

Gorgon Gas Development Revised and Expanded Proposal: Barrow Island Nature Reserve

Chevron Australia Pty Ltd

**Report and recommendations
of the Environmental Protection Authority**

**Environmental Protection Authority
Perth, Western Australia
Report 1323
April 2009**

Environmental Impact Assessment Process Timelines

Date	Progress stages	Time (weeks)
17/03/08	Level of Assessment set (following any appeals upheld)	-
15/09/08	Proponent Document Released for Public Comment	26
10/11/08	Public Comment Period Closed	8
11/03/09	Final Proponent response to the issues raised	18
28/04/09	EPA report to the Minister for Environment	7

Released: 30/4/09
Appeals Close: 14/5/09

ISSN 1836-0483 (Print)
ISSN 1836-0491 (Online)

Assessment No. 1727

Summary and recommendations

This report provides the Environmental Protection Authority's (EPA's) advice and recommendations to the Minister for Environment on the proposal to revise and expand the Gorgon liquefied natural gas (LNG) development, on the Barrow Island nature reserve, by Chevron Australia and its joint venture partners Shell Development Australia and Mobil Resources Company.

Section 44 of the *Environmental Protection Act 1986* (EP Act) requires the EPA to report to the Minister for Environment on the outcome of its assessment of a proposal. The report must set out:

- The key environmental factors identified in the course of the assessment; and
- The EPA's recommendations as to whether or not the proposal may be implemented, and, if the EPA recommends that implementation be allowed, the conditions and procedures to which implementation should be subject.

The EPA may include in the report any other advice and recommendations as it sees fit.

The EPA is also required to have regard for the principles set out in section 4A of the *Environmental Protection Act 1986*.

Key environmental factors and principles

The EPA decided that the following key environmental factors relevant to the proposal required detailed evaluation in the report:

- (a) Marine turtles;
- (b) Dredging, marine blasting and marine infrastructure;
- (c) Introduced non-indigenous organisms;
- (d) Subterranean fauna / short range endemics;
- (e) Greenhouse gases;
- (f) Air quality; and
- (g) Noise.

There were a number of other factors which were relevant to the proposal, but the EPA is of the view that these are unlikely to have changed in a way that would alter the environmental outcomes from those determined during the assessment of the approved project reported in EPA Bulletin 1221 (EPA, 2006).

The following principles were considered by the EPA in relation to the proposal:

- (a) The principle of conservation of biological diversity and ecological integrity;
- (b) The precautionary principle; and
- (c) The principle of intergenerational equity.

Conclusions

The EPA has considered the proposal by Chevron Australia Pty Ltd and its joint venture partners Shell Development Australia and Mobil Resources Company to revise and expand the Gorgon LNG development on the Barrow Island nature reserve.

The EPA notes that it previously advised that due to the very high environmental and unique conservation values of Barrow Island it held the view that, as a matter of principle, industry should not be located on a nature reserve and specifically not on Barrow Island (EPA, 2003). The EPA also notes that it recommended against the original Gorgon proposal for two LNG processing trains and associated infrastructure on Barrow Island (EPA, 2006). The EPA reiterates as a matter of principle, its original view that any development on Barrow Island A class nature reserve should not be implemented, particularly given the very high and unique conservation and environmental values of the island.

The EPA recognises that an LNG processing and export project has been granted environmental approval on Barrow Island, following an appeals process, undertakings by the proponent to provide a number of offsets and the imposition of environmental conditions by the then Minister for the Environment. These existing conditions require the production of environmental management plans by the proponent, the provision of specialist advice on quarantine, dredging and marine turtles by Expert Panels and endorsement of those plans by the Minister or her delegate.

It is therefore important to note that the EPA has not undertaken a re-assessment of the original proposal in its current assessment of the revised and expanded proposal.

The EPA has assessed the current revised and expanded proposal mindful that the proponent expressed a view that essentially the same undertakings and conditions should apply to the new proposal as currently apply to the approved project and that no further conditions or offsets are warranted.

The EPA's assessment of the revised and expanded proposal has lead it to a different view. The EPA considers that there is an increased likelihood of additional impacts and risks, beyond those assessed as likely from the approved project. Furthermore, based on current knowledge there remain varying levels of uncertainty around those additional impacts and risks and the degree to which they may be manageable under the conditions and other undertakings required for the approved project.

The EPA particularly notes the increased likelihood of additional impacts to high value environmental assets, especially marine turtles and the high value coral-dominated habitat of the Lowendal Shelf, associated with the proposed 50% increase in LNG production and revisions to marine infrastructure.

The impacts of the revised and expanded proposal on the long-term viability of the Town Point flatback turtle rookery is of increased concern to the EPA, since this is one of the most significant rookeries in Western Australia

The proponent has stated that:

“It is considered that the impacts and risks of the Revised Proposal can be effectively managed under conditions the same or consistent with those already set by the Western Australian Minister for the Environment in Statement No. 748. No additional measures or controls are anticipated to be necessary to manage the potential marine fauna impacts associated with the revised proposal.” (Chevron, 2008 -p.160).

Following a detailed and considered review of all the latest available information on the potential impacts of the revised and expanded proposal on flatback turtles, the EPA expresses its fundamental disagreement with this unsubstantiated assertion.

Put simply, the proposal *as presented* does not provide a reasonable prospect for the long term viability of this valuable turtle rookery.

Having reached this conclusion, the EPA also considered whether there are any means by which the increased level of risks to this significant flatback turtle rookery might be reduced to an acceptable level, and with an acceptable degree of certainty that its long-term viability can be assured.

The EPA has concluded that the primary method of achieving its objective for this factor would be by way of a condition having the objective of the achievement of an *unaltered light horizon* (compared with the current natural conditions) from the perspectives of both gravid female flatback turtles and hatchlings. This condition should apply to those beaches and waters adjacent to Town Point that are used for nesting and by resultant hatchlings in their initial journey to the ocean.

The precise geographical extent to which this condition should apply, and the precise manner in which this objective would be achieved, should be developed by the Expert Panel, and advised to the Minister for Environment by the Panel itself, prior to the Minister’s implementation decision on the final set of conditions that may be applicable to the proposal.

It is the EPA’s view that, as a minimum, to meet this condition would require:

- the relocation of flares to an appropriate inland location (to be determined by the Expert Panel);
- opaque shrouding of plant lighting;
- opaque shrouding of all major lighting on the MOF facility and jetty;
- maximum possible shrouding and light source reduction on ships (including dredging vessels).

This would need to be complemented by advice from the Marine Turtle Expert Panel on the management of other significant risks to turtles (eg. noise, blasting, vibration).

The EPA also regards the increased potential impacts of dredging and marine infrastructure construction on the high value coral dominated habitat of the Lowendal Shelf as an important issue. Noting that modelling now shows that the moderate zone of impact has moved from about 1000m away from the Lowendal Shelf to within about 350m of it, the EPA considers that the conditions now in place for the approved

project would not for the revised and expanded proposal meet the EPA's objectives for protection of this important environmental asset.

The EPA considers that management of dredging and marine infrastructure construction could meet the EPA's objective if a condition is imposed that requires that these activities be required to use and be managed according to real time monitoring and modelling against sub-lethal trigger levels with corrective action (including the cessation of dredging when required to protect environmental values) as set out in conditions and following advice to the Minister for Environment by the Construction Dredging Environmental Expert Panel.

The EPA considers that the current proposal could only meet the EPA's environmental objectives if, and only if, stringent conditions were applied to it.

The EPA notes that the Minister for Environment makes the decision as to whether or not a proposal may be implemented and, if so, under what conditions. Should a decision be made that the revised and expanded Gorgon proposal may be implemented, the EPA makes the following recommendations:

1. The EPA's assessment and recommendations be expressly brought to the attention of the Expert Panels on Marine Turtles, Dredging and Quarantine and that, as per existing condition requirements, prior to the Minister making a decision on implementation, she seeks the advice of the Expert Panels on how best to achieve the EPA's objectives and implement its recommendations.
2. The long duration and high value environment associated with this proposal requires that implementation is executed with the utmost diligence and absolute vigilance. To this end, the EPA strongly recommends that the implementation and effectiveness of Ministerial conditions be subject to regular, five yearly strategic review by the Minister with advice from the EPA and the Expert Panels.
3. The Expert Panels should be requested to provide specific advice on how measurable and auditable outcomes have been incorporated into environmental management plans for the proposal to the maximum extent possible.
4. The Expert Panels should be requested to provide specific advice, consistent with EPA Guidance Statement No. 19 (EPA, 2008) on the matter of possible additional offsets for additional residual impacts to high value environmental assets that cannot otherwise be managed.
5. The Chairs of each Expert Panel to ensure the existence and retention of subject specialist panel members that are technically independent of proponent influence.

By way of 'Other Advice', the EPA further advises that:

1. Gas from the Gorgon field is high in carbon dioxide. A fundamental justification by the proponent for using Barrow Island was the need for access

to a suitable aquifer beneath the island for long term carbon dioxide storage. The EPA also notes that sequestration of carbon dioxide was a Government requirement for access to Barrow Island for the Gorgon project and that this requirement is contained in binding conditions applied to the approved Gorgon project. If injection and long term storage of carbon dioxide produced with gas that is processed at the Gorgon plant is not achieved (for whatever reason, including the introduction of carbon markets) then the decision to permit gas processing on Barrow Island nature reserve should be reconsidered.

2. It is highly desirable that given the scale of the proposal, its longevity and the significant environmental values at risk, the Chairs of the Expert Panels meet on a regular basis with the EPA to review performance and address strategic matters.
3. If a decision is made that the revised and expanded proposal may be implemented, creation of conditions to manage the proposal would be undertaken by the Office of the Appeals Convenor. While there will be expectations from both the community and the proponent that the intent of the existing conditions would be honoured, due to the increased level of risk resulting from the revised and expanded proposal some modifications to those conditions would be required to ensure these risks are properly managed. There are also some aspects of the existing conditions that could benefit from review and clarification by the Expert Panels to ensure that they, as far as possible, contain measurable outcomes and are auditable. Should this occur, it would be desirable for there to be one Ministerial Statement dealing with the totality of the Gorgon project.

