

**Submission to the Western Australian Environmental Protection Authority
in relation to Woodside Energy Ltd North West Shelf Project Extension
Environment Review Document: EPA Assessment No. 2186**

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Summary

- Woodside is proposing to obtain additional offshore gas to enable the North West Shelf Joint Venture (NWSJV) project to continue operation until 2070.
- My major concern is that Woodside is proposing to continue to use existing emissions management systems and therefore current levels of chemical release into the atmosphere, while understating the damage inflicted on the world-unique petroglyphs, on public health and the impacts of greenhouse gas release.
- There is strong scientific evidence that emissions from the Woodside plant are already dissolving the outer patina of rocks close to the Woodside site. Observations on Murujuga show clearly that the petroglyphs will be lost once the patina is destroyed. The impacts of emissions on the rock art are cumulative over time. Allowing continued high emissions will almost certainly damage Australia's unique heritage.
- There has been ongoing concern from health authorities around the world that there is no safe level of exposure for humans to pollutants such as ozone, nitrogen dioxide or PM_{2.5} particles. Ozone is a product of the Woodside operation emissions. Recent analyses of world data show impacts on human health with concentrations of ozone as low as 31ppb. Ozone concentrations at Karratha and Dampier exceeded or were close to 30 ppb for 10 days in every 100 days.
- Doctors for the Environment in Australia now believe the maximum exposure for nitrogen dioxide should be less than 9 ppb. Nitrogen dioxide concentration in Karratha exceeded 9 ppb at least one day in 100 days and, for some years on Murujuga, exceeded the concentration on 10 days in every 100 days.
- There is strong evidence these emissions are affecting the health of people living in the area. Results from the Pilbara Health Profile Planning and Evaluation Unit report in November 2018 show children aged between 0 and 14 years, are hospitalised for lung disorders of asthma and bronchiectasis, which is damage and widening of the airways, 1.7 and 11.5 times more, respectively, than the Western Australian State average.
- Continuation of emissions from Woodside at the current level will exacerbate the health issues of local residents. It is irresponsible for the Government to put the public and workers on Murujuga and in the towns of Karratha and Dampier at such continuing risk.
- The adverse effects of climate change caused by an increase in atmospheric carbon dioxide from pre-world-industrialisation is clearly evident in this year's Australian bushfire season. Woodside is a significant contributor to Australia's greenhouse gas production, with 7.7 mt/year from scope 1-2 emissions and 80.2 mt/year in scope 3 emissions. The world is close to the 'tipping point',

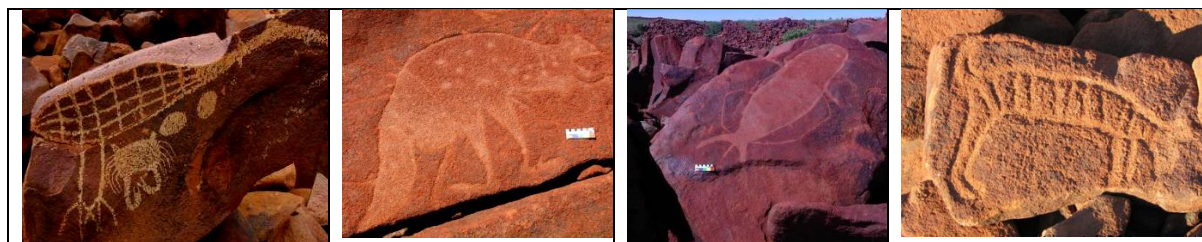
when the arctic tundra's melt and release entrapped methane, which is 25 times more potent as a greenhouse gas. Humanity is in serious threat of catastrophe through large sea level rise, droughts, failed crops, fires and cyclones. For the sake of humankind, this project extension should not be approved.

- Woodside's claim that natural gas is important for the transfer from coal is outdated. The whole of the Australian Capital Territory is 100% renewables for electricity production and technology is currently available to replace all uses of gas.
- Current technology is available to reduce nitrogen oxide and volatile organic compound emissions from industry to near zero and for greenhouse gas release to be carbon neutral. The Government must change the relevant Ministerial Statements and regulations to include emissions limits for the Woodside operation to be close to zero. A strict and rapid timetable must be imposed for installation of the relevant emission reduction technology for all existing operations.
- Meaningful penalties for breaches of licence conditions must be introduced. Australian Governments appear to be weak on ensuring compliance with licences and prosecuting for breaches. For example, in the 2016 Financial Year, 462 Commonwealth EPBC Act projects were monitored and 96 were found to be non-compliant. No company was prosecuted. Instead, the Department '*relied on administrative measures such as variations to conditions of approval, revisions to management plans, conservation agreements and warnings.*' Such a conciliatory approach to non-compliance will not ensure the health of citizen on Murujuga or preservation of the petroglyphs.
- I am astonished at the 'spin' and dishonesty of the Proposal documentation. I am reminded of the tactics used by the tobacco industry in its campaign to downplay the impact of tobacco smoke on public health. The document casts doubt on current scientific evidence, presents erroneous conclusions about Woodsides own data and continually seeks more research to further delay action.

Detailed Submission

Petroglyphs

- The petroglyphs on Burrup Peninsula and the wider Dampier Archipelago (Murujuga) are unique in the World. Nowhere else does there remain today, 50,000 years or more of the culture and spiritual beliefs of human-kind preserved in rock engravings. The rock art is believed to contain the oldest known representation of the human face (Mulvaney 2015). Other petroglyphs include elaborate geometric designs, extinct megafauna, the fat-tailed kangaroo and Thylacines, as well as existing animals, birds and sea creatures. The petroglyphs are enormously significant for continuation of Aboriginal lore and for the enjoyment and study by the wider world population. These petroglyphs are priceless and irreplaceable.



