary responsibility for the day-to-day implementation of the strategy. This will be undertaken in partnership with the Murujuga Aboriginal Corporation (MAC), representing the Traditional Owners of Murujuga, and in consultation with stakeholders, including the community and industry.

The Western Australian Government released the draft Burrup Rock Art Strategy in September 2017 and sought public comment over a two-month submission period. Eighteen submissions were received. In March 2018, the comment period was extended for a further two months to provide an opportunity for stakeholders to respond to the Australian Senate Environment and Communications References Committee's report on the protection of Aboriginal rock art of the Burrup Peninsula. An additional nine submissions were received. All submissions were analysed and considered by DWER in finalising the strategy, which has been done in consultation with the Murujuga Rock Art Stakeholder Reference Group.

When the draft strategy was released for public comment, it was referred to as the 'Burrup Rock Art Strategy'. In recognition of the significance of the area to Aboriginal people, the strategy is to be known as the 'Murujuga Rock Art Strategy' and the Stakeholder Reference Group as the 'Murujuga Rock Art Stakeholder Reference Group'.

2.0 Introduction

2.1 The petroglyphs on Murujuga

The Dampier Archipelago, including the Burrup Peninsula and surrounds, traditionally referred to as Murujuga (which means ‘Hip Bone Sticking Out’ in the Ngarluma-Yaburara language) is located in the Pilbara region of WA (Figure 1). With more than one million images, Murujuga is home to one of the largest, densest and most diverse collections of rock art in the world.¹

Aboriginal people have occupied the mainland Pilbara region of north-west Australia for at least 35,000 years² and there is evidence of Aboriginal occupation dating to 27,000 BP on the Montebello Islands³ and 47,000 BP on Barrow Island.⁴ While rock art is difficult to date, it is estimated that the rock art on Murujuga is between 4,000 and 30,000 years in age.⁵ The archaeological record also includes campsites, quarries, shell middens and standing stone arrangements, including lines of up to three or four hundred stones.⁶

1 Bird and Hallam (2006); Mulvaney (2011a, b; 2015); Australian Heritage Council (2012).

2 Slack et al. (2009); Law et al. (2010); Mulvaney (2015).

3 Veth et al. (2007).

4 Veth et al. (2017).

5 Gregory (2009); Mulvaney (2011b).

6 Bird and Hallam (2006); Mulvaney (2011a; 2015); Australian Heritage Council (2012).

1.0 Purpose

The purpose of this strategy is to protect the Aboriginal rock art located on Murujuga by providing a long-term framework for the monitoring and analysis of changes to the rock art and describing a process by which management responses will be put in place to address adverse impacts on the rock art.

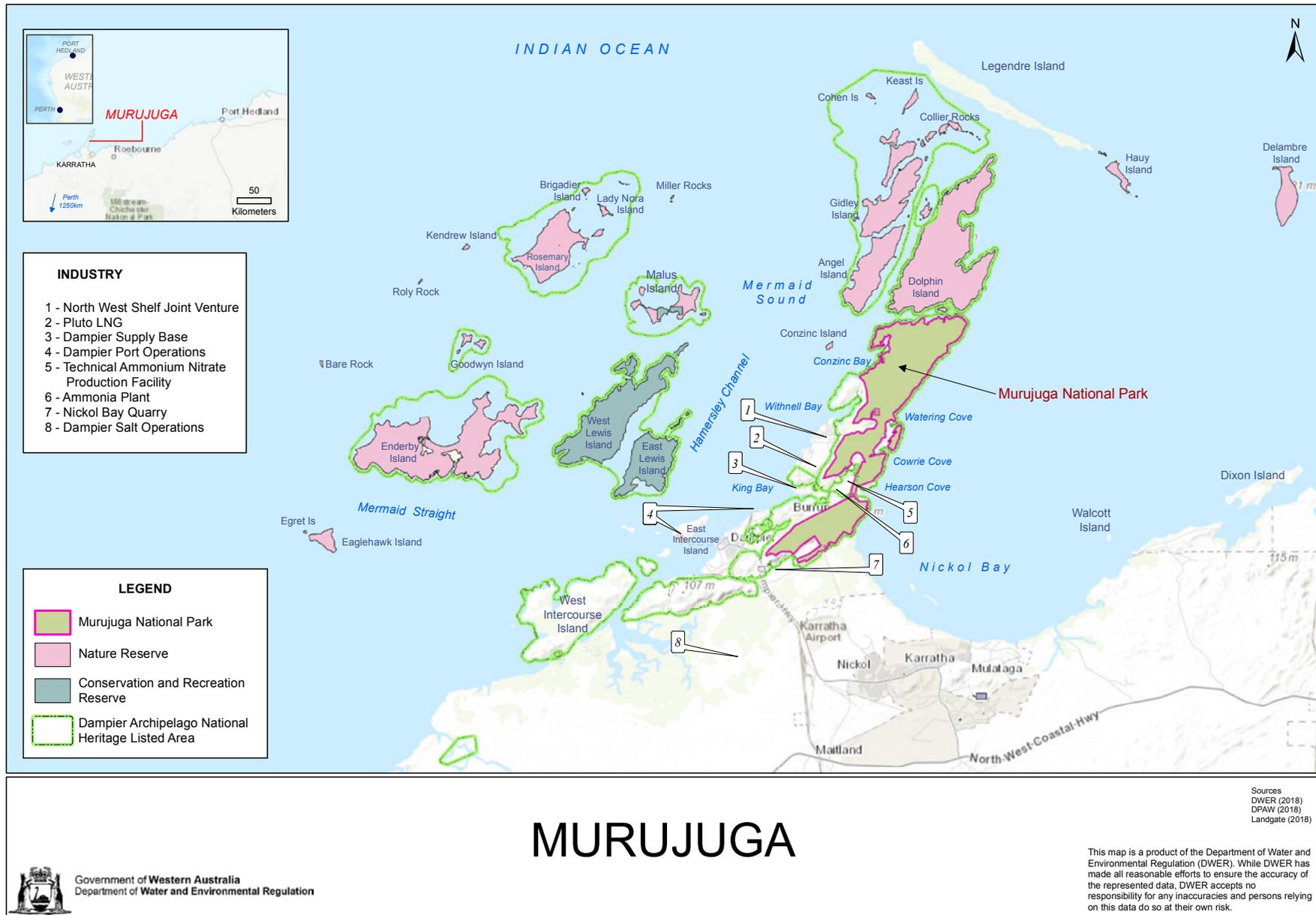


Figure 1: Dampier Archipelago National Heritage-listed Place, Murujuga National Park and industry on Murujuga

Traditional Aboriginal belief is that the rock art are the work of creation spirit-beings known as *Marrga* who, during the Dreaming times, formulated the rules of social conduct for human beings to follow.⁷ The *Marrga* left the rock art behind as permanent visual reminders of how the Law should be followed and they are places of continuing spiritual power. The rock art has deep meaning for the local Aboriginal people, providing a tangible link to stories, customs and knowledge of their land and resources, and connecting them to the events and people of the past.

The Murujuga rock art displays a wide range of techniques, subjects and styles.⁸ Almost all the rock art is in the form of petroglyphs, rather than drawings or paintings. Petroglyphs are images created by removing part of a rock surface by hammering (pecking, pounding, bruising) and abrading (rubbing, incising, scraping) the hard granitic rocks. There are images of terrestrial and marine fauna – macropods, birds, extinct mammals, snakes and reptiles, fish, turtles, crabs and crayfish. Other images comprise tracks and groups of animal footprints and a range of geometric and other abstract designs. The human figures exhibit a

diversity of poses and activities depicting everyday as well as sacred activities.

In recognition of the region’s outstanding Aboriginal heritage values, the Dampier Archipelago (including the Burrup Peninsula) was added to the National Heritage List under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (Cwlth) in July 2007 (Table 1). In August 2018, the Western Australian Government and MAC agreed to progress the nomination of the Burrup Peninsula and Dampier Archipelago for World Heritage recognition (see Section 2.5 of this strategy).

Murujuga and its rock art provide important tourism value to the Pilbara region. Visitors to the area are able to access the rock art as well take guided tours. MAC has plans for the creation of a Living Knowledge Centre with the purpose of promoting the conservation, protection and interpretation of cultural values and sites on Murujuga.⁹

7 Government of Western Australia (2013).

8 Bird and Hallam (2006); Donaldson (2009); Mulvaney (2011a, b; 2015); Australian Heritage Council (2012).

9 Murujuga Aboriginal Corporation and Pilbara Development Commission. *Murujuga Tourism Precinct, Pilbara WA. Investment Prospectus*.

2.2 Industrial development on Murujuga

Industrialisation began on the Dampier Archipelago in the 1950s after the first offshore gas deposits on the North West Shelf were discovered in 1954.¹⁰ In 1963, the Western Australian Government and Hamersley Iron Pty Ltd entered into an agreement to develop an iron ore mine at Mount Tom Price and the Dampier Archipelago was chosen as the location for its associated deep-water port. The township of Dampier was established in 1965 and the first shipment of iron ore from Parker Point was in 1966. In 1971, Hamersley Iron expanded its operations to East Intercourse Island.

Development of the port and industrial area involved the construction of a rail and road causeway across the tidal mudflats to connect Dampier Island (the largest island in the archipelago) with the mainland, forming the Burrup Peninsula. In the late 1960s, the intervening tidal mangrove flats were converted into salt evaporation beds and Dampier Salt commenced operations in 1972.

In 1978, the Burrup Peninsula was selected as the site for a processing plant for offshore gas deposits from the North West Shelf, with Withnell Bay the location for the North West Shelf liquefied natural gas (LNG) development and King Bay the location of the supply base providing port facilities for the project. The Karratha Gas Plant was completed in 1984 and LNG exports from the Port of Dampier began in 1989. In 1995, new LNG extraction and storage facilities were commissioned at the Karratha Gas Plant, with construction of the fourth processing train completed in 2004 and the fifth in 2008.

During the 1990s, three native title claims were registered that included parts of the Dampier Archipelago. In January 2003, the Western Australian Government entered into the Burrup and Maitland Industrial Estates Agreement Implementation Deed (the Burrup Agreement) with the three native title claimant groups (Table 1). The Burrup Agreement enabled the State Government to acquire native title rights and interests on the Burrup Peninsula and Maitland Estates industrial land, as well as the land required by the State for residential and commercial purposes in Karratha.

¹⁰ Bird and Hallam (2006); Donaldson (2009); Gregory (2009); Mulvaney (2011a; 2015); Australian Heritage Council (2012); Dampier Port Authority (2014).

Following the discovery of the Pluto gas field in 2005, development of Woodside's Pluto LNG plant started in 2007 and LNG production began in 2012. In 2006, production commenced at Burrup Fertilisers' (now Yara Pilbara) liquid ammonia fertiliser plant and Yara Pilbara's technical ammonium nitrate production facility completed commissioning in 2017. The Burrup Peninsula now supports a range of industry, with further expansion and development proposed for the future.