Recommendations

The EPA submits the following recommendations to the Minister for Environment:

1. That the Minister considers the report on the key environmental factors of:
 - a. Marine turtles;
 - b. Dredging, marine blasting and marine infrastructure;
 - c. Introduced non-indigenous organisms;
 - d. Subterranean fauna;
 - e. Greenhouse gases;
 - f. Air quality; and
 - g. Noise;

and the environmental principles of:

- a. Conservation of biological diversity and ecological integrity;
- b. The precautionary principle; and
- c. The principle of intergenerational equity; as set out in Section 3;

2. That the Minister notes that having assessed newly identified and additional risks (including light, dredging and blasting) the proposal could meet the EPA's objectives subject to the inclusion of stringent Ministerial Conditions;
3. That should the EPA's recommended conditions not be applied to the proposal, the Minister remit the proposal back to the EPA for fresh advice;
4. Notes that the EPA has included in this Report advice on conditions to which the proposal should be subject, should the Minister decide that the proposal may be implemented; and
5. That the Minister notes the EPA's other advice presented in Section 4, including that in relation to access to Barrow Island remaining linked to carbon dioxide sequestration, improving the management of dredging, the Chairs of the Expert Panels meeting regularly with the EPA and the recommendation in respect of the Expert Panels reviewing the existing conditions to ensure, as far as possible, they contain measurable outcomes within one Ministerial Statement dealing with the totality of the Gorgon project.

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1. Introduction and background

This report provides the advice and recommendations of the Environmental Protection Authority (EPA) to the Minister for Environment on the key environmental factors and principles for the proposal by Chevron Australia and its joint venture partners Shell Development Australia and Mobil Resources Company to revise the Gorgon development on the Barrow Island nature reserve and expand liquefied natural gas production from 10 million tonnes per annum (MTPA) to 15 MTPA by the addition of a third gas processing train.

Significant revisions to the layout, size and orientation of a number of marine components and the way marine infrastructure is constructed have been proposed, which result in potentially important changes to the environmental impacts arising from the new proposal. The revised and expanded proposal also includes a 24% increase in the rate of carbon dioxide injection into the ground and changes to some terrestrial elements of the project.

The EPA is assessing the revised and expanded proposal that is now before it, as set out in Table 1 below, which has been reproduced from Table 2.2 in the proponent's response to submissions (Chevron, 2009). That is, the EPA is assessing only the revisions to, and expansions of, the previously approved project.

It is important to note that the EPA has not undertaken a re-assessment of the original proposal in its current assessment of the revised and expanded proposal. The EPA is aware that some submitters considered that the EPA should assess the fundamental decision to site the Gorgon project on Barrow Island. The EPA has not, however, done this, as explained above.

The EPA notes that there have been press reports that the Gorgon project on Barrow Island may eventually expand to five LNG processing trains. This EPA report documents the assessment of the proposal to revise and expand the approved project (two LNG trains) to incorporate a third LNG train (among other changes). Any proposal to increase the number of trains further would require referral to the EPA for a decision on any additional environmental impact assessment.

Barrow Island has been a class A nature reserve since 1910. It supports at least 24 terrestrial taxa that occur nowhere else in the world. It provides a refuge for mammals that are rare or extinct elsewhere. Barrow Island provides an example of what the fauna of the Pilbara was like before changes in land management practices and the introduction of non-indigenous predators and competitors severely altered similar ecosystems on the mainland. The waters surrounding Barrow Island also have significant conservation values, with all but the port limits comprising a marine management area, including a marine park. Oil production has occurred on Barrow Island since the 1960s and continues today.

The EPA emphasises that it continues to hold the view expressed in 2003 in its report entitled "*Environmental Advice on the Principle of Locating a Gas Processing Complex on Barrow Island Nature Reserve*" (EPA, 2003) and reiterated in 2006 in its

assessment of the original Gorgon proposal (EPA, 2006). The EPA's view of 2003 opposing the location of industry on a class A nature reserve remains unchanged:

“Given the very high environmental and unique conservation values of Barrow Island, which are reflected in its status as a class A Nature Reserve, it is the view of the EPA that, as a matter of principle, industry should not be located on a nature reserve and specifically not on Barrow Island.”

A decision was subsequently made to allow the project to proceed and a statement was issued by the then Minister for the Environment in September 2007 which enabled the implementation of a two train, 10 MTPA liquefied natural gas production and export project on Barrow Island nature reserve by Chevron and its joint venture partners. Construction of that project has not yet commenced and no experience has been gained about the effectiveness or otherwise of conditions applied to it. Throughout this report the previously approved development is referred to as the approved project or 'the project'. The current proposal is referred to as the revised and expanded proposal or 'the proposal'.

The revised and expanded proposal is being formally assessed at the level of a Public Environmental Review (PER) because it contains significant revisions to the marine infrastructure and the expansion represents a 50% increase in the production rate of liquefied natural gas and a 24% increase in the injection rate of carbon dioxide over the approved project previously assessed on Barrow Island nature reserve. The EPA's assessment, documented in this report, has focused particularly on environmental effects of the revised and expanded proposal that are additional to or different from those anticipated in the assessment of the approved project.

The EPA notes that a proposal to duplicate the feed gas line to the approved Gorgon project was assessed as environmentally acceptable by the EPA in 2007 (EPA, 2007) and approved by the then Minister for the Environment on 30 May 2008. It is important to note that the current assessment differs materially from the 2007 assessment because that proposal resulted in the duplication of a gas delivery line within the footprint already approved for disturbance as part of the original Gorgon project. The revised and expanded proposal involves additional impacts and risks, in part because the proposal extends beyond the previously approved footprint.

Further details of the proposal are presented in Section 2 of this report. Section 3 discusses the key environmental factors and principles for the proposal and Section 4 provides Other Advice by the EPA.

Appendix 4 contains a summary of submissions and the proponent's response to them. It is included as a matter of information only and does not form part of the EPA's report and recommendations. Issues arising from this process, and which have been taken into account by the EPA, appear in the report itself.

2. The proposal

The revised and expanded proposal comprises changes to the approved project.

2.1 The revised and expanded proposal

The main differences of the revised and expanded proposal from the approved project are:

- revision of the marine facilities by extending the combined length of the causeway and marine offloading facility from 1320m to 2120m and reducing the jetty length from 2.7km to 2.1km;
- addition of a 5MTPA LNG train, increasing the number of LNG trains from two to three (50% increase);
- changes to the reservoir carbon dioxide injection system to allow an increase in injection rate from approximately 2.72MTPA to 3.36MTPA (24% increase) by increasing the number of injection wells from seven wells drilled from two or three drill centre locations to eight or nine wells drilled from three or four drill centres; and
- increased annual rate of emissions of carbon dioxide equivalent greenhouse gases from 4.00MTPA to 5.45MTPA (36% increase).

The EPA also notes some further changes documented in the PER for the revised and expanded proposal namely;

- changes to the method of dredging to include a two stage spoil removal process rather than a one stage process;
- increasing the depth and amount of earthworks cut from the plant site; and
- changes to plant perimeter lighting to eliminate the use of lights on elevated poles.

Additional changes listed in the proponent's response to submissions (Chevron, 2009) are noted in section 2.2 below.

It is expected that the revised and expanded proposal would require an extra three to six months of construction beyond what was required for the approved project.

The EPA notes that the approved project is subject to a number of conditions attached to it by the then Minister for the Environment. The EPA understands that Chevron proposes that the revised and expanded proposal can be managed effectively under conditions the same or consistent with those set for the approved project and that no additional measures or controls are anticipated to be necessary.

The main characteristics of the proposal, with the changes highlighted, are summarised in Table 1 below. A description of the proposal and various views of the proposed layout are provided in Section 2 of the PER (Chevron, 2008) and updated in the proponent's response to submissions dated 3 February, 2009 (Appendix 4).

It is important to note that the current proposal involves important revisions to the approved project, including additions and deletions from the previously approved marine infrastructure that would influence the nature of impacts to the marine environment. Figure 1 illustrates changes to the predicted extent of zones of impact as a result of new modelling of the revised approaches to dredging and marine construction.

Table 1. Gorgon gas development revised and expanded proposal – description based on Response to Submissions (Chevron, 2009)

Aspect	Element	Description of Approved Two Train Project Elements	Description of Revised and Expanded Proposal Elements (PER)
<i>Terrestrial Infrastructure</i>			
Gas Treatment Plant	Location	Town Point	No change
	Number of LNG trains	2	3
	Size of LNG trains	5 MTPA nominal	No change
	Gas Processing Drivers	4 x 80 MW dry low NO _x (DLN) gas turbines	6 x approximately (nominal) 80 MW dry low NO _x (DLN) gas turbines
	Power Generation	4 x 116 MW conventional gas turbines without DLN burners	5 x approximately (nominal) 116 MW conventional gas turbines with DLN burners
	Condensate Production Rate	2000 m ³ /day	Approximately 3600 m ³ /day
	LNG Tank Size	2 x 165 000 m ³ (net)	2 x 180 000 m ³ (net)
	Flare design	Ground flare for main plant flare Elevated flare in storage and loading area (rarely used)	No change
	Domestic gas production rate	300 TJ/day	No change
	Condensate Tank Size	2 x 60 000 m ³	4 x 35 000m ³ (net) (Note: Change in tank size will not change land take requirement)
	Volume of earthworks	Details not specified in Statement No. 748 [approximately 3 million m ³]	Up to approximately 6 million m ³