Examples of the petroglyphs on Murujuga.

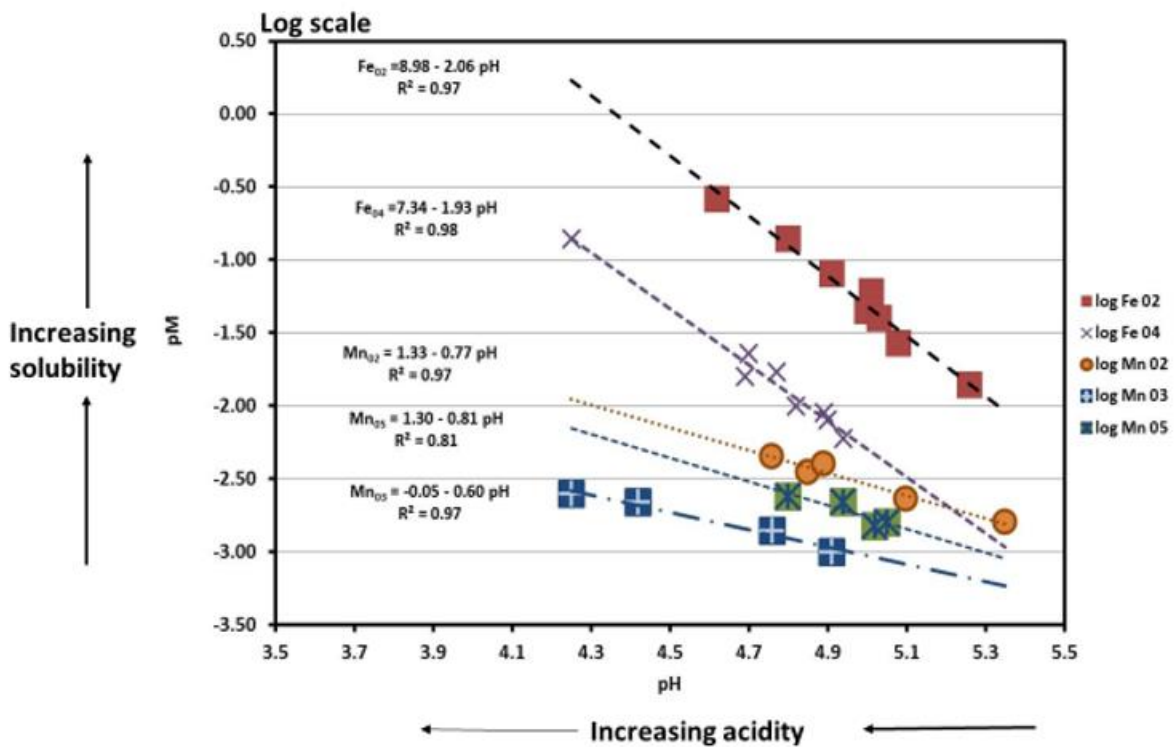
- Desecration of this rock art gallery through industrial emissions would be an unthinkable tragedy for the local indigenous community, Australia and the world.

- The Woodside Proposal, in its present form, makes destructions of the petroglyphs inevitable through the continued emissions of acid forming chemicals until 2070.
- There are two ways industrial and shipping emissions cause an increase in acidity of rock surfaces on Murujuga.
 - a) Sulphur dioxide and nitrogen dioxide form sulphuric and nitric acids and, when combined with salt water spray, can also form hydrochloric acid.
 - b) Nitrogenous compounds deposited on rocks stimulate the growth of bacteria, fungi and lichens which produce organic acids on the rock surface.
- Woodside is currently releasing 8,900 tonnes per year of oxides of nitrogen NO_x (as nitrogen dioxide, Table 2-2) and smaller amounts of sulphur dioxide.
- Nitrogen and sulphur dioxides combine with atmospheric water to form strong nitric and sulphuric acids; the major causes of acid rain around the world.
- Measurements of rock surfaces adjacent to the Woodside operation in 2003, 2004 show 1000-fold increase in acidity compared with rocks collected pre-industrialisation of Murujuga (MacLeod 2005). The following quote is from MacLeod's paper: *'the most acidic rock (pH 3.58) ... was found down in a gully downwind a few hundred metres from the gas production facility'*. More recent measurements in 2017 of the same rocks showed continuing decline in pH with individual sites being as low as 3.81 ± 0.15 . The lowest individual measurement was pH 2.89. At the extreme, these measurements suggest the acidity of rock surfaces has increased by more than 10,000-fold following industrialisation of Murujuga (rock surface pH falling from 7 to 3). A Report by the Yara Pilbara representative to the last Murujuga Rock Art Stakeholder Reference Group Meeting (MRASRG) stated that pH of the same rocks continued to decline during the 2019 measurements made by Dr MacLeod.

Woodside claim on p523 that *'no data was presented to link industrial air emission or subsequent deposition to changes in pH on Murujuga rock surfaces.'* The Proposal ignores the following information (Black *et al.* 2018) that was provided in a document circulated at the first MRASRG meeting, at which Woodside were a participant.

"Natural rainfall precipitation in equilibrium with an atmosphere uncontaminated by industrial and transport emissions has a pH of approximately 5.6 (Appelo and Postma 2005). Reaction with minerals in rock surfaces usually increases the pH to circum-neutral values (7.0 ± 1.0), as found on Murujuga rocks pre-industrialisation. Organic acids from biological activity will lower the pH of rock surfaces. However, in well-oxygenated environments such as the Murujuga, organic acids will not normally reduce pH of rock surfaces below 4.2, which is the buffering point of aluminium oxide (Appelo and Postma 2005). The recorded pH values as low as 2.9 on petroglyph-bearing rock surfaces of Murujuga are indicative of the influence of strong mineral acids, such as may be produced by anthropogenic generated sulphur and nitrogen oxides."