The Western Australian Government considers that with appropriate management, industry and tourism can successfully co-exist with the cultural heritage and environmental values of the area. While it acknowledges that Traditional Owners have expressed a preference for new industry to be located where possible at the Maitland Strategic Industrial Area, the Western Australian Government is also cognisant of the commercial and logistical challenges in establishing certain industries away from key export infrastructure.



Photo: Industry on Murujuga

Given the amount of industry associated with the area, the Port of Dampier has become an important part of the export precinct in the North West region and is Australia's second largest bulk export port, exporting iron ore, salt, LNG and anhydrous ammonia as well as project cargo, break bulk and general cargo. Total throughput at the port has increased from 51.19 million tonnes (Mt) in 1992 to 75.69 Mt in 1998 and 133.95 Mt in 2007/08, with more than 4,000 vessel arrivals at the port.¹¹ In 2014/15, the total throughput increased to 172.9 Mt and there were 19,113 vessel movements.¹² The port recorded a total annual throughput of 177.3 Mt and 9,583 vessel movements in 2017/18.¹³

International Maritime Organization regulations to reduce sulphur oxides (SO_x) emissions from ships came into force in 2005, under Annex VI of the International Convention for the Prevention of Pollution from Ships (the MARPOL Convention). From 1 January 2020, the limit for sulphur in marine fuel will be reduced from the current 3.50% mass by mass (m/m) to 0.50% m/m.¹⁴ This will significantly reduce the amount of sulphur oxides emanating from ships.

¹¹ Dampier Port Authority (2008, 2014).

¹² Pilbara Ports Authority (2015).

¹³ Pilbara Ports Authority (2018).

¹⁴ Refer to imo.org

2.3 Existing legislative framework for protection of the rock art

This section provides an overview of the environmental and heritage legislation that provides for the management and protection of the cultural, archaeological and natural values of Murujuga.

2.3.1 The *Environmental Protection Act 1986*

The EP Act is the principle legislation in WA that provides for “the prevention, control and abatement of pollution and environmental harm” and for “the conservation, preservation, protection, enhancement and management of the environment”.

Within the context of the EP Act:

- ▲ ‘Environment’ means “living things, their physical, biological and social surroundings and interactions between all of these”, where ‘social surroundings’ are defined as “aesthetic, cultural, economic and social surroundings to the extent that those surroundings directly affect or are affected by ... physical or biological surroundings”.
- ▲ ‘Pollution’ includes direct or indirect alteration of the environment to its detriment or degradation or to the detriment of an environmental value.
- ▲ ‘Environmental harm’ includes direct or indirect alteration of the environment to its detriment or degradation or potential detriment or degradation, and alteration of the environment to the detriment or potential detriment of an environmental value.

- △ 'Environmental value' means a beneficial use or an ecosystem health condition, where:
 - △ 'beneficial use' includes a use of the environment (or any portion of it) which is conducive to public benefit, public amenity, public safety, public health or aesthetic enjoyment and which requires protection from the effects of emissions or environmental harm; and
 - △ 'ecosystem health condition' includes a condition of the ecosystem which is relevant to the maintenance of ecological structure, ecological function or ecological process and which requires protection from the effects of emissions or environmental harm.

The object of the EP Act is to protect the environment of the state, having regard to a number of principles, including:

- △ **The precautionary principle**, which holds that 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, decisions are to be guided by: (a) careful evaluation to avoid, where practicable, serious or irreversible

damage to the environment; and (b) an assessment of the risk-weighted consequences of various options.

- △ **The principle of intergenerational equity**, which holds that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.
- △ **The principle of waste minimisation**, which holds that all reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment.
- △ **Principles relating to improved valuation, pricing and incentive mechanisms**, which include the 'polluter pays principle' whereby those who generate pollution and waste should bear the costs of containment, avoidance or abatement.

The object and principles guide the overall application of the powers of the EP Act. The Environmental Protection Authority (EPA) is responsible for assessing proposals that have a significant effect on the environment under Part IV of the EP Act and reporting to the Minister for Environment on whether proposals should be implemented. The EPA also recommends conditions to mitigate the detrimental impact on the environment that a proposal may cause.

The EPA is required to have regard for the principles as a condition of the valid exercise of its powers to assess and report on proposals under Part IV of the EP Act.¹⁵

With respect to air quality, the EPA’s environmental objective is “to maintain air quality and minimise emissions so that environmental values are protected”.¹⁶ Considerations for impact assessment include:

- ▲ application of the mitigation hierarchy to avoid and minimise emissions, where possible;
- ▲ application of technology appropriate to the potential environmental impacts and risks;
- ▲ whether proposed mitigation is technically and practically feasible; and
- ▲ the significance of the likely changes to air quality as well as the environmental values affected by those changes in the context of existing and predicted cumulative impacts.

The EPA encourages the application of all reasonable and practical measures to minimise harmful emissions to air, which can include

¹⁵ Environmental Protection Authority (2018).
¹⁶ Environmental Protection Authority (2016a).

facility design, technology choice, operation and closure.¹⁷ ‘Reasonable and practical’ measures include those that are reasonably practicable, having regard to, among other things, local conditions and circumstances (including costs) and the current state of technical knowledge.

Under Part V of the EP Act, DWER regulates to protect the Western Australian community and the environment against unacceptable impacts from emissions and discharges. The Department’s regulatory decisions are proportionate to the level of risk posed to public health and the environment, with consideration of cumulative impacts and informed by the best available information, including sound science.¹⁸ Approvals are subject to conditions for the prevention, control and mitigation of pollution and environmental harm. The principles of the EP Act guide DWER’s environmental regulatory functions.¹⁹ Environmental licensing as part of these functions follows the principles of good regulatory practice to achieve the outcomes outlined in the object and principles of the Act.

DWER is responsible for ensuring compliance with the EP Act in accordance with the interim Compliance and Enforcement Policy.²⁰

¹⁷ Environmental Protection Authority (2016a).
¹⁸ Department of Water and Environmental Regulation (2018).
¹⁹ Department of Water and Environmental Regulation (2015).
²⁰ Department of Water and Environmental Regulation (2017).

2.3.2 Aboriginal heritage and the *Environmental Protection Act 1986*

Aboriginal sites are of cultural heritage importance to both the Aboriginal and wider community. The *Aboriginal Heritage Act 1972* (AH Act) is the principal legislation providing for the preservation of Aboriginal cultural heritage places and objects in WA (Table 1). All Aboriginal heritage sites or places to which s.5 of the AH Act applies are protected, whether or not they are registered with the Department of Planning, Lands and Heritage (DPLH). If there is a risk that an activity will unlawfully ‘impact’ an Aboriginal site (i.e. by excavating, destroying, damaging, concealing or in any way altering the site) then approvals may be required under the AH Act. Advice can be sought from DPLH.

The EP Act can complement the AH Act where Aboriginal heritage is linked directly to the physical or biological attributes of the environment and where the protection and management of those attributes are threatened as a result of a proposal.²¹ In addition to Aboriginal heritage, the EP Act can consider social surroundings such as Aboriginal cultural associations, including traditional Aboriginal customs, directly linked to the physical or biological aspects of the environment.

The EPA’s environmental objective for ‘social surroundings’ is “to protect social surroundings from significant harm”.²² The objective recognises the importance of ensuring that social surroundings are not significantly affected due to the implementation of a proposal.

Considerations for impact assessment include:

- ▲ application of the mitigation hierarchy to avoid or minimise impacts on social surroundings where possible;
- ▲ the aesthetic, cultural, economic and/or social values which may be impacted, and whether those values are significant;
- ▲ the contribution implementation of the proposal may make to existing or predicted cumulative impacts to aesthetic, cultural or social values;
- ▲ the level of confidence with which the predicted impacts to social surroundings have been made, and the risk should predictions be incorrect; and
- ▲ whether proposed management or mitigation of impacts to aesthetic, cultural, economic and/or social surroundings is technically and practically feasible.

²¹ Environmental Protection Authority (2004, 2016b).

²² Environmental Protection Authority (2016b).



2.3.3 *The Environment Protection and Biodiversity Conservation Act 1999*

The EPBC Act is the Australian Government’s key piece of environmental legislation providing for the protection and management of internationally and nationally important flora, fauna, ecological communities and heritage places, which are defined in the EPBC Act as ‘matters of national environmental significance’.²³ Matters of national environmental significance relating to cultural heritage include National Heritage places.

The EPBC Act was amended effective from 1 January 2004 to:

- ▲ incorporate a new heritage protection and management system that provide for the inclusion of National Heritage places as a new ‘matter of national environmental significance’;
- ▲ establish a National Heritage List and a Commonwealth Heritage List; and
- ▲ include arrangements for nominating, listing, managing and protecting sites on the new lists.²⁴

The objectives of the EPBC Act include:

- ▲ to provide for the protection of the environment, in particular matters of national environmental significance;

- ▲ to enhance the protection and management of important natural and cultural places; and
- ▲ to provide a streamlined national environmental assessment and approvals process where matters of national environmental significance are involved.

Under the EPBC Act, actions that have, or are likely to have, a significant impact on a matter of national environmental significance require approval from the Commonwealth Minister for the Environment. As a consequence of the listing of the Dampier Archipelago as a National Heritage Place in July 2007 (Table 1), the provisions of the EPBC Act apply to developments on Murujuga.

However, the application of the EPBC Act is limited to actions commenced after 16 July 2000 (the commencement date of the Act). Hence, the industrial developments on Murujuga that commenced before that date are exempt from the assessment and approval provisions of the EPBC Act. As neither the amendments to the EPBC Act relating to national heritage in 2004 nor the listing of the Dampier Archipelago as a National Heritage Place in 2007 operate retrospectively, existing proposals determined as not likely to have a significant impact on matters of national environmental significance are permitted to continue, unless there is a significant alteration to the nature of those activities

²³ Refer to environment.gov.au/epbc

²⁴ Refer to environment.gov.au/epbc/about/history



Photo: Quoll engraving



2.3.4 Other legislative mechanisms and agreements

Existing legislative mechanisms and agreements that provide for the protection of the rock art on Murujuga are summarised in Table 1.

