

Comments on Burrup Rock Art Strategy, Department of Water and Environmental Regulation

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Since 2002 the Western Australian Government has developed a monitoring program for the important petroglyphs on the Burrup Peninsula and adjacent Dampier Archipelago islands. It is timely that the Department of Water and Environmental Regulation is conducting a review of the program, particularly with questions being raised regarding the most appropriate measurement equipment and statistical analysis approaches.

The following comments are provided in relation to the Draft Strategy of 19 October 2017..

2.0 Introduction

In order to support the impressive extent of the petroglyphs of the Burrup Peninsula it may be useful to include a map showing localities of recorded sites such as that from Bird et al 2006 (Figure 1).

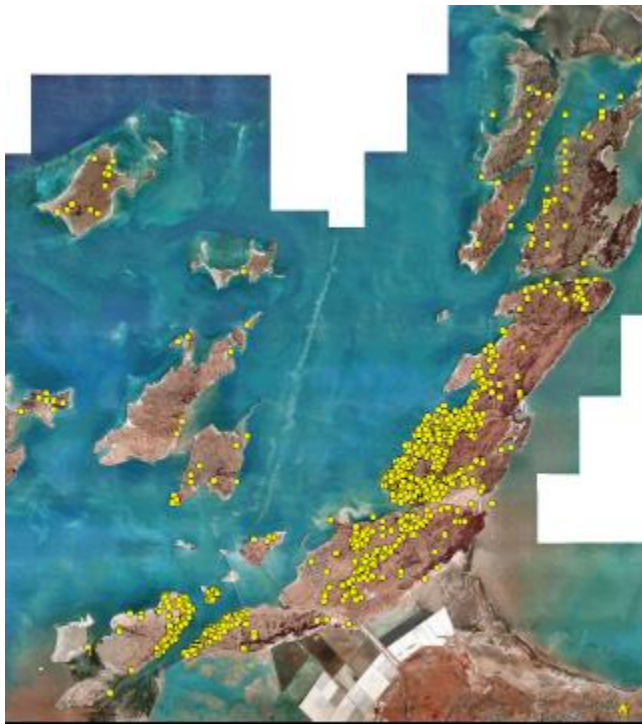


Figure 1 Petroglyph locations Burrup Peninsula and Dampier Archipelago

As discussed at the end of p3 and beginning of p4, the Murujuga Aboriginal Corporation (MAC) has plans to promote the conservation, protection and interpretation of cultural values and sites on the Burrup Peninsula. Currently there is little management of access to the rock art outside the industrial areas.

There is no interpretation or managed access to specific sites at this stage. Vandalism and inadvertent damage are continuing issues.

2.1 Monitoring of the Burrup Rock Art

P7, paragraph 3. It is agreed that there are few studies around the world comparable with the Burrup rock art monitoring program.

A couple of examples are as follows:

Dahlin et al (2001) discuss monitoring of the rate of weathering of petroglyphs on glaciated fresh granitic rock surfaces that are being affected by physical, chemical and biological weathering in southern Scandinavia. Norway implemented this ten year project between 1998 and 2008 for the research and conservation of three hundred important rock art sites (Doehne et al 2010, p55). The weathering is due to: acid rain arising from prevailing south westerly winds from Central Europe and England; pollution from local industry and traffic; high salt concentrations from the North Sea; frost action; and biological deterioration caused by lichens.

The United States Bureau of Land Management (2010) has developed a monitoring program to assess the impact of dust accumulation on petroglyphs in Nine Mile Canyon, Utah arising from vehicle traffic.

These examples consider some elements that confront monitoring of the Burrup petroglyphs. However the Burrup rock art monitoring has considerable constraints and complexities including those mentioned on p7, paragraph 3, namely that:

- there is a paramount requirement to use non-invasive techniques to ensure the rocks are not marked
- there are major problems associated with the collection of data in remote, exposed locations with rough terrain, often at high temperatures
- the petroglyphs have smooth to uneven and rough surfaces with a range of orientations
- the lithologies supporting the various petroglyphs need to be considered, the main ones being granophyre and gabbro
- any atmospheric monitoring needs to have its own power supply as there is little reticulated power available
- accessing of areas on islands needs to cope with a high tidal range
- control sites need to have similar geographic situations in terms of facing and degree of marine influence
- the choices of petroglyphs for study also need to be acceptable to elders of MAC and there have been a number of occasions when proposed sites were rejected on cultural grounds.

4.0 Monitoring and analysis

With reference to the growth of industry, Table 1 demonstrates the considerable increase in shipping and tonnages through Dampier Port. Ship visits increased by 160% and tonnage increased by 180% from 2004/2005 when monitoring commenced until now. This was related to increases in exports of iron ore, LNG and ammonia in particular.