- As shown in the peer reviewed scientific publication (Black *et al.* 2017), electrochemical principles dictate that an increase in acidity of the rock surface where pH falls below 6.5 will dissolve the outer layer, or patina, of the rock types on Murujuga.
- MacLeod (2005) provides empirical evidence of a logarithmic (ten-fold) increase in the dissolution of manganese and iron compounds within the patina with each unit decline in pH. These measurements confirm the electrochemical principles showing dissolution of the outer rock patina is actually occurring.



Relationship between solubility of iron and manganese compounds with decreasing pH of rock surfaces on Murujuga (data from MacLeod 2005). pM is the negative value of the log concentration of Fe and Mn ions in solution following equilibration in water on rock surfaces.

- There is ample evidence on Murujuga to show that loss of the outer patina destroys petroglyphs.

The two examples below show clearly that removal of the patina results in destruction of the petroglyph.



The left photograph from Pillans and Fifield (2013) shows an ancient petroglyph being destroyed by flaking of the patina and weathering rind. The right photograph from Donaldson (2009) shows partial loss of a petroglyph through patina flaking.

- The impact of acidic emissions on the petroglyphs will be cumulative over time. Current scientific evidence shows this will lead to continuing dissolution of the outer rock patina and destruction of the petroglyphs.
- Despite the available published evidence outlined above, the Woodside Proposal states on p122; *No published peer reviewed studies identified measurable or observable changes to the condition and integrity of rock art as a result of industrial emissions.* The proposal also states: *It should be noted that there is an absence of readily observed change to rock, and rock art over the 15-year period during which the peer reviewed studies have been undertaken, and that during this time, the NWS Project operated with emissions rates comparable to the Proposal.*
- In answer to a query from me, Dr MacLeod wrote in an email on 2 February 2020; *It (the 2005 paper) was peer reviewed by the organising committee of the International Council of Museums - Committee for Conservation as all the preprints have a double blind peer review plus that of the managing editor.*
- Nitrogen emitted from Woodside and deposited on rocks will also increase nitrogen available for adventitious microbial and fungal growth. MacLeod (2005) showed a log increase in microbial mass with increasing nitrate in rock surface water. There is evidence that organic acids from trees (Bednarik 2009) and acidic bird droppings (Duffy *et al.* 2017) dissolve the patina from rocks on Murujuga. Microbes, fungi and lichen produce organic acids which further increase the acidity of rock surfaces and dissolve rock patina (Dragovich 1986).
- The evidence suggests that the impact of nitrogen emissions from the Woodside plant will have a direct effect on patina dissolution through the formation of nitric acid and an indirect effect through the organic acids formed from excessive growth of microorganisms. An increase in microbial growth on buildings and rock surfaces is seen as a darkening of the surface (Mihajlovski *et al.* 2017).
- Dissolution of the darker manganese, magnetite and associated iron compounds in the outer patina and an increase in the proportion of red ferrous oxide and lighter-coloured clay minerals as surface acidity increases will make the rock surfaces lighter, redder and more white/yellow in colour over time. A possible example of colour changes to a rock with a petroglyph close to the Woodside site is shown below. The patina is likely to become thinner and more porous as the manganese and iron compounds are dissolved. Increased porosity is likely to facilitate the passage of acidic solutions to the patina-weathering rind interface and to weaken the chemical bonds holding the patina to the rock. In addition, on drying, the crystallisation of nitrate and sulphate compounds at this interface may further encourage flaking of the patina.



A petroglyph adjacent to the Woodside site from an area where rock surface pH has fallen to less than 4 showing increases in red and light clay colouration as is predicted from electrochemical theory with dissolution of darker manganese and iron compounds. The darker overlay of the petroglyph could be caused by increased microbial growth, but no measurements of this have yet been made on this rock.

- Potential evidence of the destructive power of emissions can be seen at the Woodside Visitor's Centre.

Woodside Visitors centre



Approximately 100 mm gap between roof lines



Dark colour: possibly microbial growth stimulated by nitrogen compounds

Erosion of concrete paving stones where rain falls

Is this an effect industrial emissions on the Burrup Peninsula environment?

- An apparent attempt to destroy evidence? Some person is clearly concerned about the impacts of industrial emissions on rock surface acidity and the likely destruction of the petroglyphs. The Yara Pilbara representative reported at the last MRASRG meeting, that before measurements of pH were made by Dr MacLeod in 2019, the petroglyph at the former CSIRO site 4 adjacent to the Woodside operations was washed with high chlorine, town water. The pH measurement of the rock surface on the petroglyph was near 7, similar to rock surface pH prior to industrialisation, but pH of rocks close to the site 4 petroglyph remained at 3.6 (WA Legislative Council Question Without Notice C1363, Tuesday 29 October 2019). The Minister for the Environment stated in response to the

question that he would investigate the reason for the change. Is there a result from this investigation?

Human Health

- Although statements in the Proposal about measured emission levels presented for ozone and nitrogen dioxide being below the Australian National Environment Protection (Ambient Air Quality) Measures (NEPM) are correct, there are two reasons why the impact on human health is likely to be higher than suggested in the Proposal:
 - Recent evidence suggests the air concentration limits set by NEPM are too high for a healthy environment, and
 - Observations of the Woodside NWSJV operations show an almost continuous cloud of nitrogen dioxide over the plant on Burrup Peninsula.
- There has been ongoing concern from health authorities around the world that there is no safe level of exposure of humans to pollutants such as ozone, nitrogen dioxide or PM_{2.5} particles.