Table 1: Existing State and Commonwealth mechanisms and agreements that provide for the protection of the rock art on Murujuga

Mechanism and (responsible government)	Date	Summary of the provisions for the protection of the rock art on Murujuga
<p><i>Aboriginal Heritage Act 1972</i> (AH Act)</p> <p>(WA)</p>	Various	<p>The Department of Planning, Lands and Heritage (DPLH) maintains a Register of Aboriginal Places and Objects that includes more than 2,800 records for Murujuga. However, many more on Murujuga have not yet been registered.</p> <p>It is an offence under s.17 of the AH Act to excavate, destroy, damage, conceal or otherwise alter any Aboriginal site unless authorised by the Registrar of Aboriginal Sites (s.16) or the Minister for Aboriginal Affairs (s.18).</p> <p>Section 19 of the AH Act provides for the declaration and gazettal of Protected Areas, which are Aboriginal sites of 'outstanding importance'. Once an area has been gazetted as a Protected Area, regulations may be made prohibiting or imposing conditions or restrictions on use of the Protected Area and activities (s.26). There are two areas on Murujuga declared as Protected Areas under s.19: the 'Climbing Men' site near Withnell Bay and the northern portion of the Burrup Peninsula.</p> <p>Section 15 of the AH Act requires the reporting to the Registrar of the location of anything to which there is a reasonable expectation the AH Act might apply.</p>
<p>Burrup and Maitland Industrial Estates Agreement Implementation Deed (the Burrup Agreement)</p> <p>(WA)</p>	January 2003	<p>The State Government entered into the Burrup Agreement with three Aboriginal groups (the Ngarluma-Yindjibarndi, the Yaburara-Mardudhunera and the Wong-Goo-Tt-Oo) in 2003. The Burrup Agreement enabled the State Government to acquire native title rights and interests in the Burrup Peninsula and parcels of land near Karratha.</p> <p>The Burrup Agreement allows for industrial development to progress at the southern end of the Burrup Peninsula, provided for the development of newly created conservation estate (Murujuga National Park) and ensures the protection of Aboriginal heritage.</p> <p>The Department of Jobs, Tourism, Science and Innovation is the lead agency for the development of the Burrup Strategic Industrial Area and LandCorp is the estate manager.</p>

Mechanism and (responsible government)	Date	Summary of the provisions for the protection of the rock art on Murujuga
Burrup Maitland Industrial Estates Agreement Additional Deed (WA)	January 2003	The State Government committed to organise and fund a minimum four-year study into the effects of industrial emissions on rock art within and near part of the industrial estate on the Burrup Peninsula.
Listing of the Dampier Archipelago as a National Heritage Place – <i>Environment Protection and Biodiversity Conservation Act 1999</i> (EPBC Act) (Cwlth)	July 2007	<p>The EPBC Act contains provisions relating to the listing of national heritage. The national heritage management principles are set out in Schedule 5B of the <i>Environment Protection and Biodiversity Conservation Regulations 2000</i> and in the document <i>Australia's National Heritage: Applying the Principles</i>.</p> <p>The Dampier Archipelago was assessed by the Australian Heritage Council in 2007 and found to meet five of the eight criteria for national heritage listing under the EPBC Act.²⁵ The listing of the Dampier Archipelago 'recognised the extraordinary extent, diversity and significance of petroglyphs, standing stones and circular stone arrangements of the place'.</p> <p>National heritage listing means that any proposed action that could have a significant impact on the National Heritage-listed portion of the Burrup Peninsula must be referred to the Commonwealth Minister for the Environment as a matter of national environmental significance for assessment and decision.</p>
EPBC Act Conservation Agreements (Cwlth)	July 2007	At the time of listing on the National Heritage List, EPBC Act Conservation Agreements were signed by the then Commonwealth Minister for the Environment and Water Resources with Woodside Energy Ltd, and with Hamersley Iron Pty Ltd and Dampier Salt Ltd (Rio Tinto). Under the agreements, these companies provide funding for research, management and monitoring of the National Heritage values of the place.
Ministerial Statement No. 757 Pluto Liquefied Natural Gas Development (Pluto LNG) (Woodside Energy Ltd) (WA)	December 2007	<p>The offsets package for Pluto LNG required the rehabilitation/restoration of degraded areas that fall both outside of the lease and outside of areas of potential industrial development on the Burrup Peninsula, with a focus on Murujuga National Park and adjacent areas.</p> <p>The program initiated as a result of this requirement aims to rehabilitate and restore degraded areas on the Burrup Peninsula. It includes rock art site rehabilitation and restoration.</p>

²⁵ Commonwealth of Australia (2007).



Mechanism and (responsible government)	Date	Summary of the provisions for the protection of the rock art on Murujuga
EPBC Act Approval (EPBC 2008/4546) for the Construction of the Technical Ammonium Nitrate Production Facility (TANPF) (Yara Pilbara Pty Ltd) (Cwlth)	September 2011 (variations were approved under the EPBC Act in 2103, 2014 and 2017)	<p>The Commonwealth Minister for the Environment determined the proposal for the construction of the TANPF was a controlled action under the EPBC Act for likely impacts to the National Heritage Place.</p> <p>The Commonwealth Minister for the Environment approved the proposed action, with conditions relating to the protection of the National Heritage Place, including:</p> <ul style="list-style-type: none"> Δ contributing funds towards the implementation of the rock art monitoring program and reporting of results; Δ providing the Department of the Environment and Energy with a management plan in the event that accelerated changes in the rock art are detected; and Δ air-quality monitoring and emissions limits.
Murujuga National Park established (WA)	January 2013	<p>Murujuga National Park, covering 4,913 hectares, is freehold land on Murujuga owned by the Murujuga Aboriginal Corporation (MAC) and leased back to the State Government. The granting of title to the non-industrial lands of the Burrup Peninsula was a result of the Burrup Agreement.</p> <p>Murujuga National Park is jointly managed by the Department of Biodiversity, Conservation and Attractions (DBCA) Parks and Wildlife Service and MAC through a partnership arrangement that operates under the provisions of the <i>Conservation and Land Management Act 1984</i> (CALM Act). Together, the CALM Act and the Conservation and Land Management Regulations 2002 provide for the formal protection of the park's values.</p> <p>Amendments to the CALM Act in 2012 allowed for:</p> <ul style="list-style-type: none"> Δ joint management of Aboriginal land by DBCA; Δ the addition of a management objective for DBCA-managed land to protect and conserve the value of the lands and waters to the culture and heritage of Aboriginal people; and Δ Aboriginal people to undertake certain customary activities on DBCA-managed lands and waters. <p>The focus of the Murujuga National Park Management Plan (2013) is to ensure protection and awareness of the cultural and natural values of the area.</p>

Mechanism and (responsible government)	Date	Summary of the provisions for the protection of the rock art on Murujuga
The Deep Gorge Joint Statement (DGJS) (Cwlth)	July 2017	The DGJS, signed by the Australian Government, Woodside and Rio Tinto, reaffirms the commitments made under each of the bilateral Conservation Agreements to support the ongoing protection, conservation and management of the National Heritage values of Murujuga and the wider Dampier Archipelago.
Approvals and licences for industry located on Murujuga under the EPBC Act and the EP Act (Cwlth and WA)	Various	<p>The approvals and licences include conditions relating to the protection of Aboriginal heritage (including rock art), emission limits to air and air-quality monitoring requirements.</p> <p>Approvals made under the EPBC Act can be accessed from the Department of the Environment and Energy’s website: epbcnotices.environment.gov.au/referralslist/</p> <p>Ministerial Statements can be accessed from the Environmental Protection Authority’s website: epa.wa.gov.au/all-ministerial-statements</p> <p>Works approvals and licences can be accessed from the Department of Water and Environmental Regulation’s website: der.wa.gov.au/our-work/licences-and-works-approvals/current-licences</p>

Various other agreements also influence the protection and management of rock art on Murujuga. For example, Australia is a participant in the International Council on Monuments and Sites (ICOMOS), a non-governmental professional organisation closely linked to UNESCO (the United Nations Educational, Scientific and Cultural Organization), particularly in its role as UNESCO’s principal adviser on cultural matters related to World Heritage. The Burra Charter, first adopted by the Australian National Committee of ICOMOS (Australia ICOMOS) in 1979 and updated in 2013,²⁶ provides guidance on the conservation and management of all types of places of cultural significance in Australia.

²⁶ Australia ICOMOS Incorporated (2013).





Photo: Fish engraving

2.4 Senate inquiry into the protection of Aboriginal rock art of the Burrup Peninsula

On 30 November 2016, the Australian Government Senate referred a range of matters concerning the protection of Aboriginal rock art of the Burrup Peninsula to the Senate Environment and Communications References Committee for inquiry and report.²⁷ Submissions to the inquiry raised a number of issues relating to the adequacy of the Western Australian Government's rock art monitoring program.

On 21 March 2018, the Senate Committee tabled its report on the inquiry. The Senate Committee recognised and acknowledged the vast cultural and historical values of the rock art and noted it was critical for the petroglyphs to be protected and conserved for current and future generations.

The Senate Committee's report included a number of recommendations that directly relate to the scope of this strategy, including:

- △ the development and implementation of a new, fully funded independent monitoring and analysis program;
- △ proposals for further monitoring included in the draft strategy be implemented as soon as possible; and
- △ the development and implementation of the Murujuga Rock Art Monitoring Program be undertaken by DWER in partnership with MAC.

The Western Australian Government is progressing further initiatives related to the recommendations from the inquiry.

²⁷ The Terms of Reference, submissions received by the Committee, transcripts of the public hearings and the Committee's report are available at: aph.gov.au/Parliamentary_Business/Committees/Senate/Environment_and_Communications/BurruPeninsla

2.5 World Heritage nomination

The World Heritage List is comprised of places throughout the world that have 'Outstanding Universal Value'. This means that the cultural and/or natural heritage values of these places are 'so exceptional as to transcend national boundaries' and are 'of common importance for present and future generations of all humanity'. World Heritage listing is the highest global recognition of the importance of a place. With this acknowledgement at an international level comes a commitment at the local, state and national levels to manage the property for present and future generations.

There has been sustained and ongoing advocacy for the World Heritage listing of Murujuga because of its significant Aboriginal rock art. On 27 August 2018, the Premier of Western Australia and MAC announced they would pursue World Heritage listing for the area and wrote to the Commonwealth Minister for the Environment seeking Australian Government support for progressing the nomination.

The Department of Biodiversity, Conservation and Attractions (DBCA) has the lead role in preparing the World Heritage nomination on behalf of the Western Australian Government. DBCA will work in partnership with MAC, representing the Traditional Owners of Murujuga, and in liaison with the Australian Government and other stakeholders. An Interagency

These include:

- A DWER conducted a technical desktop review of Condition 5-1: Air Quality in Ministerial Statement 870 for the Technical Ammonium Nitrate Production Facility (TANPF) to determine whether contemporary best practice pollution control technology has been implemented. The review found that contemporary best practice pollution control technology has been incorporated into the TANPF and that, towards the end of the commissioning period, the plant was substantially achieving best practice stack emission concentrations under normal operating conditions. The report was tabled in Parliament in April 2018.²⁸
- A The EPA is undertaking an inquiry under s.46 of the EP Act into changing Condition 5-1: Air Quality in Ministerial Statement 870 for the TANPF to protect the rock art. The EPA is expected to report in March 2019.
- A On 27 August 2018, the Premier of Western Australia and MAC, announced their intention to formally begin the UNESCO World Heritage nomination process for the Burrup Peninsula and Dampier Archipelago.

²⁸ Refer to [parliament.wa.gov.au/publications/tailedpapers.nsf/displaypaper/4011238c3835b9b8b7330ca94825826c00075331/\\$file/tp-1238.pdf](http://parliament.wa.gov.au/publications/tailedpapers.nsf/displaypaper/4011238c3835b9b8b7330ca94825826c00075331/$file/tp-1238.pdf)

Taskforce and Heritage Committee have been established to prepare and inform the World Heritage nomination process.