Financial Year	Vessel Visits	Export Tonnage	Source
2015/16	4209	173mt	Pilbara Ports Authority Annual Report 2016
2007/08	4029	134mt	Dampier Port Annual Report 2008
2004/05	2669	96mt	Dampier Port Annual Report 2005

Table 1 vessel visits and export tonnage through Dampier Port

Such large increases strongly support the need for a continuation of monitoring of the Burrup Peninsula petroglyphs.

Gillett (2008) in reporting on the CSIRO air pollution study on the Burrup showed changes in air quality between 2004/2005 and 2007/2008. The results for gasses are summarized in Table 2.

Site	NH ₃ 04/05	NH ₃ 07/08	NO ₂ 04/05	NO ₂ 07/08	SO ₂ 04/05	SO ₂ 07/08	HNO ₃ 04/05	HNO ₃ 07/08
1	0.3	0.3	0.6	0.6	101	112	144	158
3	0.3	0.3	0.7	0.8	139	152	162	157
4	0.4	0.5	1.8	2.0	178	191	198	217
5	0.4	0.7	2.4	2.8	215	223	240	272
6	0.5	0.9	1.8	1.7	176	167	241	203
7	0.4	0.6	1.4	1.3	141	145	210	176
8	0.4	0.6	2.1	2.1	164	177	250	243
9	2.6	2.4	2.2	2.4	89	105	276	280
10	0.8	0.6	0.5	0.8	83	115	160	173

Table 2 Summary of annual average gas concentrations measured at the Burrup Peninsula sites. Concentrations of NH₃ and NO₂ are in ppb while SO₂ and HNO₃ are in ppt (from Gillett 2008).

Sites 1 at the northern end of Dolphin Island, Site 3 at the northern end of the Burrup Peninsula and Site 10 on Mardie Station 81 km south west of Dampier were selected as control sites. Sites 4 to 8 were in the industrial area of the Burrup Peninsula.

Gillett (2008) considered that concentrations of ammonia, nitrogen dioxide, sulfur dioxide and nitric acid are very low compared with measurements made at other remote locations. However in his discussion of the background concentrations of gasses he observed that much lower sulphur dioxide measurements have been made at the South Pole (20 ppt) and a remote part of New Zealand (15ppt).

4.1 Colour change and spectral mineralogy

It is appropriate that monitoring of colour contrast and spectral mineralogy are continued annually with a review after five years. This review should include not only the results of the program but also the instrumentation involved to ensure that the most appropriate techniques are employed as knowledge improves.

4.1.1 Methods for monitoring and analysis

The Data Analysis Australia recommendations have been constructive and it was pleasing to see that the latest CSIRO report had a much improved statistical analysis of the data collected.

Page 10 principles. The principles for a revised method for the collection and analysis of data are appropriate.

The equipment and procedures used for the monitoring program need to be kept under review as technology continues to evolve. We have seen this with the replacement of the BYK spectrophotometer by the Konica Minolta instrument. For example hand held XRF may be useful for assessing the mineralogy of surfaces.

As each of these instruments are placed on the rock surface there is concern that there may be a gradual removal of material at the points of contact. This will need to be taken into account when considering the number of placements of the instrument for statistical purposes during each monitoring run.

It has been noted that there may be a need to improve the means of relocating the sample points at each visit. The most effective may be the use of a series of more detailed photographs of each petroglyph under study to allow for accurate placement of the instruments.

As well as colour change and surface mineralogy, there is a need to consider microtopographic changes to petroglyph surfaces due to processes such as exfoliation or chemical erosion. Photogrammetric approaches using known fixed points would seem to be the most desirable as there is no disturbance of the rock surfaces. Laser measurements of change need fixed points such as brass pins attached to the panels and this is not seen to be desirable.

Site selection for petroglyph sites close to industry and for distant “control” sites were based predominantly on predicted gas concentrations derived from modelling by SKM. In addition, geology was important to ensure we included both the major rock types of the Gidley Granophyre, namely granophyre and gabbro, that supported petroglyphs. The following figure shows the outcome of modelling of SO₂ from shipping (SKM 2009).