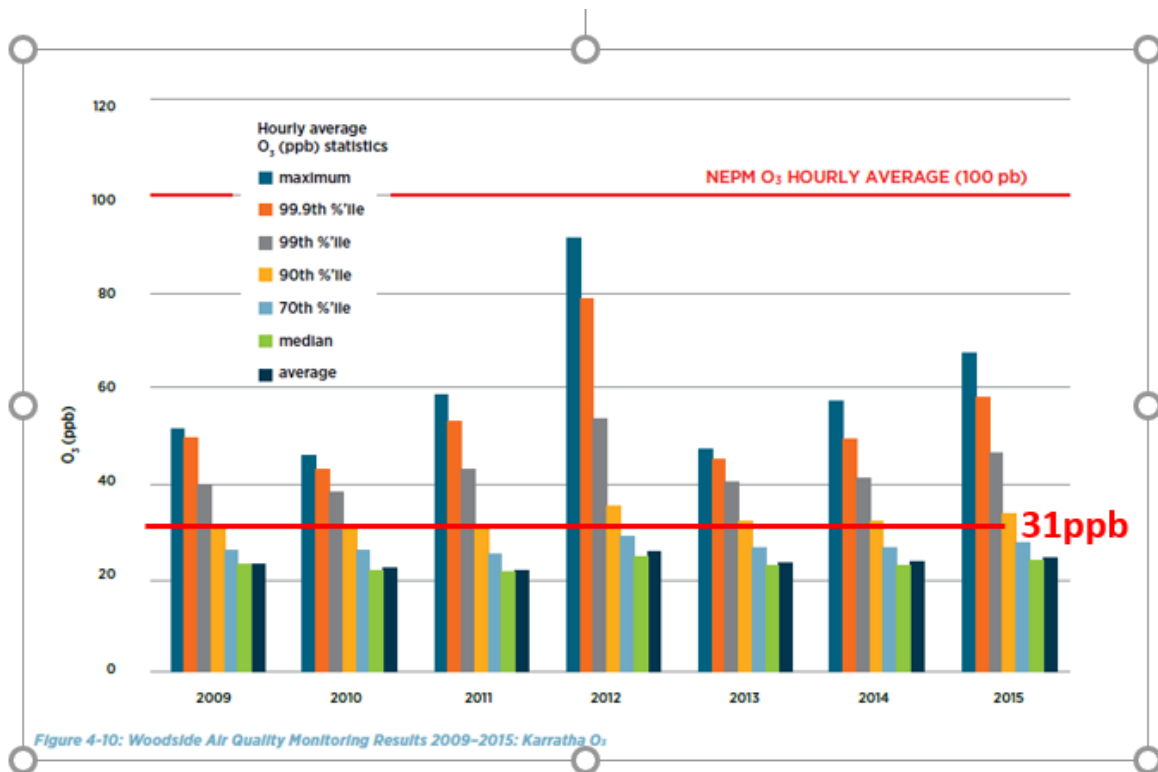
Ozone

- Ozone is formed in a complex process from nitrogen dioxide, volatile organic compounds and carbon monoxide released by the Woodside plant and ultraviolet light.
- Atmospheric ozone decreases lung function, increases asthma, respiratory infections, exacerbates other respiratory diseases and is associated with metabolic disorders such as diabetes (USEPA 2019).
- The United States Environmental Protection Agency (USEPA 2019) is currently reviewing evidence on the effects of ozone and related photochemical oxidants on human health. The report makes the following statements:

“Recent studies support and expand upon the strong body of evidence, which has been accumulating over the last few decades, that short-term ozone exposure causes respiratory effects. The strongest evidence comes from controlled human exposure studies demonstrating ozone-induced decreases in lung function and inflammation in healthy, exercising adults at concentrations as low as 60 ppb after 6.6 hours of exposure”. “In addition, epidemiologic studies continue to provide strong evidence that ozone is associated with respiratory effects, including asthma and COPD (Chronic Obstructive Pulmonary Disease) exacerbations, as well as hospital admissions and emergency department visits for respiratory diseases.” “Emerging evidence indicates that short- and long-term ozone exposure contributes to metabolic disease, including diabetes.” “Evidence from recent epidemiologic studies of short-term ozone exposure and hospital admission or emergency department visits observed associations at concentrations as low as 31 ppb”.

This report implies that the maximum limit for ozone is less than 30 ppb, which is well below the current Australian NEPM limit of 100 ppb.