Aspect	Element	Description of Approved Two Train Project Elements	Description of Revised and Expanded Proposal Elements (PER)
<i>Associated Terrestrial Infrastructure</i>			
	Materials offloading prior to MOF access	Upgrade existing WAPET landing. As specified in Attachment 1 to Statement 748 – approval under Section 45 C of the <i>EP Act 1986</i> for Change to Proposal (EPA 2008).	No change
	Construction Village (inclusive of operations accommodation)	2.6 km south of Gas Treatment Plant. Standalone pioneer camp eliminated	No change
	Administration and Operations Complex	Near the Gas Treatment Plant outside the Plant boundary	No change
	Utilities Area	Located near the Gas Treatment Plant	Located within the Gas Treatment Plant site
	Utilities Corridors	Between Utilities Area, Construction Village and Gas Treatment Plant	No change
	Road Upgrades	WAPET landing to Town Point. Town Point to the Airport (via Construction Village). Feed Gas Pipeline System route.	No change
	Airport Modifications	Extension of existing runway to the south. No realignment. Vegetation clearing within current airport perimeter required.	No change
	Communications	Microwave communications tower and associated infrastructure to be installed on Barrow Island. Optic fibre cable no longer required. As specified in Attachment 1 to Statement 748 – approval under Section 45 C of the <i>EP Act 1986</i> for	No change

Aspect	Element	Description of Approved Two Train Project Elements	Description of Revised and Expanded Proposal Elements (PER)
		Change to Proposal (EPA 2008).	
Carbon Dioxide (CO ₂) Injection System	CO ₂ Compression Facilities	Located within Gas Treatment Plant boundary	No change
	CO ₂ pipeline	Length approximately 5 km Easement approximately 6 ha	Length approximately 10 km Easement approximately 8 ha
	CO ₂ injection wells	Approximately 7 injection wells directionally drilled from 2 or 3 surface locations	Approximately 8–9 injection wells directionally drilled from 3–4 drill centres Note: The final location of the drill centres and injection wells is subject to ongoing technical assessment.
	Observation Wells	Observation wells may be drilled from each cluster of injection wells	No change
	Pressure management wells	Pressure relief wells may be required once injection performance is established	Approximately 4 pressure management wells (or water production wells) will be required to manage pressure in the Dupuy formation Note: The final location of the wells is subject to ongoing technical assessment.
	Pressure Management Water Injection Wells	Details not specified in Statement No. 748	Approximately 4 pressure management water injection wells for the re-injection of water produced from the Lower Dupuy formation by pressure management wells. The water will be reinjected into the Barrow Group from a vertical depth of approximately 1200–1600 m. Note: The final location of the wells is subject to ongoing technical assessment.

Aspect	Element	Description of Approved Two Train Project Elements	Description of Revised and Expanded Proposal Elements (PER)
	Anode wells	Details not specified in Statement No. 748	Four shallow drilled anode wells are required for each CO2 drill centre for the purposes of cathodic protection. Anode wells are also required for cathodic protection of pressure management wells and pressure management water injection wells (one anode well per water producer/injector well pair). An anode well will also be required for each observation bore not on the drill centre. Total anode well count is 19 (subject to final cathodic protection design). Note: The final location of the wells is subject to ongoing technical assessment.
	Monitoring	Monitoring activities, including the acquisition of seismic data, will be undertaken as part of ongoing reservoir performance management.	No change
Greenhouse Gas Emissions Abatement	Abatement actions below are anticipated to yield a greenhouse gas emissions intensity of 0.35 tonnes CO2e per tonne of LNG shipped.		
	<i>"Beyond No Regrets Measures"</i>		
	Underground injection of reservoir carbon dioxide		No change

Aspect	Element	Description of Approved Two Train Project Elements	Description of Revised and Expanded Proposal Elements (PER)
	Improved LNG Technology	Adoption of a no routine venting or flaring policy. Use of dry compressor and hydrocarbon pump seals. Providing a cold recovery exchanger for the overhead gas from the Nitrogen Rejection Column to allow reuse of overhead gas in the high pressure (HP) fuel gas system.	No change
	<i>"No Regrets Measures"</i>		
	Gas production via a sub-sea production system		No change
	Improved LNG Technology	LNG processing trains increased to the maximum capacity that is practicable. A-MDEA selected as the carbon dioxide removal medium. Utilisation of waste heat, such that fired heaters are only required for plant start-up.	No change
Feed Gas Pipeline	Length onshore (Barrow Island)	Approximately 14 km	No change to pipeline length. Minor realignment over a distance of approximately 500 m to accommodate changes to the Gas Treatment Plant footprint.
	Design onshore	Buried (approximately 1000 mm cover)	No change
	Construction easement (onshore)	Approximately 42 ha	No change
	Shore crossing	North Whites Beach	No change
Domestic Gas Pipeline	Route onshore (Barrow Island)	Within Gas Treatment Plant footprint	No change
	Length onshore (mainland)	30 to 40 km	No change

Aspect	Element	Description of Approved Two Train Project Elements	Description of Revised and Expanded Proposal Elements (PER)
	Construction easement (mainland)	90 to 120 ha	No change
	Shoreline crossing (mainland)	To be determined by the Proponent	No change
Water Supply	Source	Seawater intake will be required, As specified in Attachment 1 to Statement 748 – approval under Section 45 C of the <i>EP Act 1986</i> for Change to Proposal (EPA 2008).	No change
	Location	Preferred intake location under MOF structure.	Adjacent to MOF
	Volume	Approximately 5,150 m ³ /day raw water supply	No change
Wastewater	Wastewater Treatment Plant (WWTP)	Wastewater treatment plant installed during pre-construction (with sufficient capacity for construction workforce) will be modified as necessary to support operations workforce.	No change
	Treated effluent disposal	Deep well injection of surplus treated effluent	No change
	Reverse osmosis (RO) brine disposal	Deep well injection or ocean outfall (east coast Barrow Island)	No change. Need for Ocean outfall confirmed – east coast of Barrow Island
	Contaminated wastewater disposal	Deep well injection of contaminated wastewater streams when practicable	No change
	Process water disposal	Deep well injection of process water	No change
Clearing	All elements	Clearing of native vegetation for the purpose of implementing the proposal	No change

Aspect	Element	Description of Approved Two Train Project Elements	Description of Revised and Expanded Proposal Elements (PER)
<i>Marine Facilities</i>			
Marine Offloading Facility (MOF)	Causeway design	Solid	No change
	MOF Design	Solid with offloading facilities including wharf, dock, mooring dolphins, ramp and tug pens to support a range of vessel sizes and loads.	No change
	Causeway length	Approximately 800 m	Combined length of approximately 2120 m
	MOF length	Approximately 520 m	
	MOF access	Constructed channel approximately 1.6 km long x 120 m wide, dredged to 6.5 m relative to chart datum	Constructed channel approximately 750 m long and approximately 165 m wide, dredged to 6.5 m relative to chart datum. Berthing Pocket dredged to 8 m (relative to chart datum)
Offshore Feed Gas Pipeline System	Length in State waters	5.6 km (3 nautical miles)	No change
	Shore crossing	North Whites Beach	No change
Domestic Gas Pipeline	Distance Offshore (State Waters)	Approximately 70 km (route to be confirmed)	Approximately 70 km (route from Barrow Island confirmed [refer to Figure 2.1 in Chevron, 2009])
	Offshore route	Essentially direct line	Minor changes – see description in Section 2.0 of Chevron, 2009.
LNG Jetty	LNG jetty design	Open pile structure	No change
	LNG jetty length	Approximately 2.7 km	Approximately 2.1 km

Aspect	Element	Description of Approved Two Train Project Elements	Description of Revised and Expanded Proposal Elements (PER)
	Turning basin and access channel design	Turning basin 1 x 700 m circle (approximately), channel 300 m wide (approximately) Dual berth facility dredged to 14 m relative to chart datum	Shape of turning basin has been revised as shown in Figure 1. Dual berth facility (redesigned to meet safety requirements) Turning Basin and Access Channel dredged to 13.5 m (relative to chart datum), Berthing Pocket dredged to 15 m (relative to chart datum)
	LNG and Condensate load-out	Via dedicated lines installed to the LNG Berth (eastern end of LNG Jetty)	No change
Dredging	MOF volume	1.1 million m ³	No change
	LNG Turning Basin and Shipping Channel volume	6.5 million m ³ (dual berth). Design to be determined by the Proponent. Refer to section 2.1.4 (Part A, Final EIS/ERMP Chevron, 2005)	No change
Dredge Spoil Ground	Location	Closest point is approximately 10 km from the east coast of Barrow Island	No change
	Area	900 ha	No change
Direct Seabed Disturbance (Dredged or Covered area)	All elements	Details not specified in Statement No. 748	Approximately 212 ha.
Drill and Blast	All elements	Details not specified in Statement No. 748	Approximately 50 000 m ³
Marine Disturbance Footprint (MDF)	All elements	Details not specified in Statement No. 748	The Marine Disturbance Footprint (MDF) is to be defined within the Coastal and Marine Baseline State and Environmental Impact Report. This definition process is currently being undertaken.