Major steps in the World Heritage process will include the development of a World Heritage Tentative List submission to have Murujuga added to Australia's World Heritage List, followed by the preparation of a more comprehensive and formal nomination dossier.

The World Heritage nomination process will require a collaborative and cooperative approach to ensure the social, economic, spiritual and cultural values of Murujuga are fully considered in the nomination and incorporated into a sustainable management regime. Meaningful, ongoing and culturally appropriate engagement with MAC will be the foundation of this World Heritage nomination. Other stakeholders including scientific experts, community, non-government and industry members, and where required international and national experts, will also be actively engaged to assist in, and guide, the nomination.

The boundary and size of the proposed World Heritage area will be determined during the nomination process based on the potential 'Outstanding Universal Value' of the area and where World Heritage criteria are met. The boundary of the National Heritage area will be used as the starting point.

For a property to be included on the World Heritage List, the World Heritage Committee must find that it meets one or more of the 10 selection criteria.²⁹ The protection, management, authenticity and integrity of a property are also important considerations for the World Heritage Committee. This strategy, which provides the framework for monitoring, analysing and responding to changes in the rock art, will play an important role in informing the World Heritage nomination process.

²⁹ Refer to environment.gov.au/heritage/about/world/world-heritage-criteria

3.0 Scope

The scope of this strategy is to:

- 1 Establish an Environmental Quality Management Framework, including the derivation and implementation of environmental quality criteria (see Section 4.2 of this strategy).
- 2 Develop and implement a robust program of monitoring and analysis to determine whether change is occurring to the rock art on Murujuga (see Section 5.3 of this strategy).
- 3 Identify and commission scientific studies to support the implementation of the monitoring and analysis program and management.
- 4 Establish governance arrangements to ensure that:
 - ▲ monitoring, analysis and reporting are undertaken in such a way as to provide confidence to the Traditional Owners, the community, industry, scientists and other stakeholders about the integrity, robustness, repeatability and reliability of the monitoring data and results; and
 - ▲ government is provided with accurate and appropriate recommendations regarding the protection of the rock art, consistent with legislative responsibilities.
- 5 Develop and implement a communication strategy in consultation with stakeholders.

This strategy will be regularly reviewed and updated as knowledge is gained and conditions on Murujuga change (see Section 12.0 of this strategy). It will be reviewed and published in a timely way in consultation with key stakeholders.

4.0 Environmental Quality Management Framework

4.1 Proposed approach

An Environmental Quality Management Framework (management framework) will be implemented to provide a transparent, risk-based and adaptive framework for monitoring and managing environmental quality to protect the rock art on Murujuga from anthropogenic emissions (emissions caused by humans). This approach has been successfully applied in other situations in WA (and other jurisdictions). The key elements of the management framework are shown in Figure 2.

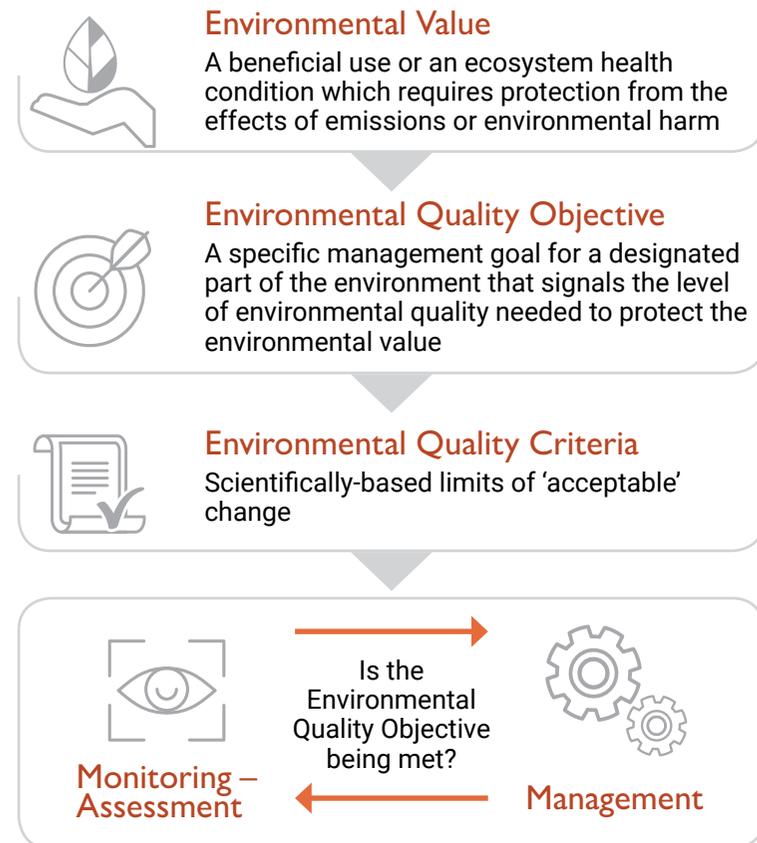


Figure 2: Structural elements of the Environmental Quality Management Framework

The management framework comprises:



environmental values, which form the basis of the management framework. Environmental values include 'beneficial uses' or 'ecosystem health conditions' (see Section 2.3.1 of this strategy);



environmental quality objectives, which are the primary management objectives that must be achieved to protect the environmental values;



environmental quality criteria, which are the scientifically-based limits of 'acceptable' change. The criteria are the benchmarks against which environmental monitoring data are compared in order to determine the extent to which environmental quality objectives have been met, and if not, whether a management response is required. Criteria should be clear, readily measurable and auditable, with standardised approaches for measuring the indicators and comparison of the monitoring data against the criteria.

There are two types of criteria: environmental quality **guidelines** and environmental quality **standards**. Criteria should be established using a risk-based approach. Guidelines provide early warning of potential

environmental effects; while standards, located further along the pressure/response (cause/effect) pathway, indicate when the level of risk is no longer acceptable, triggering a management response to prevent environmental harm or pollution. In keeping with the risk-based approach, several standards should be established to give greater certainty that an effect has or has not occurred (multiple lines of evidence).

Criteria are applied through a risk-based approach that is intended to capture any uncertainty around the level of impact by staging monitoring and management responses according to the degree of risk to environmental quality:

- ▲ If monitoring data meet the guideline, there is a low risk of adverse environmental effects and a high degree of certainty that the associated objective has been achieved. Routine monitoring and assessment should continue.
- ▲ If monitoring data are between the guideline and the standard, there is an increasing risk of adverse environmental effects and uncertainty about whether the objective has been achieved. This triggers a more detailed assessment against the standard to determine whether the environmental value is at risk. This assessment is risk-based and investigative in nature.

▲ If the monitoring data exceed the standard, there is a high risk of adverse environmental effects and that the associated objective has not been achieved and the environmental value is at risk. This triggers a management response to prevent environmental harm or pollution and restore environmental quality to within acceptable levels. The response would normally focus on identifying the cause (or source) of the exceedance and reducing the loads of the contaminant of concern (i.e. source control). The response may also require *in situ* conservation or intervention work to be undertaken.

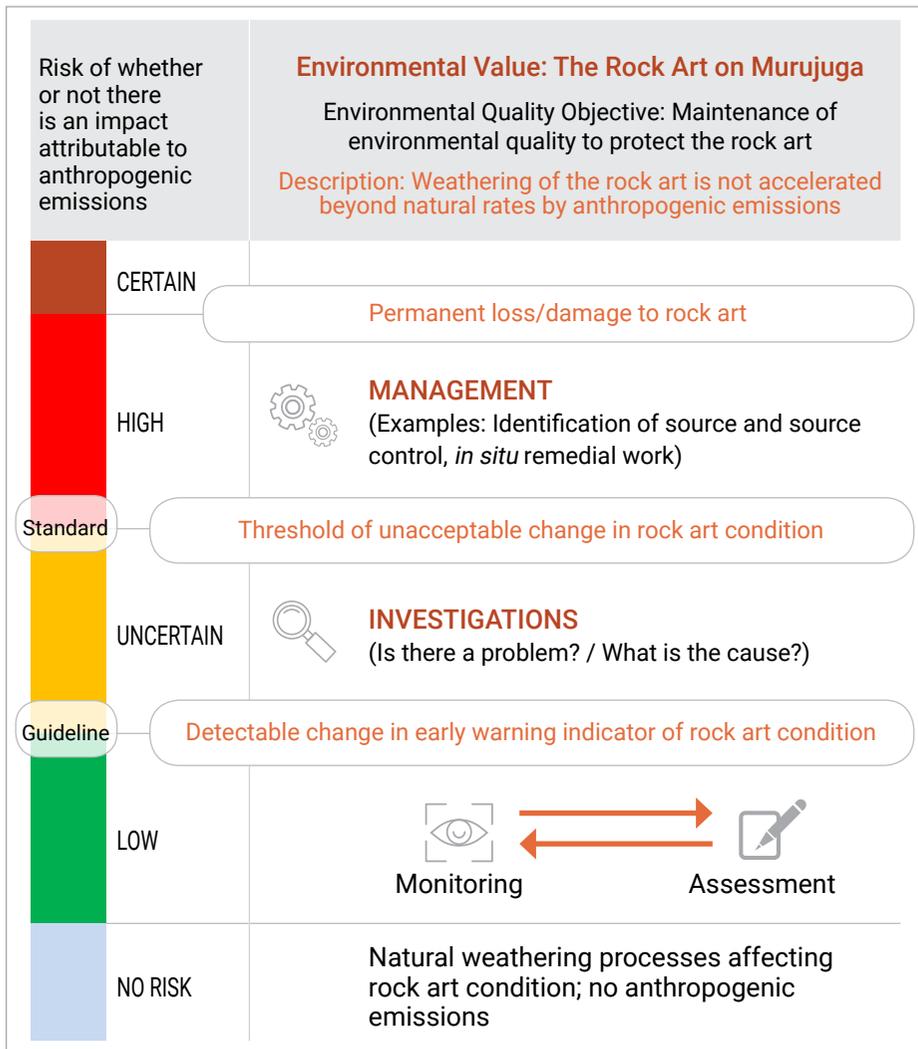
It is important to note that criteria define the scientifically-based limits of 'acceptable' change to environmental quality. They do not represent pollution levels that trigger enforcement action if exceeded; nor do they infer it is acceptable to 'load up' the environment to these levels. Avoidance and minimisation strategies should always be adopted.

4.2 Environmental Quality Management Framework to protect the rock art on Murujuga

The conceptual framework behind the Environmental Quality Management Framework to protect the rock art on Murujuga is shown in Figure 3.

The environmental value in this instance is the rock art on Murujuga. The management framework applies to the protection of the rock art, which is one of the physical elements of the Aboriginal cultural heritage of Murujuga, and does not directly address the protection of other tangible and intangible Aboriginal cultural heritage values. In the absence of any specific environmental quality requirements for the protection of these values, it is considered that if environmental quality is managed to protect the integrity of the rock art, then this may go some way towards maintaining some of these cultural heritage values. The management framework also does not address the other significant ecological and social environmental values of Murujuga. The management framework could be extended in the future to incorporate other Aboriginal cultural heritage values, social and ecological environmental values.