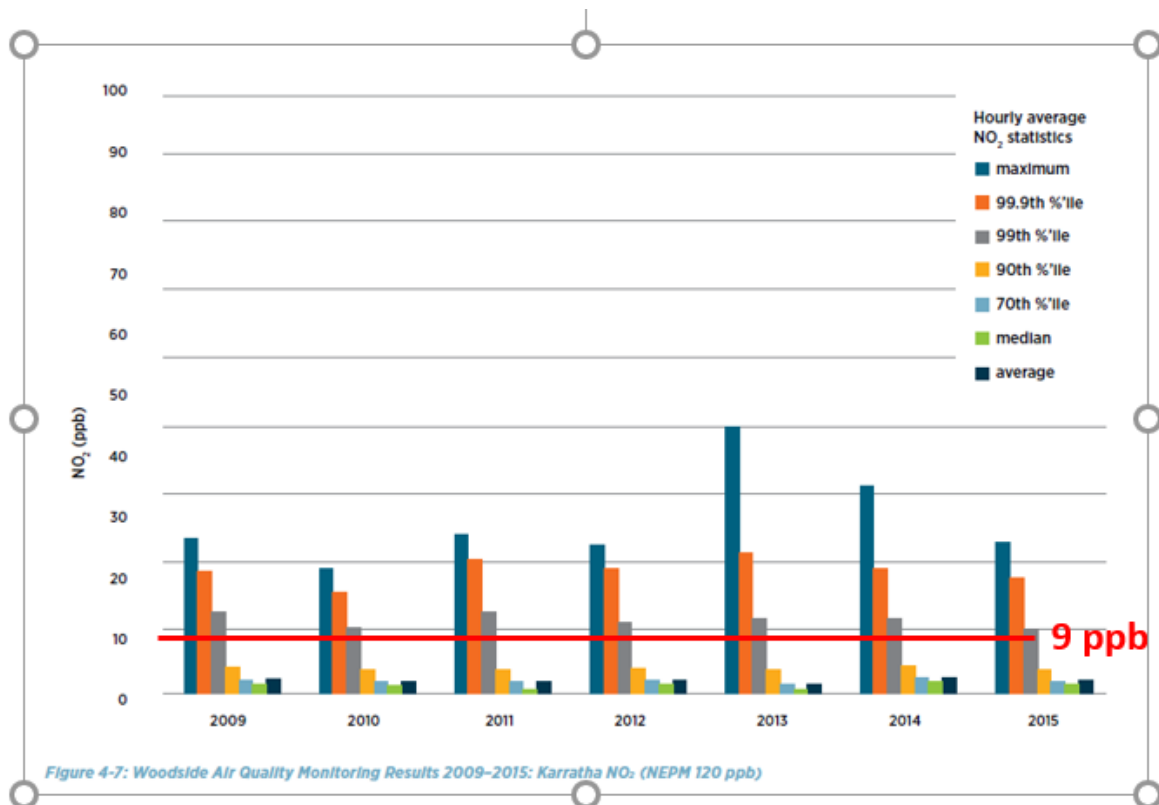
- Results presented in the Woodside Proposal (Figure 4-10) show that ozone concentrations at Karratha were exceeding or close to 30 ppb for 10 days in every 100 days. Similar results were presented for the township of Dampier.



- Revision of health impacts of ozone with a limit of 30 ppb suggest the concentrations measured on Murujuga, Karratha and Dampier are likely detrimental to the health of people in these regions and further controls should be placed on emission by Woodside of compounds responsible for its formation.

Nitrogen dioxide

- Nitrogen dioxide also causes respiratory diseases in humans, particularly asthma, impaired pulmonary function and cardiovascular disease (American Lung Association, 2020).
- The current NEPM limit for atmospheric nitrogen dioxide is 120 ppb, but is being reviewed.
- Doctors for the Environment in Australia (2019) now believe there is probably no safe level for exposure to nitrogen dioxide and the maximum value should be less than 9 ppb.
- Measurements presented by Woodside between 2009 and 2015 (Figures 4-7, 4-8, 4-9) show nitrogen dioxide concentration in Karratha exceed 9 ppb at least one day in 100 days (99th percentile) and for some years on Murujuga exceeded the concentrations on 10 days per 100 days.



- Observation of the Woodside plant shows a yellow cloud of nitrogen dioxide almost continuously hanging over the operation (see pictures below taken at different years, times and dates).



Nitrogen dioxide becomes visible as a yellow coloured gas cloud once the concentration reaches 0.47 ppm (470 ppb, 0.99 mg/m³) at a distance of one mile in Maga (1965). Thus, the nitrogen dioxide in the visible clouds photographed have a *minimum* concentration of 470 ppb and may be far greater. This minimum concentration for visualisation of nitrogen dioxide released by the Woodside operations is almost four-times greater than the Australian health standard NEPM guideline for safety of 120 ppb and 52 times greater than the recommended limit set by Doctors for the Environment in Australia.

- There must be extreme concerns for the health of outside workers at the Woodside plant, unless wearing effective protective gear, and to people close to the perimeter of the Woodside site.

Impact on the health of local people

Accepting the latest information on concentrations of ozone and nitrogen dioxide that impact human health, the modelling in Appendix E of the Woodside Proposal suggests health impact level from cumulative emissions in the Burrup Peninsula Karratha region would be **high** and the risk **highly likely** because average hourly concentrations of ozone and nitrogen dioxide around Karratha were modelled to be around 60 ppb and 20 ppb, respectively, which are approximately twice those concentrations now thought to be the upper limits of 30 ppb and 9 ppb, respectively.

Ratings listed in **Table 6-10: Air Quality (Health and Amenity) Impact Assessment Summary** needs to be changed to reflect the current known impacts of ozone and nitrogen dioxide on human health.

Impact	Receptor Sensitivity	Magnitude	Likelihood	Impact level
Gaseous emissions causing A reduction in ambient air quality impacting human health	Medium High¹	No lasting effect long-term effect	Unlikely Certain	Risk rating - Low Risk rating – Highly likely

¹Revised ratings if more likely upper concentration limits Of 30 ppb for ozone and 9 ppb for nitrogen dioxide are used.

- The high concentrations of ozone and nitrogen dioxide over Murujuga, Dampier and Karratha suggest it may be related to the local anecdotally named ‘Karratha respiratory syndrome’.

Results from the Pilbara Health Profile Planning and Evaluation Unit report in November shows that these respiratory issues are not anecdotal (Anderson *et al.* 2018). From 2011 to 2015 there were significantly higher potential preventable hospitalisations for respiratory causes in children aged 0-14 years of age in the towns of Karratha, Port Headland and Newman than for the average of Western Australia. Hospitalisation for chronic asthma in the Pilbara was 1.7 times greater than the state average, while hospitalisation for bronchiectasis, which is damage and widening of the airways, was 11.5 times greater than the state average. Damaged airways increase susceptibility to other respiratory diseases and is likely associated with hospitalisations of children with pneumonia and influenza being 2 times greater than the state average.

Pilbara leading Potentially Preventable Hospitalisations (PPH) in children aged 0-14 years (2011-2015). From Pilbara Health Profile Planning and Evaluation Unit report, November 2018 (Anderson *et al.* 2018).