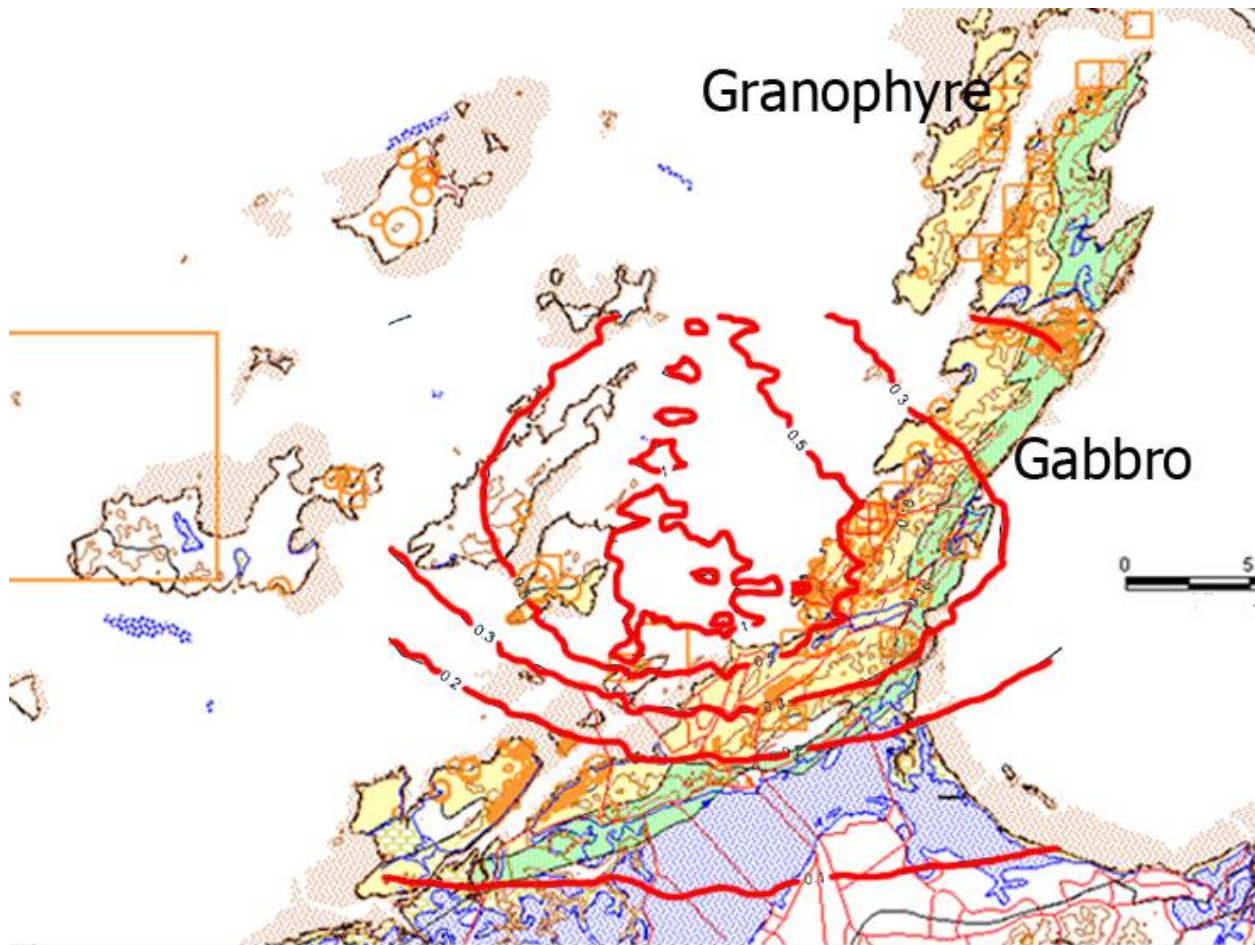


Figure 2 SO₂ concentration (ppb) modelling (SKM 2009) overlying simplified geology and petroglyph locations

Other factors then came into play such as distance from the sea, facing, and cultural acceptability. Until recently there was only one gabbro site close to industry (Site 7). With the recent addition of Sites 22 and 23 we now have three gabbro petroglyph sites close to industry.

It is important to assess the number of separate petroglyphs needed on each rock type close and distant from industry and also the number of monitoring spots on each to achieve statistically significant conclusions.

The proposal to incorporate additional control sites is highly desirable. Currently there is only one gabbro and one granophyre “control” site in the Gidley Granophyre on islands of the Dampier Archipelago. There is a need to increase the number of “control” petroglyph sites distant from industry. This may include further sites on Dolphin Island (gabbro) and Gidley Island (granophyre). As there has been a question raised concerning the effect of emissions from shipping, there should be consideration of looking further afield.

Options with petroglyphs may include:

- coastal gabbro outcrops bearing petroglyphs. A number exist but there is potential for future nearby port developments
- coastal petroglyph bearing granitic rocks. These are similar in chemistry to the granophyre and there are some examples but not remote from port developments.