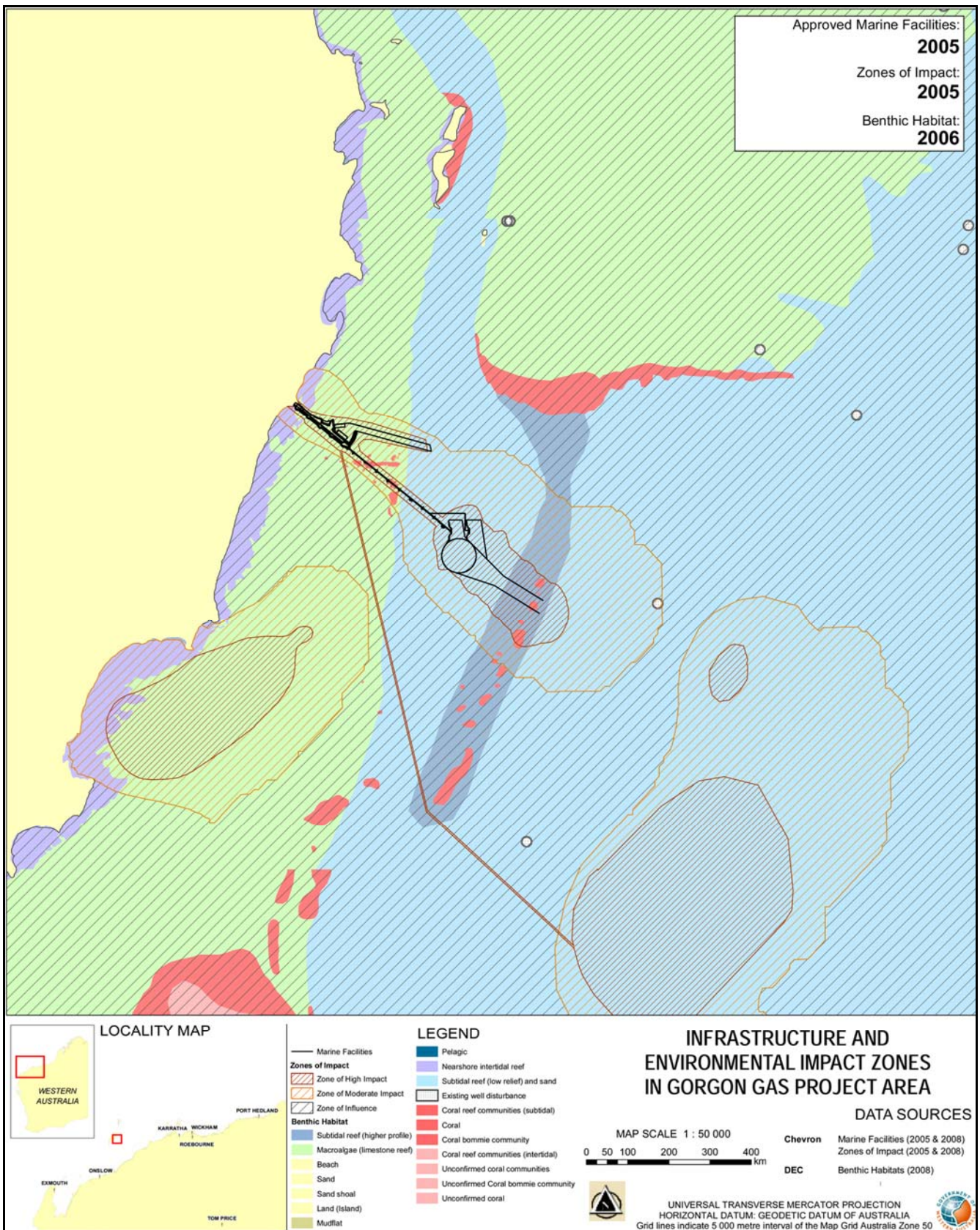


Figure 1a: *Infrastructure and environmental impact zones in Gorgon gas project area. Approved project with previously predicted zones of impact.*

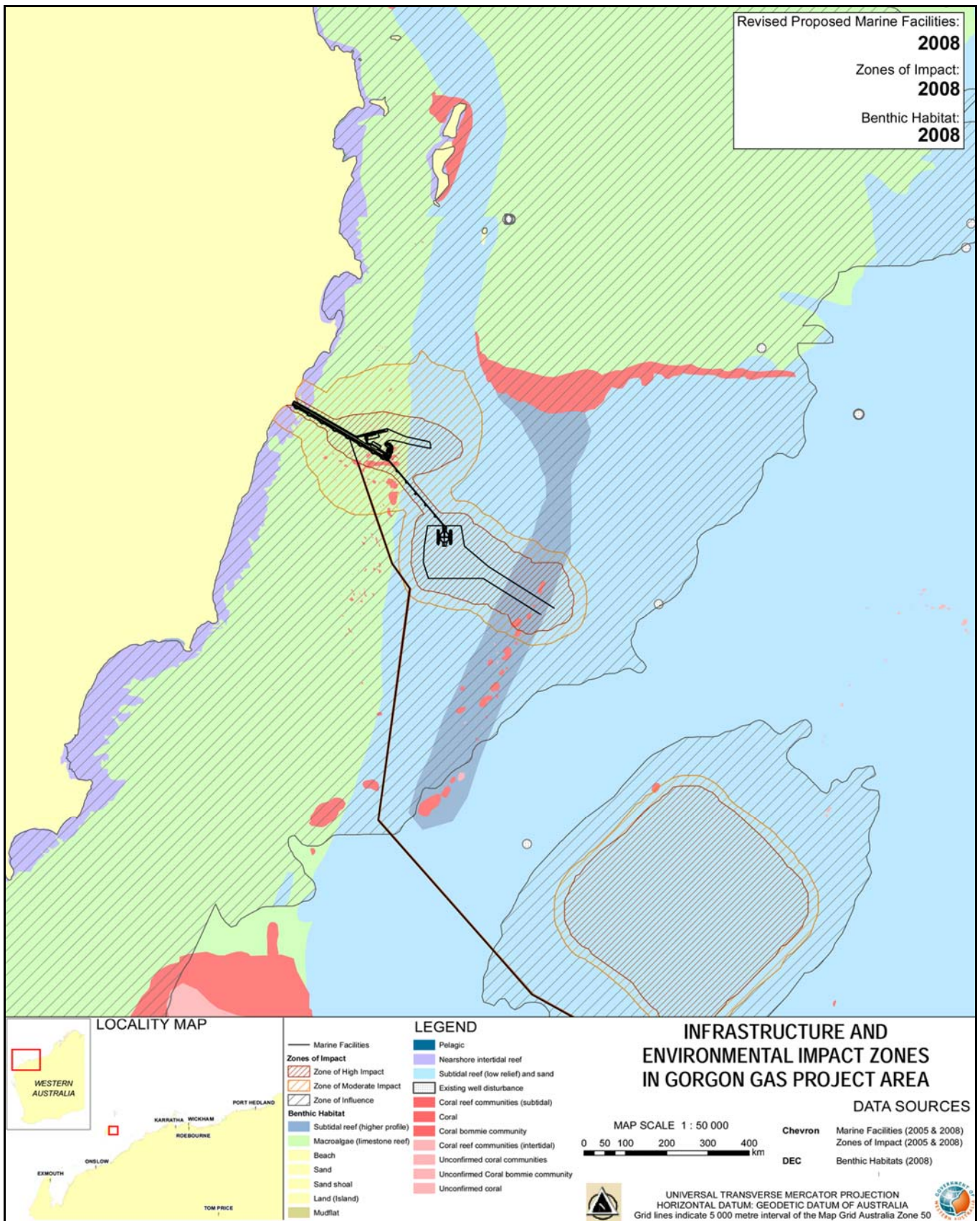


Figure 1b: *Infrastructure and environmental impact zones in Gorgon gas project area. Current proposal with currently predicted zones of impact.*

2.2 Changes to the proposal

Since the release of the PER, a number of modifications to the revised and expanded proposal have been made by the proponent, as set out in the response to submissions (Appendix 4).

Domestic gas pipeline

The domestic gas pipeline design has been modified since the release of the PER. The off-take point has been moved from near the marine offloading facility (MOF) on the causeway to a location on the jetty that is approximately 1.4 km further offshore. There has also been a repositioning of the pipeline to avoid sensitive benthic primary producer habitat within the Barrow Island Port. The total area of coral habitat that would be lost as a result of the realignment remains unchanged. However, the proponent reports that the realignment allows highly valued high relief sub-tidal and bombrora coral communities that were to be affected as part of the revised and expanded proposal to be avoided (see Figure 2.1 in Response to Submissions (Chevron, 2009) Appendix 4).

Anode wells

Chevron has advised that the anode well requirement was described incorrectly in the PER. The PER stated, “Four shallow drilled anode wells are required for each CO₂ injection well for the purposes of cathodic protection. Anode wells are also required for cathodic protection of pressure management wells and pressure management water injection wells.” The revised and expanded proposal would require four anode wells per drill centre for the CO₂ injectors (total of 12 if three drill centres are used) plus one anode well for each pressure management water producer/injector well pair (total of four). A total of three anode wells (one for each observation well not on a drill centre) would also be required. The total anode well requirement would therefore necessitate 19 wells, which would represent an associated land take of 3.61ha.

Boil off gas flare

The PER stated that there would be two marine boil off gas (BOG) flares, contrary to the one flare design that was part of the two train development. Gas treatment plant design updates have resulted in the reversion to the one BOG flare design, rather than two as described in the PER.

East coast marine facilities construction

In the ERMP for the now approved project (Chevron, 2005) it was stated that: “On the east coast of Barrow Island construction activity would take approximately 3 years and will occur 24 hours per day” (page 496). Construction is now expected to take an additional three to six months. The PER (Chevron, 2008) section 7.1.2.2 (bullet point 1) stated that “Construction of east coast marine facilities (with the exception of dredging) will be restricted to dayshift...” (page 150). The proponent now intends to construct the marine facilities on the east coast of Barrow Island in accordance with the methodologies listed in Table 2.1 in their Response to Submissions (Chevron, 2009). This includes a number of activities planned as 24 hour per day operations. The proponent reports that these methodologies are necessary to ensure compliance with relevant safety standards and regulations and to meet project schedule requirements. The proponent has stated the sensitivities relating to the potential impacts of offshore artificial lighting on marine turtles are recognised.

The environmental risk assessment undertaken by the proponent and the proposed management of those risks are summarised in Table ES0.2 of the proponent's PER document (Chevron, 2008).

The proponent has modified the approach to dredging from that of the approved project. The approved project involved the use of a cutter suction dredge (CSD) filling hopper barges which transport sediment directly to the spoil dumping ground. The current proposal involves the CSD initially side-casting spoil onto the sea floor where it would remain for a period of days to months. A trailer suction hopper dredge (TSHD) would pick up the spoil some time later for transport to the dumping ground, resulting in spoil being handled twice.

3. Key environmental factors and principles

Section 44 of the *Environmental Protection Act 1986* requires the EPA to report to the Minister for the Environment on the environmental factors relevant to the proposal and the conditions and procedures, if any, to which the proposal should be subject. In addition, the EPA may make recommendations as it sees fit.