The objective is "maintenance of environmental quality to protect the rock art", such that weathering of the petroglyphs is not accelerated beyond natural rates by anthropogenic emissions. Other potential impacts on the rock art associated with increased development on Murujuga, for example on the visual and audio shed, are considered as part of the assessment for proposals under Part IV of the EP Act and through licences granted under Part V of the Act (see Section 2.3.1 of this strategy).



This strategy acknowledges there are other factors that may represent a significant risk to the rock art, including threats from vandalism and graffiti, unrestricted public access to the area, weeds and fire. Natural forces such as cyclones and other meteorological events, as well as climate change also pose significant threats. The Murujuga National Park Management Plan (2013)³⁰ addresses other potential impacts on the rock art. All factors potentially affecting the rock art, which may be interrelated and may exacerbate each other, would need to be considered as part of any investigation into changes in the integrity of the rock art and the development of recommended management options (see Section 6.1 of this strategy).

30 Available at: parks.dpaw.wa.gov.au/park/murujuga

Figure 3: The Environmental Quality Management Framework for protecting the rock art on Murujuga

The successful implementation of the management framework to protect the rock art from anthropogenic emissions will require:

- ▲ the application of criteria that are based on sound scientific information;
- ▲ a monitoring program that is appropriately designed and implemented to take the necessary measurements, to analyse the data and to report on the integrity or condition of the rock art and change in that condition (see Section 5.3 of this strategy); and
- ▲ a governance process that enables information to be assessed and appropriate management actions to be implemented (see Section 6.1 of this strategy).

Successful implementation of the management framework will require a collaborative approach involving all stakeholders.

4.2.1 Development of environmental quality criteria

There are currently no existing or default guideline 'trigger values' for protecting the rock art from anthropogenic emissions that could be used as criteria. There are also very few examples in the scientific literature where limits of 'acceptable' change have been identified that could be used to protect materials of cultural heritage.

The development of interim guidelines and standards, based on the best available scientific information at the time, will be informed by the monitoring studies undertaken to underpin the design of the Murujuga Rock Art Monitoring Program (see Section 5.3 of this strategy). This will include:

- ▲ the rationale underpinning each of the criteria;
- ▲ the statistical methods for interpreting the monitoring data against the criteria and the statistical sensitivity to detect a change; and
- ▲ the decision schemes for evaluating the monitoring data against the criteria.

It is anticipated that the interim guidelines and standards will be refined over time. As more data and information become available, the interpretation of the monitoring data against the criteria will be an important step in refining the criteria where there is a significant degree of uncertainty. If criteria are too stringent, they may trigger unwarranted concern; if too lax, they may fail to identify problems before they become very difficult or too late to rectify. Incorporating this feedback loop will be an important outcome of monitoring and assessment.

It is anticipated that the contract for the Murujuga Rock Art Monitoring Program, which will include the studies to underpin the design of the monitoring program and the derivation of the criteria, will be awarded by mid-2019. This strategy will be updated in the future to include the criteria.

4.3 Review

An independent review of the management framework will be undertaken regularly (at least every five years, or earlier at the request of the Minister for Environment). These reviews will include an evaluation of the effectiveness of the management framework in protecting the rock art on Murujuga.



5.0 Monitoring and analysis



Photo: Industry on Murujuga

5.1 History of scientific studies and monitoring

In 2002, the Western Australian Government established the Burrup Rock Art Monitoring Management Committee³¹ (BRAMMC) in response to concerns about possible adverse impacts on the rock art from industrial air emissions.

BRAMMC commissioned a number of independent scientific studies to investigate the possible effects of current and future industrial emissions on the rock art.³² These included:

- △ air-dispersion modelling of emissions from a range of sources on the Burrup Peninsula to predict emissions, transport and subsequent ground-level concentrations and deposition rates of nitrogen oxides, nitrogen dioxide, sulphur dioxide and ammonia;³³

³¹ Membership of BRAMMC included representatives with expertise in atmospheric science, archaeology, chemistry, land conservation and mineral science from the WA Museum, the Chemistry Centre, Department of Environment and Conservation, Department of Indigenous Affairs, Aboriginal representatives, professionals, local government representatives and Department of State Development (observer and secretariat). Associate Professor Frank Murray of Murdoch University was the Chair of the Committee.

³² Burrup Rock Art Monitoring Committee (2009); SKM (2009a).

³³ SKM (2003, 2009b).

- △ air-quality monitoring between August 2004 and September 2005 and between February 2007 and September 2008 to measure ambient concentrations of nitrogen dioxide, sulphur dioxide, ammonia gases and nitric acid, and benzene, toluene, ethylbenzene and xylene (BTEX);³⁴
- △ assessment of microclimate and its influence on the amount of dust deposited and retained on rock surfaces³⁵ and dust deposition processes and the composition of deposited dust;³⁶
- △ accelerated weathering (erosion) tests in fumigation chambers to investigate physical, chemical and mineralogical changes in rock surfaces at current, future and five to 10 times future pollutant estimates and the role of dust in rock surface modification;³⁷ and
- △ the gross number and diversity of microorganisms on rock surfaces from 2004 to 2007 to investigate whether microbial activity was stimulated by air pollutants.³⁸

The scientific reports from these studies were independently peer reviewed by international experts in relevant disciplines. The results of these studies and the independent reviewer’s reports are available on DWER’s website at dwer.wa.gov.au/Murujuga.

Annual monitoring to detect changes in the colour contrast and spectral mineralogy of the rock art has been undertaken by CSIRO (Commonwealth Scientific and Industrial Research Organisation) since 2004 at seven sites, with three additional sites incorporated since 2014.³⁹ Monitoring has not been undertaken at all the monitoring sites since 2016. Annual monitoring reports can be found on DWER’s website at dwer.wa.gov.au/Murujuga.

In 2009, after reviewing the information from these studies and the comments from the international peer reviewers, BRAMMC concluded there was no scientific evidence of any measurable impact of industrial emissions on the rate of deterioration of the Burrup rock art.⁴⁰ BRAMMC recommended that no environmental management measures

34 CSIRO (2006, 2008a).
 35 CSIRO (2008a).
 36 CSIRO (2007).
 37 CSIRO (2007).
 38 O’Hara (2006, 2008).

39 CSIRO (2007, 2008b, 2010, 2011, 2012, 2013, 2014, 2015, 2017a).
 40 Burrup Rock Art Monitoring Committee (2009).

specifically to protect the rock art from air pollution were necessary at that time.

BRAMMC recommended that colour contrast and spectral mineralogy monitoring be continued on an annual basis for 10 years and be reviewed after five years; and that a technical working group be established to consider the results of monitoring and other studies. BRAMMC also recommended that the monitoring of ambient air quality and rock microbiology be suspended and only recommenced if warranted by a major increase in emissions or if evidence became available indicating further monitoring was required.

The Burrup Rock Art Technical Working Group⁴¹ (BRATWG) was established to oversee the colour contrast and spectral mineralogy monitoring program and other studies between September 2010 and June 2016. The then Department of Environment Regulation (DER) managed the monitoring program from the expiry of BRATWG's tenure in June 2016 until the formation of DWER on 1 July 2017.

In 2016, extreme weathering experiments to investigate the effects of nitric acid, sulphuric acid, ammonium nitrate and ammonia at a range of concentrations on rock surfaces were undertaken.⁴² The aim of the study was to provide an assessment of the concentrations and the associated pH at which damage to the rock art can occur and to also provide an indication of the precision of the colour and mineralogical measurements. The results of this study is available on DWER's website at dwer.wa.gov.au/Murujuga.

⁴¹ Membership of BRATWG included an expert in the rock art monitoring field and representatives from the Western Australian Museum, Department of Indigenous Affairs, Department of Parks and Wildlife, and industry. The Department of Environment Regulation (DER) provided secretariat services to the group. Associate Professor Frank Murray of Murdoch University was the Chair of the Working Group.

⁴² CSIRO (2017b).

5.2 Opportunities for improvements

There has been criticism of the methodology used and the interpretation of the findings from some of the research studies and monitoring undertaken over the past 15 years.⁴³ A number of inadequacies in the statistical analysis of the annual colour change and spectral mineralogy monitoring data have also been identified.⁴⁴

DER commissioned independent reviews of the monitoring program and data analysis.⁴⁵ The conclusions from these reviews included:

- △ the colour change and spectral mineralogy monitoring program is less than ideal in experimental design and is not based on firm statistical principles, which has led to a lack of clarity in purpose, inefficient design of data collection and a lack of focus on analysing the results;
- △ given the considerable quantity of monitoring data collected, there is a need for robust data management practices to be implemented (including preparation of appropriate metadata); and
- △ there is a need for improved statistical methods, with the data subject to appropriate statistical analysis if the meaning and significance of the data are to be understood.

The independent reviews recommended that consideration be given to redesigning the monitoring program based upon well-established principles of experimental design, including:

- △ a clearly stated definition of effects or changes that the monitoring should be able to detect which will enable the design to be optimised for monitoring such possible changes;
- △ identification of the optimal number of sites, sampling spots within sites, replicates with spots and duplicates within replicates, based on an understanding and quantification of the sources of error;
- △ a clear role for the control sites, with an appropriate balance between the number of control sites and impact sites, noting that for simple designs with a constraint on total effort it is optimal to have equal numbers of control and treatment sites; and
- △ the required level of statistical power to detect a change of a certain size, with consideration of the size of changes that are meaningful or of practical importance.

⁴³ Bednarik (2004, 2007, 2009); Hallam (2009); Black et al. (2017).

⁴⁴ Black and Diffey (2016); Black et al. (2017).

⁴⁵ Data Analysis Australia (2016, 2017).

Specific suggestions for consideration in the redesign included:

- ▲ the inclusion of additional control sites to bring the number close to the number of treatment sites;
- ▲ the inclusion of additional monitoring sites to balance the monitoring program design across factors such as distance from the sea, rock types, age and orientation, and to enable formal analysis of site-specific effects; and
- ▲ the number of replicate measurements made at each sampling spot – it is likely that fewer replicate measurements could be made at each spot as the measurements are more repeatable at this level.

The independent reviews also recommended that:

- ▲ a formal monitoring program design document should be produced, including explanations for any departures from the established principles of experimental design;
- ▲ data collection should follow a fully documented and detailed protocol to maintain scientific rigour, with any changes in measurement practices documented; and

- ▲ data analysis should be based on a formal analysis plan produced in parallel with the design document and certified by a competent statistician.

The independent reviews confirmed that the design and analysis of the existing monitoring program could be substantially improved.

Since the start of the rock art monitoring on Murujuga in 2004 there has been an increase in industrial development and associated activities, such as shipping and vehicular traffic, as well as an increase in the local population and urban development. In addition, there is increased recognition of the cultural and spiritual significance of the rock art on Murujuga to Aboriginal people and of its significant state, national and international heritage value. It is therefore timely to revise the design of the monitoring program to ensure that it is contemporary and fit-for-purpose.