Black et al (2017) refer to rocks stored in the Western Australia being useful controls. As the air quality is not controlled in such a situation this is not seen to be useful but the suggestion by Duffy et al (2017) to store rocks from each of the monitoring sites in the dark in a controlled environment of no humidity and an argon atmosphere has merit.

4.1.2 Collection and reporting of annual monitoring data and analysis program

I agree that it would be desirable for data collection and analysis to be undertaken by separate parties. The statistician will need to fully understand the data collection process, techniques, and equipment so that there can be constructive input regarding data presentation and issues associated with acquiring the data.

The principles for annual monitoring are considered suitable for the program.

The last dot point refers to an annual monitoring and analysis report which assumes that the monitoring report and statistical analysis of data collected will be compiled into one document. Is it expected that this will be done by the monitoring team?

In addition, the last dot point refers to an Independent review of the monitoring and analysis report. This is considered to be an essential component of the annual program to provide constructive advice to the Minister and inform the Burrup Rock Art Stakeholder Reference Group. This review should be conducted by someone of international reputation in a relevant field.

4.2 Other studies

4.2.1 Air quality

I note that there is reliable and targeted air and meteorological monitoring on the Burrup Peninsula. Currently publicly available information (temperature, wind, relative humidity) is available from two locations, namely the Karratha airport immediately south east of the Burrup Peninsula and Legendre Island at the northern end of the Dampier Archipelago. Such information is also available from Mardie Station and Roebourne.

Woodside and possibly Yara have meteorological and ambient air monitoring. It is important that a long term and coordinated monitoring network is implemented across all industries with data available in a form that can be incorporated in the annual petroglyph monitoring report. However the industry data may not provide sufficient information concerning the exposure of petroglyphs outside company boundaries. In particular there is a need to monitor air quality in areas selected as control sites for petroglyph monitoring as was done during the last comprehensive monitoring in 2004/2005 and 2007/2008 (Gillett 2008).

Dust levels and composition should be considered as part of the monitoring program as they may also have a bearing on the longevity of the petroglyphs.

4.2.2 pH

The strategy recommends regular measurement of pH on gabbro and granophyre rock surfaces. Black et al (2017) describe obtaining such measurements from rock surface washing. This is desirable but the experimental approach will need to be carefully designed. Previous attempts on the Burrup Peninsula have not provided reliable results.

As discussed in **4.2.1 Air quality** there is a need to ensure that there is a suitable meteorological air quality and rainfall composition monitoring program to provide sufficient information concerning the exposure of petroglyphs close to and distant from industry. The air quality should include relevant gasses and dust.

4.2.3 Microbiology

As there has been an increase in shipping and industrial emissions since the last microbiological assessment on the Burrup Peninsula and Dampier Archipelago Islands (O'Hara 2008) it is agreed that there should be a repetition of the microbiology study. The study should be linked to the location of the petroglyph monitoring sites, especially if there is a regional expansion.

4.2.4 Source of pollutants

It is agreed that as part of the pollutant monitoring program there should be studies of the source of the pollutants. Gillett 2008 describes such a study to assess the origin of airborne dust while Duffy et al (2017) discuss the potential contribution of phosphorus and nitrogen to rock surfaces by guano.

5.0 Management Responses

5.1 Joint management – Murujuga National Park

It is essential that elders of the Murujuga Aboriginal Corporation and the Murujuga Park Council agree to the approach to monitoring including the particular petroglyphs being studied and the location of air quality monitoring stations. When Yara reestablished an air quality monitoring station adjacent to Deep Gorge there was some concern expressed as it was in the vicinity of a planned interpretive trail.

As has occurred in previous years, involvement of the MLSU in data collection is desirable, particularly in providing access to monitoring locations on islands, but vessel safety and reliability issues are essential considerations.

Vandalism and graffiti continue to cause adverse impacts to the rock art on the Burrup Peninsula and it is desirable that the Murujuga National Park Management Plan strategies to manage visitor access and activities are implemented along with restoration of damaged art.

6.0 Governance

The proposed Strategy is suggesting an expansion of the monitoring program that has been conducted up to now and there will need to be a dedicated team in DWER to provide the necessary support for day to day implementation.

7.0 Funding

The approach to funding is sound but researchers should be contracted by DWER so that there is no question about industry influence on the results and conclusions reached in specific studies.

8.0 Stakeholders and consultation

It is pleasing to see that DWER will consult widely during the development, implementation and review of the strategy.

9.0 Custodian

It is important that there is a clear custodian for the development and implementation of the strategy and DWER is appropriate.

10.0 Communication

It will be a strength of the Burrup Rock Art monitoring program that the information will be readily available on the DWER website.

11.0 Evaluation and review

A 5 yearly review of the strategy is appropriate

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