PPH Condition	Number of PPH	% all child PPH	SRR
ENT infections (acute)	473	26%	1.4
dental conditions (acute)	451	25%	1.0
cellulitis (acute)	216	12%	2.7
asthma (chronic)	180	10%	1.7
convulsions and epilepsy (acute)	132	7%	1.1
urinary tract infections, including pyelonephritis (acute)	106	6%	1.0
pneumonia and influenza (vaccine)	55	3%	2.0
bronchiectasis (chronic)	46	3%	11.5
diabetes complications (chronic)	21	1%	0.8
gangrene (acute)	20	1%	5.7
All Potentially Preventable Hospitalisations (PPH) (0-14 years)	1,813	100%	1.4

Note: The standardised rate ratio (SRR) is the ratio between a particular health region (or district) and the State. A ratio of 1 means the regional rate is the same as the State, a value of 2 indicates the regional rate is twice that of the State, and an SRR of 0.5 indicates the rate in a region is half that of the State population.

- These results suggest that emissions on Burrup Peninsula are already affecting the health of young people in the region.
- Surely, the Government is not prepared to put the public and workers on Murujuga and in the towns of Karratha and Dampier at such risk and set itself up for public litigation?
- This threat to human health provides another reason for ensuring any licence approved for the Woodside proposal has virtually zero emissions of chemicals causing ozone formation and of nitrogen dioxide.

Greenhouse gas emissions

- Atmospheric carbon dioxide concentration has increased from around 280 ppm pre-world-industrialisation to 414 ppm on 4 February 2020 (CO₂-earth, 2020). Atmospheric carbon dioxide is continuing to rise at a steady rate with an increase of 3.38 ppm between December 2018 and December 2018. The adverse effects of climate change caused by the increase in temperature and acidity of the sea due to increasing atmospheric carbon dioxide is clearly evident in this year's Australian bushfire season, the rapid melting of polar icecaps, changes in major ocean currents, sea level rise and even thinning of pearls grown in Western Australia.
- Continuing greenhouse gas emissions and temperature rise will be a disaster for Australia and the world.
- Woodside is a significant contributor to Australia's greenhouse gas production, with 7.7 mt/year from scope 1-2 emissions and 80.2 mt/year in scope 3 emissions.
- Under current Federal Government regulations Woodside has a baseline emission rate of 7.57 CO₂-e mt/year. Additional greenhouse gas emissions above the baseline must be

offset. This allowable baseline is now not compatible with the urgency of reducing world atmospheric CO₂ concentrations.

- The world is close to the ‘tipping point’, when the arctic tundra’s melt and release entrapped methane, which is 25 times more potent as a greenhouse gas. Humanity is in serious threat of global catastrophe through large sea level rise, droughts, failed crops, fires and cyclones. Currently, Woodside is reported to offset only 12% of its emissions. For the sake of humankind, this project should not be approved at all, but if it is there must be full offset of emissions through Woodside investment in renewable energy source, reforestation and other effective methods. Woodside’s net greenhouse gas emissions must be zero for the sake of humanity.
- Woodside’s claim on p29 that natural gas is important for the transfer from coal is outdated. The whole of the Australian Capital Territory already gets 100% of its electricity from renewable solar and wind. Gas is being disconnected in the city and all public and city government vehicles are being converted to electric. Incentives are being provided for residents to move to electric cars. Current estimates are that South Australia will have 100% renewable power before 2030 and SA during the two latest recorded annual quarters in 2019 had the cheapest electricity in Australia. An interconnector has just been approved between South Australia and New South Wales where solar power units can dominate and share power loads with variations in wind and sun strengths. Gas powered electricity simply cannot compete with renewables on price. The building of internal combustion cars will be banned from 2025 in the United Kingdom.

Dishonesty in Proposal documentation

- The Woodside Proposal contains many overstatements of benefits, understatements of risks, has convenient omissions and some untruths. I am reminded of the tactics used by the tobacco industry in its campaign to downplay the impact of tobacco smoke on public health (Saloojee and Dagli 2000). The document casts doubt on current scientific evidence, presents erroneous conclusions about Woodsides own data and continually seeks more research to further delay action. Several examples are given.
- Claimed reduction that has already occurred in NO_x emissions.

The proposal states on p27: *Key improvements in design, processes, and technology have been incorporated in the NWS Project facilities as the opportunity has arisen; these include but have not been limited to:*

+ *Installation of more efficient gas turbines, dry low NOX burners,*

These improvements have resulted in overall improvements in emissions, in particular, NO_x emissions to air, as shown in Figure 2-3