Photo: Engraving of two marine species

5.3 The Murujuga Rock Art Monitoring Program

5.3.1 Murujuga Research Protocols

MAC is the central organisation for developing and managing all research within Murujuga. MAC has a central leadership role in linking research to the cultural and strategic plan of Murujuga, under the governance and direction of the Circle of Elders.

The Murujuga Research Protocols⁴⁶ have been developed as a set of governing laws and principles to ensure that research is conducted in a respectful and culturally appropriate manner. The Protocols form the basis on which to build ethically and mutually beneficial research partnerships.

The Protocols apply to all organisations and researchers involved with the Murujuga Rock Art Monitoring Program.

5.3.2 Rationale

An essential step in the Environmental Quality Management Framework (see Section 4.2 of this strategy) is the development and implementation of an appropriate monitoring and analysis program to provide the data for measuring and assessing environmental performance against the environmental quality criteria. This will require:

- ▲ identification of relevant environmental quality indicators;
- ▲ identification of the criteria that define acceptable and unacceptable environmental quality conditions; and
- ▲ standardisation of procedures for the measurement of indicators and procedures to compare, interpret, understand and evaluate the results.

It will further require an understanding of:

- ▲ the natural geological, chemical, physical/mechanical and biological weathering/alteration/degradation processes, as well as the interaction mechanisms between these processes, that affect the surface and near-surface of the rock art and the surrounding rock surface;

⁴⁶ Murujuga Aboriginal Corporation (2015). Further information is available at: murujuga.org.au/murujuga-national-park/cultural-protocols/

- Δ the pressures and threats to the integrity of the rock art, in particular anthropogenic emissions and how these affect natural weathering processes or trigger other processes that are not naturally occurring, the interrelationships between these processes and the integrity of the rock art; and
- Δ the likely initial and secondary signs of these effects.

An understanding of the weathering processes that are naturally affecting the rock art and surrounding rock, and how anthropogenic emissions may alter these processes, will be important in establishing whether changes reported through the monitoring program are due to natural causes or are the result of anthropogenic emissions requiring in turn a management response.

It is acknowledged that the proposed monitoring and scientific studies are globally unique, that the work is complex and specialised, and that a multidisciplinary approach will be required.

5.3.3 Revised monitoring program

The Western Australian Government in partnership with MAC and in consultation with international and national experts in relevant disciplines and the Murujuga Rock Art Stakeholder Reference Group,

will develop and implement a revised long-term Murujuga Rock Art Monitoring Program. The development and implementation of the monitoring program will be informed by the findings and lessons from the past 15 years of scientific studies and monitoring of the rock art on Murujuga, as well as information available in the scientific literature. A staged approach is proposed, including focused monitoring studies to inform the design of the monitoring program and the development of the Environmental Quality Management Framework (see Section 4.2 of this strategy).

The following key design principles⁴⁷ will underpin the design of the revised monitoring program to enhance the ability to determine whether the rock art on Murujuga is being subject to accelerated change and to enable inferences on the likely causes of any such change:

- Δ The program should be based on specified possible causes of change that may be of concern and the possible nature of that change. The specific cause of concern relates to anthropogenic emissions.
- Δ The program should distinguish between changes in the integrity of the rock art that are attributable to anthropogenic emissions

⁴⁷ Based on Data Analysis Australia (2016).

and other causes that are not of direct relevance to this investigation. Causes that are not of direct relevance may include weathering effects that are not influenced by human activity and which would have happened regardless of anthropogenic emissions. This will be addressed through the inclusion of appropriate controls in the design that will allow for separation of the two types of causes, adjustment for the causes that are not of direct relevance, and estimation of the net effects due to anthropogenic emissions.

- ▲ The program should be able to detect changes that are of concern and should be reasonably reproducible.
- ▲ The program should have sufficient replication of measurements that it is possible to determine whether changes are 'real' or due to random fluctuations in measurement.
- ▲ Where there are multiple causes of change, the design should allow these to be distinguished.

In addition:

- ▲ Data collection will follow a documented and detailed protocol and any departures from this protocol will be documented.

- ▲ All data will be systematically archived and held by DWER to provide a baseline record and to facilitate comparisons with future data. The archival data format should enable ready access to the data via standard statistical software.
- ▲ The methods and results will be published on DWER's website to enable interested third parties to be informed about the monitoring program and its findings and to allow review and comment.
- ▲ The annual monitoring and analysis reports will be reviewed by independent peer reviewers engaged by DWER (see Section 7.0 of this strategy).

5.3.4 Purpose and objectives

The purpose of the Murujuga Rock Art Monitoring Program is to monitor, evaluate and report on changes and trends in the integrity of the rock art, specifically to determine whether anthropogenic emissions are accelerating the natural weathering/alteration/ degradation of the rock art. This will enable timely and appropriate management responses by the Western Australian Government, industry and other stakeholders to emerging issues and risks.



The objectives of the monitoring program are to:

- ▲ obtain data for comparison against the environmental quality criteria to ascertain whether the environmental quality objective is being achieved and the environmental value (the rock art) protected;
- ▲ provide the Western Australian Government, MAC, industry and the community with robust, replicable and reliable information on changes and trends in the integrity or condition of the rock art on Murujuga;
- ▲ ensure decisions regarding the protection of the rock art are based on the best available science; and
- ▲ inform the evaluation of the effectiveness of any measures taken to mitigate adverse effects on the rock art, including efforts to protect the rock art.

5.3.5 Guiding principles

The following principles will also guide the development and implementation of the Murujuga Rock Art Monitoring Program:

- ▲ The development and implementation of the Murujuga Rock Art Monitoring Program will be undertaken in partnership with MAC.

The selection of monitoring sites, monitoring methodologies and other decisions about the design and implementation of the monitoring program will be determined with the agreement of MAC.

- ▲ International best practice and standards developed for the design, monitoring and management of rock art will be reviewed for relevance to the Murujuga rock art.
- ▲ Equipment and procedures used for the monitoring program will be reviewed to ensure that best practice technologies, methods and procedures are used.
- ▲ The design of the monitoring program and the statistical analysis of the monitoring data will be endorsed by competent statisticians.
- ▲ Statistical analysis will support the examination of long-term trends to understand whether there are issues affecting multiple sites and to contrast sites near and far from anthropogenic emission sources.
- ▲ Consistent with the Government of Western Australia's Open Data Policy (2015), the data will be published on DWER's website in formats that are modifiable, non-proprietary and machine-readable.

- ▲ Individuals and organisations that have previously been involved with the monitoring and analysis of rock art colour change and spectral mineralogy will be consulted, together with additional experts as required.
- ▲ Research questions will be defined in consultation with key stakeholders.

5.3.6 Scope

The scope of the Murujuga Rock Art Monitoring Program will be developed by DWER in partnership with MAC, in consultation with international and national experts in relevant disciplines and the Murujuga Rock Art Stakeholder Reference Group.

The selection of appropriate parameters to monitor will be an important element of the design of the monitoring program and the development of the Environmental Quality Management Framework. The monitoring program may include monitoring of colour change, pH/acidity, microbiology and sources of pollutants, but will not be limited to these.

The monitoring program will employ cost-efficient, best-practice technologies, methods and procedures. Since the start of the rock art monitoring program in 2004, the development of new or improved technologies have made available accurate, relatively simple to use, reasonably cost-effective and essentially non-intrusive and non-

destructive methods for measuring and monitoring changes in rock surfaces and near-surfaces. These will need to be assessed within the context of the monitoring program to determine their applicability (and limitations) for long-term monitoring of the rock art.

It is anticipated that the contract for the Murujuga Rock Art Monitoring Program will be awarded by mid-2019.

5.3.7 Review

An independent review of the Murujuga Rock Art Monitoring Program will be undertaken regularly (at least every five years, or earlier at the request of the Minister for Environment). These reviews will address matters such as the design and effectiveness of the monitoring program, whether best-practice methodologies and techniques are being implemented, changes in environmental risks and any relevant emerging environmental issues.

5.4 Atmospheric deposition monitoring network

An atmospheric deposition monitoring network will be established to provide data on the composition and concentrations of contaminants that are potentially transferred from the atmosphere to the rock surfaces.⁴⁸ This information will assist in evaluating the exposure of the rock art to atmospheric contaminants and assessing changes in that exposure over time.

5.5 Ambient air-quality monitoring network

The Western Australian Government is considering the establishment of a long-term, coordinated ambient air-quality monitoring network on Murujuga and in the surrounding area. The introduction of a centralised and coordinated monitoring network would expand the knowledge base to manage the air quality in the region and result in more informed decision-making.

⁴⁸ The scoping of the atmospheric deposition monitoring network (Section 5.4) and the ambient air-quality network (Section 5.5) will be informed by the monitoring that is currently undertaken on Murujuga.





Photo: Dolphin engraving



6.0 Management responses

6.1 Management framework

The Environmental Quality Management Framework (see Section 4.2 of this strategy) will provide managers and decision-makers with information to support the implementation or amendment of management actions before permanent loss or damage to the rock art occurs. This is intended to ensure the rock art is protected from the impacts of anthropogenic emissions in the long-term. The conceptual framework in Figure 3 shows that the intensity of the management response triggered by exceeding an environmental quality criteria depends on whether a guideline or standard has been exceeded, which in turn reflects the level of risk of whether there is an environmental issue.

If the environmental quality objective is met, subsequent management focus should be on maintaining the existing environmental quality through continuous improvement (for example, through identifying and implementing methods of reducing current levels of emissions) and emission minimisation (for example, management of new and expanding emission sources with a focus on emission minimisation).

If the objective is not met, the management focus should be on improving environmental quality to meet the objective through the implementation of management processes to avoid and reduce anthropogenic emissions. The response may also require *in situ* conservation or intervention work to be undertaken. DWER in partnership with MAC will work with the Murujuga Rock Art Stakeholder Reference Group to recommend a range of management options to government for consideration.

The application of the precautionary principle outlined in the objects of the EP Act is relevant to the consideration of a management response.

6.1.1 Exceedance of environmental quality guidelines

In the event of an exceedance of the guidelines, DWER will notify the Murujuga Rock Art Stakeholder Reference Group and the Minister for Environment within five working days of DWER and MAC being notified of the exceedance.

DWER in partnership with MAC, with advice from independent experts and in consultation with the Murujuga Rock Art Stakeholder Reference Group, will determine whether an investigation is required against the environmental quality standards. In the event that an investigation is required, within three months of notification of the exceedance, DWER in partnership with MAC, with advice from independent experts and in consultation with the Murujuga Rock Art Stakeholder Reference Group, will undertake the investigation and prepare a report to the Minister for Environment for decision.

6.1.2 Exceedance of environmental quality standards

In the event of an exceedance of the standards, DWER will notify the Murujuga Rock Art Stakeholder Reference Group and the Minister for Environment within five working days of DWER and MAC being notified of the exceedance.