The key factors selected for detailed evaluation in this report are summarised in Appendix 3. A number of other factors, are relevant to the proposal, but the EPA is of the view that these are unlikely to have changed in a way that would alter the environmental outcomes from those determined during the assessment of the approved project reported in EPA Bulletin 1221 (EPA, 2006).

Appendix 3 provides a summary of factors and the ability of the existing conditions to manage the impacts predicted to occur as a result of the revised and expanded proposal. It should be noted that the EPA did not recommend specific conditions for the approved project. The conditions attached to the approved project were formulated on behalf of the then Minister for the Environment.

It is the EPA's opinion that the following key environmental factors for the proposal require detailed evaluation in this report:

- a) Marine turtles;
- b) Dredging, marine blasting and marine infrastructure;
- c) Introduced non-indigenous organisms;
- d) Subterranean fauna;
- e) Greenhouse gases;
- f) Air quality; and
- g) Noise.

There were a number of other factors which were relevant to the proposal, but the EPA is of the view that these are unlikely to have changed in a way that would alter the environmental outcomes from those determined during the assessment of the now approved project reported in EPA Bulletin 1221 (EPA, 2006).

The above key factors were identified from the EPA's consideration and review of all environmental factors generated from the PER document and the submissions received, in conjunction with the proposal's key characteristics.

Details on the key environmental factors and their assessment are contained in Sections 3.1 - 3.6. The description of each factor shows why it is relevant to the proposal and how it would be affected by the proposal. The assessment of each factor is the mechanism used by the EPA to decide whether or not a proposal meets the environmental objective set for that factor.

The following principles were considered by the EPA in relation to the proposal:

- a) The principle of conservation of biological diversity and ecological integrity;
- b) The precautionary principle; and
- c) The principle of intergenerational equity.

Key factors were considered on the basis of significant additional or different impacts, and cumulative impacts, that would be likely as a result of the revised and expanded proposal currently under assessment. Incremental and cumulative impacts were considered, mindful of the conditions and offsets that are currently in place for the approved Gorgon project.

3.1 Marine turtles

Description

Night-time lighting can have a detrimental effect on the reproductive success of marine turtles. Gravid females are deterred from nesting on illuminated beaches, particularly the first time they nest. Hatchlings emerging from nests can become disoriented by lights so that they either do not reach the sea or are delayed, making them more vulnerable to terrestrial predators. Once in the water, hatchlings may be entrapped by lights on the water, also leading to increased predation (Limpus, 2006).

The addition of a third LNG train (and hence additional lights), potentially up to a 50% increase in non-routine flaring events, a construction schedule extended by 3 to 6 months and 25 to 50% more shipping associated with the export of cargoes during operations (Chevron, 2008) would be expected to increase the likelihood of lighting impacts on turtles.

Additional light mitigation strategies, including removal of elevated street lights and reductions in 'always on' lighting have been proposed by Chevron to reduce lighting as far as practicable. Unfortunately, the absolute level of lighting from the current proposal cannot be directly compared with that from the approved project because Chevron reports that different lighting models were used for the two cases.

The effect of sound levels of 70-75+ dB(A) at turtle nesting beaches from occasional ground flare upsets is not known, nor is the effect of the increased level of vibration expected by adding a third LNG train, but increased levels of impact may be expected from increasing these stressor sources. A reduction in jetty piling would reduce noise impacts from this source. Noise from 50,000m³ of blasting and from additional vessel

movements is also likely to increase disruptive effects on marine turtles, particularly if blasting is undertaken during turtle nesting seasons.

The increased duration of construction and increased frequency of shipping movements would increase the likelihood of injury and death due to vessel strike. Increasing the length of the solid causeway may increase the energy expenditure of gravid females detouring around the causeway while searching for a nest site. The extended causeway length could also increase the energy expenditure of hatchlings swimming around the causeway to reach the channel to the open ocean. The extra light stations expected to be required on the extended causeway would increase the opportunities for entrapment of hatchlings by those lights and consequently result in increased likelihood of predation.

The length of the causeway / MOF has been increased by 800m and the dredging methodology changed to a double handling process. The extent of the high impact zone of turbidity around the causeway/MOF has increased. The duration of rock and sediment dumping to form the causeway is also expected to increase, increasing the pressure on turtles that would normally use this zone. The proponent's modelling predicts that the effects of dredge plumes elsewhere would decrease.

Dredging and marine seismic activities are likely to be similar for the new proposal to those of the approved project but would nonetheless reduce available foraging habitat for a few years and add to the cumulative negative effects of the revised and expanded proposal on marine turtles (and other marine fauna).

Submissions

Key points made in submissions included:

- Increased light impacts and shipping movements on a major flatback turtle rookery were considered unacceptable in EPA Bulletin 1221 and must remain so with an increase in impacts due to additional industrial infrastructure.
- The MPRA are concerned that lights similar to a full or quarter moon will impact significantly on nesting turtles and may lead to disorientation/ mis-orientation of hatchlings.
- The impacts of dredging remain unacceptably high.
- The revised proposal presents some new risks and increases the scale of others.
- In addressing risk categories in isolation, rather than taking a cumulative approach, the PER failed to present a cumulative impact assessment of the risks to turtle populations and marine communities.
- There needs to be an assessment of the cumulative impacts of a series of impacts on the marine turtle population.
- The MPRA are concerned that the extension of the causeway will have a significant impact on flatback turtle nesting [because they] move laterally in shallow waters searching for a suitable nesting site.
- WWF assesses the risk to flatback turtles as critical (widespread long-term impact on population) and almost certain, for the populations nesting on the two beaches directly to the north and south of the Town Point site.
- Further work needs to be conducted on green, loggerhead and hawksbill turtles.

- There are a number of changes/additions to the Gorgon development that will potentially increase the risk to turtle populations nesting on Barrow Island.
- Lighting impacts of the expanded development result in no dark nights in the vicinity of Bivalve and Terminal beaches.
- No explanation is provided regarding how levels of lighting affect fauna and therefore it is not certain that lighting associated with the revised proposal poses no significant additional or different risk to fauna.
- The proponent needs to address impacts on marine fauna as a result of noise generating activities.
- Clarification is required as to what is meant by ‘significant’ when discussing the actions to be undertaken if the proposal does have a significant impact on the turtle population.
- The statement ‘*overall, the impact on nesting activity is not predicted to be different from the approved development*’ must be questioned.

Assessment

The EPA’s environmental objective for this factor is to maintain the abundance, diversity, geographic distribution and productivity of marine fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.

The EPA is aware that conditions applied to the approved project contain a number of conditions designed to assist in the management of marine turtles, including the requirement for a Marine Turtle Expert Panel (MTEP). Considering that there is much that is still not known about marine turtles, that condition will be critical if these listed fauna are not to decline in the region. The EPA notes the crucial role of this Expert Panel and particularly its subject specialists and technically independent members, in formulating the most effective approaches to marine turtle management.

In performing this assessment, the EPA was cognizant of the conditions applied to the approved project, including the requirement for the MTEP and the provision of undertakings by the proponent to offset otherwise unavoidable impacts on marine turtles. In considering possible new conditions for the proposal, the EPA recognises that there are no readily measurable performance based indicators attached to the original conditions that would allow the required outcomes for the proposal to be clearly determined. The EPA considers this to be an important matter and provides additional advice on this point under the “Other Advice” section of this report.

It is unfortunate that no conclusions can be drawn about the relative risk of lighting from the current proposal compared to the approved project, since different lighting models were used for the two cases by the proponent. It appears clear, however, that the revised and expanded proposal requires more areas to be lit in the plant site and for lights to be on more often for more frequent ship loading and other activities such as plant maintenance.

There is insufficient data available to determine just what levels or illumination or wavelengths of light are critical cues to turtle behaviour at the vital nesting and hatching and dispersal life stages. It is reported that even low level lighting is capable of influencing flatback turtle behaviour (Pendoley, 2008). It is therefore not possible

to conclude confidently that the levels of lighting, notwithstanding the mitigation measures proposed, would not have a significant, potential detrimental effect on turtle reproductive success.

It may be that the proponent considers that the measures that have been proposed to control lighting are the full practical extent of what can be done in this regard. However, given that it is not possible to judge whether these measures would be sufficient to have confidence that the risk to marine turtles would not result in adverse impacts to their populations over the long term, the EPA concludes that it is probable that the likelihood of impacts from the revised and expanded proposal would increase with the increased level of lighting required for the expansion. This is a matter that the MTEP is requested to review and assist in developing appropriate measures to meet the EPA's objectives.

Increased energy expenditure and predation is likely to reduce the overall fitness and reproductive success of individual turtles, leading to a reduction in overall success at the population level. While it is highly likely that the impacts of the proposal on turtles would be negative, it is not possible to quantify the extent of the negative impacts. However, the EPA concludes that detrimental impacts on turtles are likely to increase.

In its report of June 2006 the EPA found that:

“When mortality increases by as little as a few percent above natural rates at any life history stage and continues over a turtle generation of a few decades, a marine turtle population will decline significantly. Consistent annual losses from a population of 5-10% of a life history stage above natural mortality levels can be expected to cause serious population declines within one generation and reduce populations towards extinction within about 100 years.

Even small annual reductions in breeding success and recruitment over the 60+ year life of the Gorgon proposal are likely to lead to serious declines in the flatback turtle population, possibly leading towards local extinction. There is a reasonable probability that the combined continuing impact over the 60+ year life of the Gorgon proposal as it is currently planned will threaten the viability of one of the important flatback turtle rookeries in Western Australia. This impact will only be apparent when the next generation of turtles return to breed in several decades time.”

Overall, the increased scale and construction duration of the revised and expanded proposal can be expected to increase the likelihood of impacts on marine turtles, particularly flatbacks dependent on east coast nesting beaches.

Having reached this conclusion, the EPA also considered whether there are any means by which the increased level of risks to this significant flatback turtle rookery might be reduced to an acceptable level, and with an acceptable degree of certainty that its long-term viability can be assured.