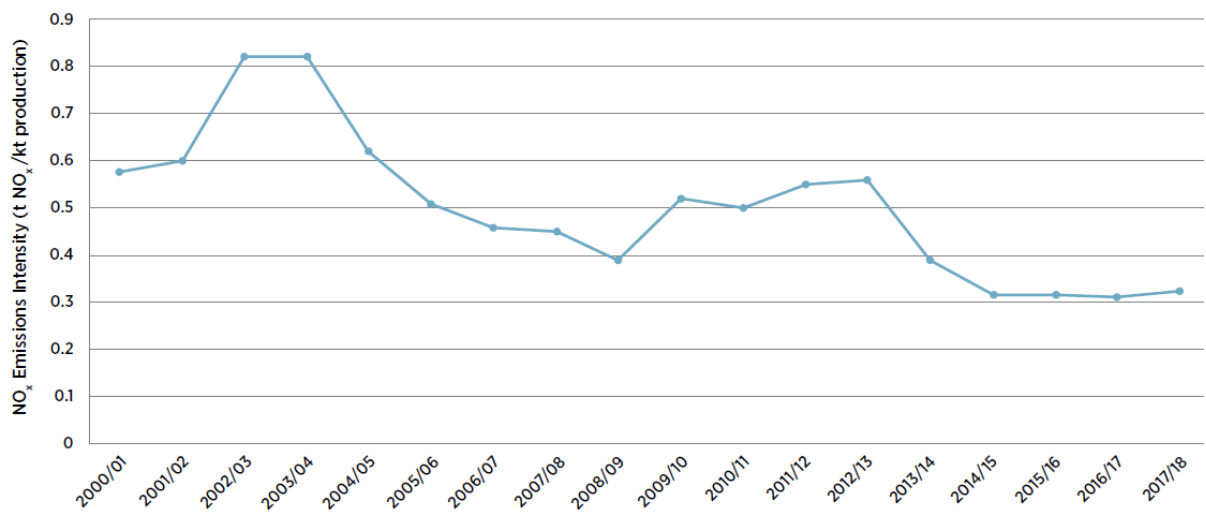


Figure 2-3: NO_x Emissions Intensity 2000-2017

This statement appears to be untrue. The same graph is presented in Karratha Gas Plant Annual Environmental Report – July 2018 To June 2019, where it states that the reduction in NO_x emissions was due simply to a change in the method of calculation and not due to additional gas scrubber technology as implied in the Proposal. The extract from the Annual Environmental Report follows:

Karratha Gas Plant Annual Environmental Report - July 2018 To June 2019

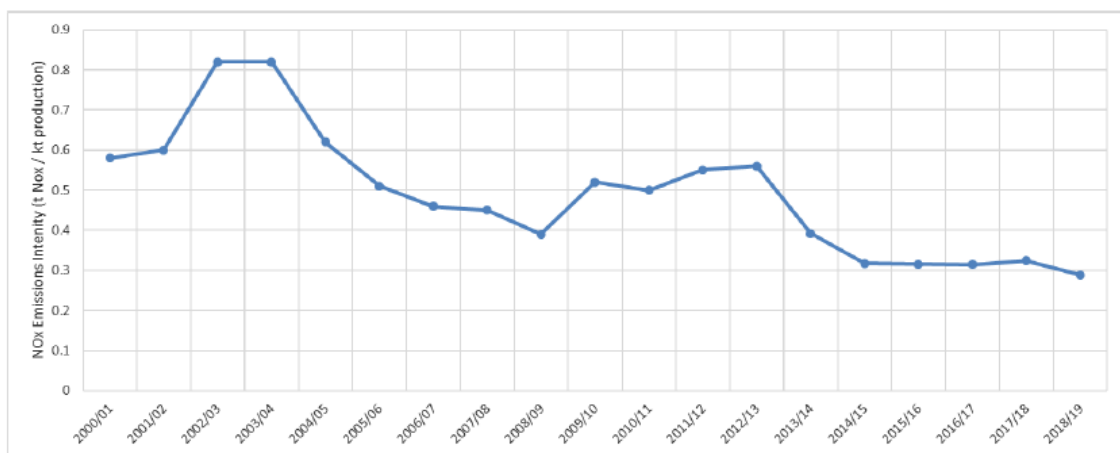


Figure 4-1: Annual NO_x emissions intensity

Figure 4-1 shows a reduction in NO_x from the 2013/14 period, which is due to improvements in the accuracy of the NO_x calculation methodology. Prior to 2014, the method had used a National Pollutant Inventory emissions estimation technique based on fuel gas consumption at the plant. The KGP now calculates NO_x based on quarterly stack testing results and engineering calculations. If the new method was applied retrospectively, the data points prior to the 2013/2014 period in Figure 4-1 would decrease by approximately 40%.

- Claims about black smoke events appear to omit important information.

Figure 2-4 ‘Regulatory Reportable Black Smoke Events’ shows no events in 2018. However, the Woodside flare emitted black smoke for at least 5 days continuously during and after the World Heritage Summit in Karratha on 6 August 2018. The picture below was taken on 2 August 2018

and conference participants who stayed over the weekend commented about the continuous plume of black smoke going for such a long time.



- Another example of selective presentation within the proposal documentation relates to Tables 5-1 and 5-2 in relation to discussions with stakeholders. Table 5-1 specifically identifies Friends of Australian Rock Art as being consulted. However, details of the meeting on 31 July 2019 between Woodside and FARA are not included in Table 5-2, which sets out date of consultation, issues raised, and the proponent response/outcome. At this meeting Woodside refused to provide FARA with the report containing results of measurements required under Ministerial Statement 757 or to discuss in detail the impacts of their emissions on the rock art. Were the outcomes of this meeting inconsistent with the glowing picture Woodside is presenting?
- There is a major inconsistency on Page 106.

Table 6-9 provides information on Existing and Proposed mitigation measures. In the Table, 'Existing measures' state *Condensate tanks installed with sealed rims to avoid loss of VOCs to atmosphere*. While 'Proposed additional measures' claim *substantially reduce VOC emissions by 31 December 2030*. English Dictionary definitions of 'avoid' include to 'prevent' or to 'stop'. What was the meaning in the Proposal?

- The Woodside Proposal states on p122; *No published peer reviewed studies identified measurable or observable changes to the condition and integrity of rock art as a result of industrial emissions*. This statement is incorrect because the peer reviewed paper by MacLeod (2005) shows clearly an increase since industrialisation of Murujuga of rock surface acidity and dissolution of manganese and iron ions from the rock surface.

Recommendations

- For the sake of the future of the world, humanity and all living organisms, this project should not be approved. The consequences from continued global warming is too profound to allow it to proceed.
- If, however, the Proposal does proceed, then extraordinarily strict limits must be placed on emissions to the air. Emissions of volatile organic compounds, nitrogen dioxide and sulphur dioxide must have limits close to zero. The technology is currently available for Woodside to

substantially reduce emissions of nitrogen dioxide and volatile organic compounds from its numerous stacks and gaseous outlets.