In the event that monitoring and analysis show that the integrity or condition of the rock art has changed beyond the standards established under the management framework, within three months of notification of the exceedance, DWER in partnership with MAC, with advice from independent experts and in consultation with the Murujuga Rock Art Stakeholder Reference Group, will prepare a report to the Minister for Environment for decision.

The report will:

- Δ describe the nature and extent of any change and implications for the rock art;
- Δ identify the likely cause of the change; and
- Δ recommend management or mitigation measures and, if required, other regulatory actions under relevant legislation.

The Environmental Quality Management Framework does not replace the monitoring, management and/or reporting requirements in approvals granted under Part IV and Part V of the EP Act (WA) or under the EPBC Act (Cwlth).

6.2 Joint management – Murujuga National Park

Murujuga National Park extends over an area of 4,913 hectares (44 per cent of the Burrup Peninsula) and occupies all of the northern and most of the eastern part of the peninsula.

Murujuga National Park is freehold land owned by MAC and jointly managed by DBCA Parks and Wildlife Service. Representatives of MAC, DBCA and the Department of Planning, Lands and Heritage form the Murujuga Park Council, which in accordance with a management agreement and the Murujuga National Park Management Plan (2013), provides the overall management decision-making body for Murujuga National Park.⁴⁹ Strategic direction for the ongoing joint management of the park will be provided on a continuous basis into the future by the Murujuga Park Council, in accordance with the approved management plan.

The objectives of joint management include:

- ▲ traditional skills and knowledge associated with looking after culture and country are respected;
- ▲ Ngarda-ngarli cultural protocols on how decisions should be made are maintained;
- ▲ contemporary park management skills are available to enable the joint management partners to look after the park in line with current best management practices; and
- ▲ Ngarda-ngarli will strive to meet their obligations to Country and satisfy their people's aspirations of benefits from land ownership.⁵⁰

The focus of the Murujuga National Park's management plan is on maintaining the key values of the park, including its cultural, natural, recreational, commercial, community, and educational and research values. The plan describes how National Heritage-listed values will be protected, how research can be conducted and how access and facilities for visitors, tourism opportunities, education and interpretation of the cultural values can be provided. The plan identifies collaborative approaches between government agencies (federal, state and local),

⁴⁹ Available at: parks.dpaw.wa.gov.au/park/murujuga

⁵⁰ Department of Parks and Wildlife and Murujuga Aboriginal Corporation (2015).

6.3 Dampier Archipelago island reserves

The Dampier Archipelago comprises 42 coastal islands, islets and rocks lying within a 45-kilometre radius of Dampier (Figure 1).⁵² Twenty-five of the islands are nature reserves managed by DBCA under the *Conservation and Land Management Act 1984* for the conservation of indigenous fauna and flora.⁵³ Some of the islands are classed as Special Conservation Zones where no public access is allowed. Other islands are managed as Conservation and Recreation Reserves. DBCA consults with MAC on cultural matters relating to the management of the island reserves.

MAC and industry partners to protect and promote the cultural values of Murujuga.

Some of the most easily observed adverse impacts on the rock art are from vandalism and graffiti. Strategies implemented under the plan to manage visitor access and activities have the potential to reduce damage to the rock art from people.

The Murujuga Land and Sea Unit (MLSU) consists mostly of Ngarluma, Yaburara, Yindjibarndi, Mardudhunera and Wong-Goo-Tt-Oo people employed by MAC and engaged by DBCA to provide land management services throughout the Murujuga National Park. The mission of the MLSU is to protect the cultural, natural and marine values of Murujuga, including the surrounding waters of the Dampier Archipelago, and to identify, protect and monitor the rock art for future generations.⁵¹ The Rangers of the MLSU conduct the practical management of the park and the surrounding sea country and islands, in partnership with DBCA.

⁵¹ Murujuga Land and Sea Unit Strategic Plan 2015-2017. Further information is available at: murujuga.org.au/murujuga-land-sea-unit/mlsu-strategic-plan/

⁵² Department of Environment and Conservation and Department of Indigenous Affairs (2010).

⁵³ Department of Conservation and Land Management (1990).

7.0 Governance

DWER has primary responsibility for the day-to-day implementation of the strategy in partnership with MAC. This includes working with MAC to oversee the development, implementation and analysis of a scientific monitoring and analysis program that will determine whether the rock art on Murujuga is subject to accelerated change.

The Murujuga Rock Art Stakeholder Reference Group has been established to facilitate engagement between MAC and key government, industry and community representatives on the development and implementation of the strategy. The membership and terms of reference for the Murujuga Rock Art Stakeholder Reference Group are provided in Appendix A.

DWER in partnership with MAC will be responsible for the design of the Murujuga Rock Art Monitoring Program. This will include coordinating, managing and overseeing the scope and implementation of the monitoring program and scientific studies to ensure the purpose and objectives of the monitoring program (see Section 5.3.4 of this strategy) are achieved. The design of the monitoring program will be undertaken in close consultation with a team of international and national experts in relevant disciplines.

The monitoring program will be undertaken by suitably qualified individuals or organisations in partnership with MAC. This will include the training and capacity building of the MLSU to undertake the monitoring program (including collection of field measurements and samples; analysis of monitoring data, presentation and interpretation of the monitoring results; report preparation and communication of

the findings from the monitoring program). MAC aspires to assume responsibility for the Murujuga Rock Art Monitoring Program in the long-term. DWER supports this aspiration.

The procurement process for commissioning the monitoring program and scientific studies will be managed by DWER in accordance with the *State Supply Commission Act 1991* and government procurement policies. The process for selecting the contractors will be undertaken in partnership with MAC.

DWER in partnership with MAC will be responsible for managing the peer review process to ensure credible and focused peer review. A panel of independent international and national peer reviewers with expertise in rock art, geology, corrosion/weathering, microbiology/geo-microbiology, analytical chemistry/geochemistry and statistical analysis will be established. The Stakeholder Reference Group will provide advice on potential independent peer reviewers. Independent peer reviews of the monitoring program and scientific studies by relevant international and national experts will be commissioned. This will include independent peer review of reports that provide key evidence used to support the implementation or otherwise of management strategies.

The independent peer reviewers will provide advice to DWER, MAC, the Stakeholder Reference Group and the Minister for Environment.

The engagement of independent peer reviewers will be managed by DWER in accordance with the *State Supply Commission Act 1991* and government procurement policies. The selection of independent peer reviewers will be undertaken in partnership with MAC.

Annual monitoring reports, reports from scientific studies and the reports of the independent peer reviewers will be provided to the Minister for Environment and the Stakeholder Reference Group. These reports will be published on DWER's website.

DWER will provide an annual report on the implementation of the strategy to the Minister for Environment and publish it on DWER's website.



8.0 Resourcing

DWER will support the development and implementation of the strategy, including secretariat support to the Murujuga Rock Art Stakeholder Reference Group; contract management and oversight of the monitoring and analysis program, scientific studies and independent peer reviewers; and preparation of the annual report to the Minister for Environment.

Historically, the monitoring program and scientific studies on Murujuga were funded by industry (Rio Tinto Iron Ore, Woodside Energy and Yara Pilbara). DWER will develop options for funding contributions to the costs of the Murujuga Rock Art Monitoring Program (Section 5.3), the atmospheric deposition monitoring network (Section 5.4), and the ambient air-quality monitoring network (Section 5.5).

Funds provided by stakeholders will be held in a Specific Purpose Account and used to support ongoing monitoring and analysis (including independent peer reviews), as well as scientific studies. Accountability for these funds rests with the Chief Executive Officer responsible for administering the EP Act, or their appropriately delegated officer.



Photo: Shell midden

9.0 Stakeholders and consultation

DWER will ensure stakeholders have opportunities to provide input through targeted consultation as required. DWER will consult key stakeholders in the development and implementation of the strategy and as part of the five-year review process, or any other review carried out more frequently (see Section 12.0 of this strategy).

Many of the key stakeholders are represented on the Murujuga Rock Art Stakeholder Reference Group (see Appendix A). Other key stakeholders include:

- ▲ Western Australian Minister for Environment
- ▲ Commonwealth Minister for the Environment
- ▲ Office of Compliance, Commonwealth Department of the Environment and Energy
- ▲ project proponents and occupiers of licensed prescribed premises on Murujuga
- ▲ research organisations and institutes
- ▲ the community.

The Stakeholder Reference Group (see Appendix A) has been established by the Minister for Environment to assist with communication and stakeholder engagement. Ongoing engagement and information sharing with key stakeholders will be facilitated through the Stakeholder Reference Group as required.

Information and reports will be published on DWER's website at dwer.wa.gov.au/Murujuga.

10.0 Custodian

DWER has primary responsibility for the development and implementation of the strategy. This will be undertaken in partnership with MAC and in consultation with key stakeholders.

12.0 Evaluation and review of the strategy

The strategy will be reviewed every five years from the date of final publication, or earlier as determined by the Minister for Environment. Any proposal to undertake an earlier review would be discussed with MAC and the Murujuga Rock Art Stakeholder Reference Group.

Five-yearly reviews will ensure that the strategy remains relevant, supports appropriate governance procedures, and reflects the best available scientific knowledge and management practices applicable to protecting the rock art on Murujuga.

11.0 Communication

Information on monitoring and analysis of the Murujuga rock art will be published on DWER's website at dwer.wa.gov.au/Murujuga. This will include the strategy, annual reports detailing the results of data collection and analysis, reports from scientific studies, the reports of independent peer reviewers and annual reports on the implementation of the strategy.

Appendix A

Murujuga Rock Art Stakeholder Reference Group – terms of reference

Context

The McGowan Government recognises the benefit of engaging in informed discussion with a diverse group of stakeholders to assist with the development and implementation of the Murujuga Rock Art Strategy.

The Department of Water and Environmental Regulation (DWER) has the primary responsibility for the day-to-day implementation of the strategy. This includes working in partnership with the Murujuga Aboriginal Corporation to oversee the development, implementation and analysis of a scientific monitoring and analysis program that will determine whether the rock art on Murujuga is being subjected to accelerated change.

This scientific monitoring and analysis program will be designed by DWER in close consultation with a team of national and international experts in relevant disciplines. It is expected that the monitoring will be undertaken by suitably qualified individuals or organisations selected through a government procurement process, and that the results of this monitoring will be subject to independent peer review.

The program may also include other studies commissioned by DWER to complement the monitoring program and strengthen the scientific knowledge informing decisions made in order to manage and protect the rock art.

The Murujuga Rock Art Stakeholder Reference Group will facilitate engagement between the Murujuga Aboriginal Corporation and key government, industry and community representatives on the development and implementation of the Murujuga Rock Art Strategy. The Stakeholder Reference Group will be invited to provide advice to DWER and the Minister for Environment on the scientific monitoring and analysis program. The Stakeholder Reference Group will also be the primary forum for stakeholders to inform the Government’s broader consideration of strategic issues relating to the monitoring and protection of the rock art.

The Stakeholder Reference Group will have an independent Chair appointed by the Minister for the Environment, and will report to the Minister for the Environment.