The EPA has concluded that the primary method of achieving its objective for this factor would be by way of a condition having the objective of the achievement of an

unaltered light horizon (compared with the current natural conditions) from the perspectives of both gravid female flatback turtles and hatchlings.

Summary

It is the EPA's opinion that the proposal as currently presented does not provide a reasonable prospect for long term viability of the listed marine turtle population.

The EPA has concluded that the primary method of achieving its objective for this factor would be by way of a condition having the objective of the achievement of an *unaltered light horizon* (compared with the current natural conditions) from the perspectives of both gravid female flatback turtles and hatchlings. This condition should apply to those beaches and waters adjacent to Town Point that are used for nesting and by resultant hatchlings in their initial journey to the ocean.

The precise geographical extent to which this condition should apply, and the precise manner in which this objective would be achieved should be developed by the MTEP, and advised to the Minister for Environment by the Expert Panel itself .

It is the EPA's view that, as a minimum, to meet this condition would require:

- the relocation of flares to an appropriate inland location (to be determined by the Expert Panel);
- opaque shrouding of all major plant lighting;
- opaque shrouding of lighting on the MOF facility and jetty; and
- maximum possible shrouding and light source reduction on ships (including dredging vessels).

This would need to be complemented by advice from the MTEP on the management of other significant risks to turtles (eg. noise, blasting, vibration).

3.2 Dredging, marine blasting and marine infrastructure

Description

While the overall volume of dredging is expected to remain about the same as for the approved project at 7.6Mm³, there would be a 6.5ha increase in the direct disturbance footprint for marine infrastructure, taking the total to ~211.9ha (ie. about a 3% increase). The area disturbed at the spoil dumping ground is expected to remain at ~900ha.

As for the approved project, numerical modelling techniques were applied to the revised and expanded proposal by the proponent to predict potential marine environmental impacts of dredging and marine infrastructure development on the east coast of Barrow Island. Modelling was outlined in the PER and a technical report was included as Appendix E. A revision of Appendix E of the PER was supplied as Appendix B to the proponent's responses to submissions.

The numerical modelling relies on, among other things, a detailed description of how different elements of the dredging would be undertaken, ie. the dredge log. The proponent has modified its approach to dredging from that proposed in, and modelled

for, the approved project. Predictions of environmental impact for the approved project were based on dredging the channel to the MOF using a CSD and disposing of spoil direct to the causeway / MOF reclamation area, where that material would be dewatered. Modelling for the approved project also assumed that harder rock material in the LNG access channel would be dredged using a CSD discharging spoil directly into hopper barges, then transporting that sediment directly to the offshore spoil dumping ground. The current proposal and dredge log is based on dredging the channel to the MOF and harder material in the LNG access channel using a CSD which would initially cut and then side-cast material onto the sea floor nearby where it would remain for a period of days to months. A TSHD would pick up the side-cast spoil some time later for transport and disposal to the dumping ground.

The current proposal is to increase the length of the approved causeway / MOF structure by about 800 meters. Increasing the causeway / MOF length from 1320m to 2120m would increase the construction time for this facility which, in turn, would extend the period of turbidity generation and sediment deposition around it. Although the extension to the construction period for this facility is not specified in the PER, the overall construction period is listed as being three to six months longer (Chevron, 2009).

Impacts on the marine environment from elevated turbidity and sediment deposition generated by construction and dredging associated with the new design and dredging methods have been re-modelled (see Appendix B of responses to submissions). The outputs of this most recent modelling have been interrogated using similar general approaches and the same coral health criteria as those used by the proponent to prepare its impact predictions for the approved project.

The proponent has used model outputs to re-predict zones of high and moderate impact and the zone of influence from the dredge plume. The boundary delineating the zone of moderate impact from the zone of influence to the north of the proposed marine infrastructure is now predicted to be closer to the high value coral communities of the Lowendal Shelf (compared with the location of the same boundary spatially-defined in Schedule 5 of Statement 748 for the approved project). The latest modelling predicts that this zone boundary would shift from its previous closest location about 1025m from the southern Lowendal Shelf to approximately 350m from the Shelf.

The changes to the proposal have resulted in changes to the predicted extent of turbidity plumes and hence zones of impact around the marine facilities. Table 2 sets out some changes in the area of impact zones in the vicinity of the Lowendal Shelf, as illustrated in Figure 1.

Table 2. Changes in the area of impact zones in the vicinity of the Lowendal Shelf.

	High impact zone		Moderate impact zone	
	Approved project	Revised proposal	Approved project	Revised proposal
Causeway/MOF	148ha	298ha (+101%)	385ha	644ha (+67%)
LNG channel	411ha	483ha (+18%)	1270ha	250ha (-80%)
Totals	557ha	781ha (+40%)	1655ha	894ha (-46%)

Revised modelling of the expected dredge plumes has removed a predicted area of impact, disconnected from the infrastructure, that was originally predicted to occur to the south of Town Point (Figure 1a and 1b). This will deliver an improved environmental outcome. The extent of predicted impact zones has also contracted in other areas, remote from the Lowendal Shelf. This too is an improvement.

The proponent included new benthic habitat maps in the PER, however uncertainty remains about the habitats present and the process used to map their extent and location. The most recent benthic habitat mapping in the vicinity of proposed infrastructure off the east coast of Barrow Island shows there are more coral communities, and shifts in the locations of some coral communities, relative to the earlier mapping. The proponent has determined that a change to the off-take pipeline alignment has allowed some coral bombrora to be avoided. The overall change in the marine infrastructure footprint has resulted in a fractional increase in predicted permanent coral loss, from 22ha to 22.06ha (ie. a 0.27% increase).

In the ERMP for the now approved project, the proponent indicated that “there is no need to do any drilling and blasting” (Chevron, 2005). Subsequent investigations by the proponent have revealed that there is considerable, very hard rock on the seabed adjacent to the east coast of Barrow Island. These investigations have resulted in the modifications proposed to extend the causeway / MOF in order to limit the amount of blasting, however some 50,000m³ of material will require blasting.

Submissions

The following points were included in submissions on this factor:

- The potential negative affects of the dredging and spoil disposal program is a concern for DOF as the project is on the fishing grounds of three commercial fisheries.
- The impacts of dredging remain unacceptably high as per Bulletin 1221. The EPA must repeat their recommendation against this scale of dredging.
- WWF Australia assesses the major stressors as sedimentation of marine benthic primary producers, and shallow benthic and coastal communities, particularly coral communities, resulting in impacts and loss of species and communities.
- The causeway itself, as a solid structure intruding into a shallow, high energy environment is likely to have a significant impact on natural sedimentation processes.

- No evidence is presented in the PER demonstrating that the models used for coastal process impact prediction have been validated for their application at Barrow Island.
- The work provided does not appear to address the concerns raised [by DPI] in the review of the previous [ERMP].
- [MPRA] are concerned that the PER document does not address the relevant cumulative impacts of expanding the existing development on and adjacent to Barrow Island.
- The PER does not adequately address marine drilling, blasting and seismic requirements and their impact assessment and management.
- Clarity is required on the total predicted loss of coral and how the 22 hectare limit of coral loss will be ensured.
- Cumulative loss thresholds are reached/exceeded in several of the marine management units.
- Benthic habitat maps in the PER show new area of coral communities. It appears unlikely that benthic habitat mapping has been conducted in sufficient detail to enable predictions of loss and impact to be thoroughly appraised in the context of limits set in the existing conditions.
- The contemporary proponent view that ‘if hard rock is encountered the production of finer material increases’ is contrary to an earlier position the proponent presented to the EPA that stronger/harder material would be more likely to shear and stay intact rather than being ground in to fines.
- No model sensitivity analysis for the source allocation of percentages of fines has been given hence it cannot be argued that they are conservative.
- No estimates have been given of the fines yield from the material that is to be drilled or blasted.
- There is no evidence that the SWAN wave model has been validated against local wave measurements off Barrow Island for different seasons of the year.
- The amount of hard rock to total dredge material is uncertain. The fines yield from the hard rock is uncertain, and the percentage source allocations for fines are uncertain and the sensitivity to these model predictions to these percentage allocations has not been tested.
- The recovery of most benthic primary producers and benthic primary producer habitat within 2 to 5 years (eg. sensitive corals) makes a large and untested assumption that patterns of recruitment and survival in corals and BPP will be maintained over that period.

Assessment

The EPA’s environmental objective for this factor is to maintain marine ecological integrity and biodiversity and ensure the criteria in EPA Guidance Statement No. 29 are met.

A key issue for the EPA in its assessment of the proposal is the level of confidence that can be placed on predictions of impact in the marine environment.

The EPA notes that Ministerial Statement 748 sets an allowable impact of 100% mortality of all coral and other biota apart from 70 % of the resilient *Porites* species of corals in the Zone of Moderate Impact. It is also noted that the outer boundary of the moderate impact zone for the proposal is now predicted to be approximately 350m

from the sensitive coral communities on the southern Lowendal Shelf which is substantially closer than the ~1000m minimum separation distance for the approved project. The EPA notes the regional significance of the coral communities on the Lowendal Shelf and that the Department of Environment and Conservation (DEC) has undertaken surveys which show that the south-western portion of the Lowendal Shelf supports high density thickets of *Acroporid* corals. Corals from the genus *Acropora* are known to be quite sensitive to turbidity and sediment deposition and the proponent has used *Acropora* corals as a 'less resilient' indicator for the purpose of predicting impacts of turbidity and sediment deposition on benthic habitats (Chevron, 2008). In view of the points above, it is reasonable to infer a material increase in the level of risk of impacts to the Lowendal Shelf from the revised and expanded proposal.