Yara International state they have technologies that can reduce sulphur dioxide emissions from ships to 0 ppm, and using Selective Catalytic Reduction (SCR) systems, can reduce nitrogen oxides by 98% on any industrial plant. Placing several of the SCR systems in series within a venting outlet would result in zero emissions.

- There should be a strict timetable for these emissions controls to be put in place.
- Currently, emissions monitoring measurements by Woodside are not available to the public and are presented in retrospect as average annual hourly averages in annual reports to government. Given the extremely high emissions of nitrogen dioxide and that an impact on human health can occur through an exposure time as low as 10 minutes (Adelaide Exposure Science and Health 2018) atmospheric emissions measurements must be made available to the public in real time.
- The seriousness of continuing emissions at the current rate by Woodside for human health, the unique petroglyphs and the world climatic environment means there must be substantial financial penalties for breaches of licence conditions by Woodside. These penalties must be a large and substantial deterrent for the company representing at least 10% of their annual profit and jail terms for managers that are repeat offenders.
- Australian Governments appear to be weak on ensuring compliance with licences and prosecuting for breaches. For example, in the 2016 Financial Year, 462 Commonwealth EPBC Act projects were monitored and 96 were found to be non-compliant (Commonwealth EPBC report). However, no company was prosecuted. Instead, the Department '*relied on administrative measures such as variations to conditions of approval, revisions to management plans, conservation agreements and warnings.*' Such a conciliatory approach to non-compliance will not ensure the health of citizen in the region, preservation of the petroglyphs or containment of climate change.

References

- Adelaide University, Adelaide Exposure Science and Health – evaluation of risks from nitrogen dioxide emissions from the Yara Pilbara Nitrates ammonium nitrate plant. <https://www.fara.com.au/burrup-peninsula-rock-art-local-health-concerns/>
- Anderson, C., Bineham, N., Lockwood, T., Mukhtar, A. and Waenerberg, N. 2018. Pilbara Health Profile; Government of Western Australia, WA Country Health Service. Planning and Evaluation Unit. Available from: http://www.wacountry.health.wa.gov.au/fileadmin/sections/publications/Publications_by_topic_typed/Reports_and_Profiles/Pilbara_Health_Profile_2018.pdf
- Appelo, C.A.J. and Postma, D. 2005. *Geochemistry, groundwater and pollution*. 2nd Edition. CRC Press, Florida, USA.
- Bednarik, R.G. 2009. Experimental colorimetric analysis of petroglyphs. *Rock Art Research* 26:55–64.
- Black, J.L., Hoerlé, S. and Watkins, R. 2018. Current Assessment of the Impact of Pollution on Murujuga Rock Art. <https://www.fara.com.au/current-assessment-of-the-impact-of-pollution-on-murujuga-rock-art/>
- Black, J.L., MacLeod, I.D. and Smith, B.W. 2017. Theoretical effects of industrial emissions on colour change at rock art sites on Burrup Peninsula, Western Australia. *Journal of Archaeological Science: Reports* 12, 457-462.
- CO₂-earth 2020. <https://www.co2.earth/daily-co2>
- Doctors for the Environment in Australia (2019) radio interview. <https://www.abc.net.au/radionational/programs/lifematters/how-clean-is-the-air-you-breathe/11400612>

- Donaldson, M. 2009. *Burrup rock art: Aboriginal rock art of Burrup Peninsula and Dampier Archipelago, Western Australia*. Perth: Wildrocks Publications.
- Dragovich, D. 1986. Weathering of desert varnish by lichens. In: *Readings in Australian geography: proceedings of the 21st Institute of Australian Geographers' Conference, Perth, 10-18 May 1986*, Edited by Arthur Conacher. Published by Institute of Australian Geographers (WA Branch) and Dept. of Geography, University of W.A Perth [W.A.]
- Duffy, N., Ramanaidou, E., Alexander, D. and Lau, D. 2017. *Burrup Peninsula Aboriginal petroglyphs: colour change and spectral mineralogy*. CSIRO, Australia: EP161761, June 2017.
- MacLeod, I. D. 2005. Effects of moisture, micronutrient supplies and microbiological activity on the surface pH of rocks in the Burrup Peninsula. In *14th Triennial Meeting, The Hague, 12-16 September 2005*: Preprints (ICOM Committee for Conservation), Isabelle Verger, ed. pp. 385-393, Earthscan Ltd.
- Maga, J.A. 1965. Considerations in Setting Standards for Oxides of Nitrogen. *Journal of the Air Pollution Control Association* **15:12**, 561-564, DOI:10.1080/00022470.1965.10468423.
- Mihajlovski, A., Gabarre, A., Seyer, D., Boust, F. and Di Martino, P. 2017. Bacterial diversity on rock surface of the ruined part of a French historic monument: The Chaalis abbey. *International Biodeterioration and Biodegeneration* **120**, 161-169.
- Mulvaney, K. 2015. *Murujuga Marni: rock art of the macropod hunters and mollusc harvesters*. UWA Press, Perth.
- Pillans, B. and Fifield, L. K. 2013. Erosion rates and weathering history of rock surfaces associated with Aboriginal rock art engravings (petroglyphs) on Burrup Peninsula, Western Australia, from cosmogenic nuclide measurements. *Quaternary Science Reviews* 69: 98–106.
- Saloojee, Y. and Dagli, E. 2000. Tobacco industry tactics for resisting public policy on health. *Bulletin of the World Health Organisation* **78**, 902-910.
- USEPA 2019. United States Environmental Protection Agency. Integrated Science Assessment for ozone and related photochemical oxidants. Draft September 2019. United States Environmental Protection Agency. <https://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=344670>