Terms of reference

The role of the Murujuga Rock Art Stakeholder Reference Group is to:

1. Contribute constructively to the monitoring and protection of rock art, being considerate of the views of all stakeholders. This includes the provision of advice to DWER and the Minister for Environment on the design, implementation and analysis of the scientific monitoring and analysis program.
2. Consult, inform and educate other stakeholders on other matters referred by DWER for input or comment, including further development of the strategy, implementation of the strategy and five-yearly reviews.
3. Inform the Government's broader consideration of other strategic issues relating to the protection of the rock art on Murujuga.

Membership

- △ Independent Chair
- △ Murujuga Aboriginal Corporation
- △ Department of Water and Environmental Regulation
- △ Department of Biodiversity, Conservation and Attractions
- △ Department of Planning, Lands and Heritage
- △ Department of Jobs, Tourism, Science and Innovation
- △ Pilbara Development Commission (Department of Primary Industries and Regional Development)
- △ Pilbara Ports Authority
- △ Western Australian Museum
- △ City of Karratha
- △ Australian Government Department of the Environment and Energy
- △ Rio Tinto
- △ Woodside Energy Ltd
- △ Yara Pilbara
- △ UWA Centre for Rock Art Research and Management
- △ Dr John Black

Secretariat support is provided by DWER.

Tenure and meeting arrangements

The Murujuga Aboriginal Corporation will be a permanent member of the Murujuga Rock Art Stakeholder Reference Group.

The initial term of appointment of the Chair and all other members of the Stakeholder Reference Group is three years, after which the membership will be reviewed by the Minister for Environment.

The Stakeholder Reference Group will meet at least annually, or as determined by the Chair.



Photo: Turtle engravings

References

Australia ICOMOS Incorporated 2013, *The Burra Charter: the Australia ICOMOS Charter for Places of Cultural Significance*, Australia ICOMOS Inc., Burwood, Victoria, Australia.

Australian Heritage Council 2012, *The potential outstanding universal value of the Dampier Archipelago site and threats to that site*, report by the Australian Heritage Council to the Minister for Sustainability, Environment, Water, Population and Communities.

Bednarik, RG 2004, 'Recipe for failure', *AURA Newsletter*, vol. 21, pp. 5–6.

Bednarik, RG 2007, 'Dampier rainwater as acidic as beer', *CSIRO, Rock Art Research*, vol. 24, pp. 139–141.

Bednarik, RG 2009, 'Experimental colorimetric analysis of petroglyphs', *Rock Art Research*, vol. 26, pp. 55–64.

Bird, C & Hallam, SJ 2006, *A review of archaeology and rock art in the Dampier Archipelago*, report prepared for the National Trust of Australia (WA).

Black, J & Diffey, S 2016, *Reanalysis of the colour changes from 2004 to 2014 on Burrup Peninsula rock art sites*, report available at: der.wa.gov.au/images/documents/our-work/consultation/Burrup-Rock-Art/Reanalysis-of-the-CSIRO-2014-Report.pdf.

Black, J, Box, I & Diffey, S 2017, 'Inadequacies of research used to monitor change to rock art and regulate industry on Murujuga ('Burrup Peninsula')', *Australia, Rock Art Research*, vol. 34, pp. 130–148.

Burrup Rock Art Monitoring Committee 2009, *Report and recommendations to the Minister for State Development*.

Commonwealth of Australia 2007, *Environment Protection and Biodiversity Conservation Act 1999: Inclusion of a Place in the National Heritage List*, Gazette Special no. S127, 3 July 2007.

Commonwealth Scientific and Industrial Research Organisation (CSIRO) 2006, *Burrup Peninsula air pollution study: final report*, report to the WA Department of Industry and Resources Rock Art Committee.

--2007, *Field studies of rock art appearance – final report: fumigation & dust deposition; – progress report: colour change & spectral mineralogy*, final report to the WA Burrup Rock Art Committee.

--2008a, *Burrup Peninsula air pollution study: report for 2004/2005 and 2007/2008*.

--2008b *Burrup Peninsula Aboriginal petroglyphs: colour change and spectral mineralogy 2004–2007*.

--2010, *Burrup Peninsula Aboriginal petroglyphs: colour change and spectral mineralogy 2004–2009*, Report P2010/408 CMSE(C)-2010-059.

--2011, *Burrup Peninsula Aboriginal petroglyphs: colour change and spectral mineralogy 2004–2010*, Report P2011.

--2012, *Burrup Peninsula Aboriginal petroglyphs: colour and spectra change 2004–2011*, Report EP123469.

--2013, *Burrup Peninsula Aboriginal petroglyphs: colour change and spectral mineralogy 2004–2012*, Report EP138017.

--2014, *Burrup Peninsula Aboriginal petroglyphs: colour change and spectral mineralogy 2004–2013*, Report EP143145.

--2015, *Burrup Peninsula Aboriginal petroglyphs: colour change and spectral mineralogy 2004–2014*, Report EP1410003.

--2017a, *Burrup Peninsula Aboriginal petroglyphs: colour change and spectral mineralogy 2004–2016*, Report EP161761.

--2017b, *Extreme weathering experiments on the Burrup Peninsula/Murujuga weathered gabbros and granophyres*, Report EP172193.

Dampier Port Authority 2008, *Dampier Port Authority 2008 Annual Report*.

Dampier Port Authority 2014, *Dampier Port Authority 2014 Annual Report*.

Data Analysis Australia 2016, *Review of statistical aspects of Burrup Peninsula rock art monitoring*, Project DER/1.

Data Analysis Australia 2017, *Review of CSIRO report on Burrup Peninsula rock art monitoring*, Project DER/2.

Department of Conservation and Land Management 1990, *Dampier Archipelago Nature Reserves: Management Plan 1990–2000*, Management Plan no. 18.

Department of Environment and Conservation 2010, *Dampier Archipelago Island Reserves*.

Department of Parks and Wildlife and Murujuga Aboriginal Corporation 2015, *Murujuga National Park visitor guide*.

Department of Water and Environmental Regulation 2015, *Guidance statement, regulatory principles, Environmental Protection Act 1986, Part V: effective and efficient regulation*.

—2017, *Compliance and Enforcement Policy (interim)*.

—2018, *Regulatory best practice principles*.

Donaldson, M 2009, *Burrup rock art: ancient Aboriginal rock art of Burrup Peninsula and Dampier Archipelago*, Wildrocks Publications, Western Australia.

Environmental Protection Authority 2004, *Guidance for the assessment of environmental factors (in accordance with the Environmental Protection Act 1986). Assessment of Aboriginal heritage*.

—2016a, *Environmental factor guideline: air quality*.

—2016b, *Environmental factor guideline: social surroundings*.

—2018, *Statement of environmental principles, factors and objectives*.

Government of Western Australia 2013, *Murujuga National Park: Management Plan 78*, Department of Environment and Conservation, Perth.

Gregory, J 2009, 'Stand up for the Burrup: saving the largest Aboriginal rock art precinct in Australia', *Public History Review*, vol. 16, pp. 92–116.

Hallam, S 2009, *Comments on Burrup Rock Art Monitoring Program, summary of study reports*, response to report to the Burrup Rock Art Monitoring Committee, cited in Australian Heritage Council 2012.

Law, WB, Cropper, DN & Petchey, F 2010, 'Djadjiling Rockshelter: 35,000 ¹⁴C years of Aboriginal occupation in the Pilbara, Western Australia', *Australian Archaeology*, vol. 70, pp. 68–71.

Mulvaney, K 2011a, 'Dampier Archipelago: decades of development and destruction', *Rock Art Research*, vol. 28, pp. 17–25.

—2011b, 'About time: toward a sequencing of the Dampier Archipelago petroglyphs of the Pilbara region, Western Australia', *Records of the Western Australian Museum Supplement*, vol. 79, pp. 30–49.

—2015, 'Burrup Peninsula: cultural landscape an industrial hub: a 21st century conundrum', *Landscape Research*, 2015, 14 pp.

Murujuga Aboriginal Corporation 2015, *Murujuga Research Protocols*.

O'Hara, G 2006, *Monitoring of microbial diversity on rock surfaces on the Burrup Peninsula*, summary report, School of Biological Sciences and Biotechnology, Murdoch University.

O'Hara, G 2008, *Monitoring of microbial diversity of the Burrup Peninsula*, final report to Burrup Rock Art Monitoring Management Committee, School of Biological Sciences and Biotechnology, Murdoch University.

Pilbara Ports Authority 2015, *Pilbara Ports Authority Annual Report 2014–2015*.

Pilbara Ports Authority 2018, *Pilbara Ports Authority Annual Report 2017–18*.

SKM 2003, *Burrup rock art: atmospheric modelling – concentrations and depositions*, report to the Department of Industry and Resources.

—2009a, *Burrup Rock Art Monitoring Program – summary of reports*, report to the Burrup Rock Art Monitoring Management Committee.

—2009b, *Burrup rock art: revised modelling taking into account recent monitoring results*.

Slack, M, Fillios, M & Fullagar, R 2009, 'Aboriginal settlement during the LGM at Brockman, Pilbara Region, Western Australia', *Archaeology in Oceania*, vol. 44, pp. 32–39.

Veth, P, Alpin, K, Wallis, LA, Manne, T, Pulsford, T, White, E & Chappell, A 2007, *The archaeology of Montebello Islands, North-West Australia: Late Quaternary foragers on an arid coastline*, British Archaeological Reports International Series S1668, Archaeopress, Oxford, 84 pp.

Veth, P, Ward, I, Manne, T, Ulm, S, Ditchfield, K, Dortch, J, Hook, F, Petchey, F, Hogg, A, Questiaux, D, Demuro, M, Arnold, L, Spooner, N, Levchenko, V, Skippington, J, Byrne, C, Basgall, M, Zeanah, D, Belton, D, Helmholz, P, Bajkan, S, Bailey, R, Placzek, C & Kenderick, P 2017, 'Early human occupation of a maritime desert, Barrow Island, North-West Australia', *Quaternary Science Reviews*, vol. 168: 19–29.



Photo: Hearson's Cove

Abbreviations

AH Act	<i>Aboriginal Heritage Act 1972</i>
BP	Before present (geological years)
BRAMMC	Burrup Rock Art Monitoring Management Committee
BRATWG	Burrup Rock Art Technical Working Group
Cwth	Commonwealth
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DBCA	Department of Biodiversity, Conservation and Attractions
DER	Department of Environment Regulation
DGJS	Deep Gorge Joint Statement
DPLH	Department of Planning, Lands and Heritage
DWER	Department of Water and Environmental Regulation
EP Act	<i>Environmental Protection Act 1986</i>
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
EPA	Environmental Protection Authority
ICOMOS	International Council on Monuments and Sites
LNG	Liquefied natural gas
MAC	Murujuga Aboriginal Corporation
MLSU	Murujuga Land and Sea Unit
TANPF	Technical Ammonium Nitrate Production Facility
UNESCO	United Nations Educational, Scientific and Cultural Organization
WA	Western Australia



Photo: Turtle with eggs engraving



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