Key inputs for predictive modelling of turbid plumes associated with dredging activities are estimates of fines generation from the various stages of the dredging methodology described in the dredge log. The proponent's most recent modelling is based on an assumption that the proposed dredging methodology using CSDs would result in 15% of the total cut material being converted to fine particles less than ~79 µm in size. The proponent reports that this figure is based on a combination of data from Geraldton and professional judgement. Data from material collected at Barrow Island were not used and previous modelling was based on assumptions of significantly lower percentage fines generation (5% or 10% of the total cut material being converted to particles less than either 75 µm or 100 µm in size). The MOF access channel development involves ~1 Mm³ of dredging, which is a part of the total 7.6 Mm³. Based on the proponent's contemporary fines generation assumption, it is estimated (assuming a specific gravity for limestone of 2.5) that approximately 375,000 tonnes of fine particles less than 79 µm would be released to the water column during MOF dredging.

Incidents associated with operational failure or unfavourable weather or sea conditions, which may lead to a loss of control of the dredge plume, may not have been accounted for in the modelling and may add to the level of cumulative risk associated with marine facilities construction. An increase in the construction period for the causeway / MOF would also increase the time in which accidents or incidents may occur.

There are no data based on experience at Barrow Island available to indicate whether the proposed change to side-casting the CSD spoil and then picking it up with a TSHD would increase the turbidity and sedimentation generated by dredging. The proponent's modelling shows that more fine sediments would be liberated at, and dispersed from, the site of dredging than if dredging were to occur without double handling. In essence, the modelling predicts 23% more fines would be produced at and near the sites of dredging, which are in close proximity to sensitive benthic communities, including those on the Lowendal Shelf. The proponent has concluded that the proposed methodology would not increase the risk of impacts over what was originally predicted.

The EPA noted previously (EPA, 2006) that it appreciates that controlling dredge plumes in a dynamic environment is not a precise exercise. The EPA recommends that the Minister obtains assurance from the Construction Dredging Environmental Expert Panel (CDEEP) that the proposed approach to monitoring and managing the

dredge plume would adequately protect the environmental values, especially since new modelling indicates that the moderate impact zone associated with dredging is now predicted to be considerably closer to the regionally important, high value coral communities on the Lowendal Shelf.

The EPA is of the view that the current management framework for dredging/construction activities, which uses measures of coral mortality as management triggers in the zone of moderate impact, averaged across that zone, allows for potentially significant impacts at some monitoring sites before management is triggered. The EPA recommends that this potential weakness in environmental protection be reviewed by the relevant Expert Panels and advice be provided to the Minister as to its adequacy to meet the EPA's objectives for this factor. The Expert Panels should consider the application of sub-lethal indicators of stress (eg. coral bleaching) in the moderate impact zone, and their possible usage at all locations within that zone.

Blasting, pile installation and marine seismic

The EPA previously indicated (EPA, 2006) that the level of uncertainty around whether or not there would be a need for drilling and blasting at sea meant that it was not then possible for the EPA to properly evaluate the risks from marine blasting or the effectiveness of indicative measures for its management. The proponent now proposes to undertake up to 50,000m³ of marine blasting. While noting that blasting can have disruptive and lethal effects on listed (and other) marine fauna, the EPA is aware that 50,000m³ is not a large volume to be blasted. Accordingly, the EPA considers that this issue could be managed by the preparation of the management plan, required by the existing conditions, imposed on the approved project.

The EPA considers that a similar management plan should be required to address the issues associated with installing piles for the LNG jetty. The scope should include appraisal and management of percussive impacts of pile-driving at a minimum, and address impacts of drilling, if that activity is required for installation of piles.

The EPA recommends that management of marine seismic be specifically incorporated into the required marine management plans and repeats its earlier view that a scientifically robust environmental monitoring and management programme which sets out the measures and schedules to avoid key ecological windows, including marine turtle and mammal breeding seasons, is required.

Summary

The latest modelling shows that the moderate zone of impact has moved from about 1000m away from the Lowendal Shelf to within about 350m.

The EPA considers that management of dredging and marine infrastructure construction could meet the EPA's objective if a condition is imposed that requires these activities to use and be managed according to real time monitoring and modelling against sub-lethal trigger levels with appropriate corrective action (including the cessation of dredging when required to protect environmental values). These management requirements should be set out in conditions formulated following advice to the Minister for Environment by the Construction Dredging Environmental Expert Panel.

The EPA considers that marine blasting of 50,000m³ of rock and management of shallow water marine seismic would be capable of adequate management through the preparation and implementation of acceptable management plans.

3.3 Introduced non-indigenous organisms

Description

Barrow Island is a critical conservation asset because it has not been subject to threatening processes that have drastically reduced native fauna populations on the mainland. Introduced non-indigenous organisms are recognised as the greatest threat to the existing biota and conservation values of Barrow Island. It thus remains important to continue to take all steps possible to exclude introduced organisms from the waters surrounding Barrow Island.

The proposal includes a 40% reduction (down from 160,000 tonnes to 97,000 tonnes) in imported sand and aggregate, mainly due to a proposed increase in excavation at the plant site on Barrow Island providing additional sand and rock supplies in-situ. The proposal would necessarily require more plant and equipment on Barrow Island. The PER indicates that additional direct shipping of pre-fabricated modules from foreign ports would occur, with a consequent decrease in the shipping of individual components from the Australian mainland. No data are provided, however, to indicate what the extent of these changes in shipping movements during construction would be.

The PER for the proposal indicates that there would be no increase in the construction workforce, although the duration of construction is expected to be extended by some three to six months (Chevron, 2008). An increase of 25 to 50% (Chevron, 2008) in shipping movements is anticipated during operations.

The proposal does not include any new or additional quarantine management measures, and instead proposes that the application of the quarantine procedures outlined for the approved project would be scaled up in number to handle the increased number of movements to Barrow Island. A target of zero-tolerance of invasions of non-indigenous organisms on Barrow Island, has been set for the proposal.

The proponent has previously been congratulated (EPA, 2006) on the process of using expert and community input to establish standards acceptable to the community for risks from introduced organisms. The proponent has not provided data on changes to the number of movements to Barrow Island as a consequence of the revised and expanded proposal. Nor have any new analyses of the risk of introductions on non-indigenous organisms been provided. The proponent considers that the existing analyses of the risk of introductions of non-indigenous organisms remain valid and that scaling up the quarantine system to deal with the increased number of movements to Barrow Island is appropriate to manage this risk.

Submissions

Submissions on this factor included the following points :

- Quarantine risk is increased directly by the increased construction period and increased movement of materials.
- WWF would like to acknowledge the efforts made by Chevron to address the likely threats presented by the Gorgon gas proposal, particularly with regard to quarantine. We do not doubt the determination of Chevron to manage these risks but are concerned that no amount of goodwill and effort will reduce the risks to a reasonable level.
- WWF Australia assesses the risk of quarantine breach and invasive plant and animal species becoming established as critical and almost certain. These risks disqualify Barrow Island as a candidate site for the proposed development.
- The process for mitigating the impact of introduced non-indigenous organisms appears to be covered by the protocols and guarantees given.
- Quarantine risks remain underestimated. For example, risk identification and management associated with additional causeway rock have been omitted.
- If the development is approved, a condition needs to be included for a Weed Management Plan to be developed and implemented, to the satisfaction of DEC.
- The very high standard of work intended with respect to quarantine measures is acknowledged.
- The DOF believes that there is a potential increase in risk profile for marine pests as a result of modularisation and the 3 to 6 month extension of the construction phase.

Assessment

The EPA's environmental objective for this factor is to maintain the abundance, diversity, geographic distribution and productivity of flora and fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.

The approved project contains a number of conditions designed to assist in the management of quarantine and the introduction of non-indigenous organisms, including the requirement for a Quarantine Expert Panel (QEP). Considering that there is much that is still not known about the biota of Barrow Island and its surrounding waters and how best to prevent the introduction of non-indigenous organisms, the EPA notes and emphasises the role of this panel to assist in formulating and developing the most effective approaches to quarantine management.

Increased shipments of modules from foreign ports would increase the likelihood of introductions of non-indigenous organisms from overseas. A decrease in the number of individual components shipped to Barrow Island from the mainland is likely to decrease the risk of introductions from that source.

The three to six month extension to the construction period would lead to an overall increase in the number of personnel, luggage and food and perishable shipments to Barrow Island, which are the quarantine pathways with the highest risk of introducing non-indigenous organisms to the island.

An increase of 25 to 50% (Chevron, 2008) in shipping movements during operations would increase the potential for non-indigenous marine organisms to be introduced to the waters surrounding Barrow Island for the 60+ year duration of the project.

The proponent plans to establish a dedicated quarantine management system for the proposal based on that proposed for the approved project. The EPA notes that this system would now be subject to the scrutiny of a QEP, and, if operated as planned, likely represents best practice in the quarantine management of a large operation. The EPA recognises, however, that the system is yet to be implemented and consequently there is no track record of its success at managing 1000's of construction workers and contractors and the shipments associated with equipment for the plant and supplies to provision the workers.

The EPA concludes that it is likely that the quarantine system proposed, subject to it being implemented as proposed, would approach the limits of what is practical in terms of quarantine control. The EPA also notes that, at this stage, it is not possible to accurately judge whether the change to increased use of modules and reduced shipping of individual components together with the increase in the construction period and the increase in operational shipping movements would change the balance of risks of introducing non-indigenous organisms.

The practical effect of the conditions on the approved project is to require the proponent to implement the proposed quarantine system underpinned by advice from the QEP. Relevant offset undertakings by the proponent for the project amount to translocation of some species from Barrow Island to other Pilbara islands.

Summary

Increased use of modules shipped from overseas ports would increase the likelihood of introductions of non-indigenous organisms from this source. An increased construction period would increase the likelihood of introductions along the high risk personnel, luggage and food and perishables pathways and increased operational shipping movements would increase the likelihood of marine pest introductions.

Overall, increased traffic to Barrow Island as a result of the revised and expanded proposal is likely to increase the likelihood of non-indigenous organisms being introduced to Barrow Island and the surrounding waters.

The EPA concludes that the quarantine management system proposed, subject to it being implemented as proposed, is likely to be world's best practice and therefore it is unlikely to be possible to recommend additional practical controls beyond that system. If the proposal were to be implemented, then best practice conditions for the control of non-indigenous organisms should be applied, modelled on those currently imposed on the existing project.

The EPA recommends that the QEP is asked to provide advice to the Minister on measurable and auditable indicators that would clearly show the success or otherwise of the quarantine control system. The EPA further recommends that the Minister conducts a five yearly review of the Quarantine Management Plans required by Ministerial conditions, on the advice of the EPA and the QEP.

3.4 Subterranean fauna / short range endemics

Description

The revised and expanded proposal necessitates an increase in the area of permanent clearing for the Gorgon proposal from 200ha to 240ha. Clearing effectively removes subterranean fauna habitat permanently, either by direct removal of habitat where earthworks cut into the subsurface or by removal of surface biota that provides allochthonous nutrient inputs which underpin the food chain for subterranean fauna.

At the time the now approved project was described in the ERMP, seven subterranean fauna taxa and two terrestrial taxa had yet to be found outside the plant footprint. When the PER was prepared, four subterranean taxa and one terrestrial taxon had yet to be found outside the plant footprint. The original two terrestrial taxa had been found elsewhere, but an additional taxon was discovered on the plant site and has yet to be found elsewhere.

Submissions

Points made in submissions on this factor included :

- Subterranean fauna impacts remain unacceptable and will increase with this proposal.
- The risk to the EPBC listed Blind Gudgeon from potential leaks of injected CO₂ appear not to have been considered and will have increased with increased injection rates.
- The PER includes minimal information on effluent disposal via the aquifers.
- The expanded proposal does not appear to pose any substantial additional threat to the unique and highly restricted subterranean fauna found on the Island.
- There are still a number of subterranean fauna and short-range endemic taxa that are yet to be found outside the disturbance footprint.
- The excavation of the plantsite is proposed to be deeper to ensure a consistent level across the site. Additional karst will be excavated and additional troglofauna habitat will be lost or impacted.
- The increased land for long-term use may consequently affect subterranean habitat.
- Many statements on the locality and distribution of stygofauna species remain unproven. Stating that specimens of the same genus are widespread is not a valid substitute for determining the status of a species.

Assessment

The EPA's environmental objective for this factor is to maintain the abundance, diversity, geographic distribution and productivity of flora and fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.

Some of the conditions applied to the approved project are designed to assist in the management of subterranean fauna, and species at risk of extinction because they are confined to the plant site. Considering that there is much still not known about the biota of Barrow Island nature reserve the EPA considers that it is important that extinctions do not occur.

The 20% increase in permanent clearing leads to a proportional increase in the loss of habitat and sources of sustenance for terrestrial and subterranean biota. Expansion of the plant area also increases the opportunities for hydrocarbon or process chemical spills to affect subterranean fauna below and beyond the plant footprint.

The discovery of three subterranean taxa and two terrestrial taxa of arthropods outside the plant footprint has effectively removed the prospect of these taxa being rendered extinct by clearing for the proposal. While discovery of these taxa may indicate improved prospects for discovering elsewhere the remaining taxa so far recorded only on the plant site, the fact that they have not yet been found, despite additional search effort, warrants caution. It remains the case that four subterranean taxa and one terrestrial taxon have so far only been found on the plant site and hence may be rendered extinct by clearing the site.

The EPA considers that the extinction of biota is an unacceptable environmental outcome in any circumstance and particularly so on a class A nature reserve such as Barrow Island. While there is still some prospect that the taxa presently recorded only on the plant site may be found elsewhere in future, the EPA considers that there is significant risk that they would not be found off the plant site. If that is the case, and extinction of those taxa were caused by the additional clearing of the plant site this would not meet the EPA's objective for this factor.

Summary

It is the EPA's opinion that, for the proposal as currently presented, a risk of extinction still exists for the taxa confined to the plant site and not yet found elsewhere. While the risk of extinction persists, this proposal cannot be managed to meet the EPA's objective for this factor.

The EPA notes, however, that the recent detection beyond the plant site of some taxa previously found only on the plant site has removed the risk that those particular subterranean and terrestrial arthropod taxa may be rendered extinct by clearing of the site. While a risk of extinction still remains for the four subterranean taxa and one terrestrial taxon not yet detected outside the plant site, and extinction of any taxon would be environmentally unacceptable, additional surveys have demonstrated that it is possible that taxa now known only from the plant site may be found elsewhere.

If a decision is made that the proposal may be implemented, a condition requiring the proponent to continue searching for those taxa currently confined to the plant site should be instituted, ideally until such time as those taxa are found elsewhere.

3.5 Greenhouse gases

Description

The addition of a third LNG train increases the rate of carbon dioxide produced with the reservoir gas. Storing this additional carbon dioxide in an aquifer below Barrow Island involves increasing the number of carbon dioxide injection centres at the surface from two or three to three or four. The number of wells would increase from seven to eight or nine and the delivery pipeline length at the surface would increase by five kilometres. The annual carbon dioxide injection rate would increase by

0.64MTPA from 2.72MTPA to 3.36MTPA, although the total volume of carbon dioxide injected over the life of the project is currently planned to remain the same as for the approved project.

The revised and expanded proposal envisages 5.45MTPA of carbon dioxide equivalents being vented ; an increase of 1.45MTPA or 36%.

Submissions

Submissions about this factor included the following comments :

- Chamber of Commerce and Industry notes that liquefied natural gas is a relatively clean fuel that imposes a smaller carbon footprint than alternative fossil fuels.
- Even if geosequestration is successful, this project represents a huge increase in WA's greenhouse gas emissions.
- The EPA should recommend against the proposal to sequester emissions at Barrow Island and require more proven technology such as re-injection in offshore oil and gas reservoirs. Woodside is proposing a dedicated CO₂ pipeline from the LNG plant to Browse or [another] depleted offshore field.
- Increasing the volume and rate of CO₂ injection increases an already high risk.
- It is especially concerning that the independent risk assessment panel found that leakage via faults is 'possible'.
- Given the project life, a more useful comparison of emissions would be to compare project emissions to the State target for 2050 of 26MTPA. This would make the Gorgon project contribute 21% of the State's emissions at [that] time.
- An independent review for the Department [of Industry and Resources] indicated that, based on the information available at the time, there appeared to be no significant issues to compromise the feasibility of the proposed injection.
- We believe that Governments must make the safe injection of reservoir carbon dioxide a strict condition of approval for this project.
- Air emissions of combustion products will increase as a result of the extra energy requirements of the third LNG.

Assessment

The EPA's objectives for this environmental factor, as set out in its Guidance Statement No. 12 *Guidance Statement for Minimising Greenhouse Gas Emissions*, are to:

- minimise greenhouse gas emissions in absolute terms and reduce emissions per unit of product to as low as reasonably practicable; and
- mitigate greenhouse gas emissions, mindful of Commonwealth and State greenhouse gas strategies and programmes.

To achieve this, the EPA expects that potential greenhouse gas emissions from proposed projects are adequately addressed in the planning, design and operation of projects, and that:

- best practicable measures are applied to maximise energy efficiency and minimise emissions;
- comprehensive analysis is undertaken of unavoidable emissions, to identify and implement appropriate mitigation measures;
- an on-going programme is implemented to monitor and record emissions and periodic assessment is undertaken of opportunities to further reduce greenhouse gas emissions over time; and
- continuous improvement in greenhouse gas intensity through periodic review, and if practicable, adoption of advances in technology and process management so that greenhouse gas intensity per unit of product is equivalent to or better than benchmarked best practice.

Gas from the Gorgon field is high in carbon dioxide. A fundamental justification by the proponent for using Barrow Island was the need for access to a suitable aquifer beneath the island for long term carbon dioxide storage. Accordingly, the EPA considers it essential that injection or equivalent greenhouse gas mitigation action occurs.

The project has a number of conditions attached to it designed to ensure that at least 80% of reservoir carbon dioxide is injected into deep aquifers and carbon dioxide equivalents generated from combustion products are offset wherever possible. Given the increase in carbon dioxide equivalents generated by the expanded proposal, the EPA considers that sequestration, management and offsets for carbon dioxide equivalents remain critically important.

The addition of more carbon dioxide injection well centres, injection wells and delivery pipeline would necessarily increase the overall likelihood of leaks of carbon dioxide at the surface prior to injection and to the subsurface during injection due to the additional pipe, flanges and wells where a leak event could occur. Leaks risk the asphyxiation of terrestrial and subterranean fauna where the carbon dioxide pools, since it is denser than air. Necrosis of vegetation can also occur as a result of exposure to sufficiently elevated carbon dioxide concentrations.

Noting the increased likelihood of a leak, the overall risk is likely to be slightly elevated.

The EPA acknowledges the effort of the proponent to sequester carbon dioxide in the long term by injecting it into a saline aquifer some 2000m beneath the ground. Sequestration is designed to effectively contain carbon dioxide that would otherwise be vented to the atmosphere. Sequestration of carbon dioxide is a Government requirement for access to Barrow Island for the Gorgon project and this requirement is contained in conditions applied to the project. It is important that sequestration continues to be a significant part of the Gorgon project as it contributes to real reductions in the amount of carbon dioxide that would otherwise be vented to the atmosphere.

The addition of an extra LNG processing train as proposed would result in a 36% increase in direct carbon dioxide equivalent emissions of 1.45MTPA over the 60+ year life of the project. An increase in emissions of this magnitude is substantial and

should be mitigated or offset via appropriate mechanisms consistent with government policy at the time.

A condition on the approved project requires that provision is made for the injection of 100% of reservoir carbon dioxide and that, on a five year rolling average, at least 80% is injected. The EPA strongly supports the setting of measurable performance indicators such as those in this condition and believes that similar measureable indicators should be applied to all management actions wherever possible.

Table 12.4 of the PER indicates that the proponent has set a long run performance target for 95% of carbon dioxide to be injected, with performance up to this level being achievable sometimes from year two onwards and more consistently from year six. The EPA supports the proponent's commitment to a higher target and believes that the removal of carbon dioxide from the atmosphere is so important that the EPA recommends the proponent be requested to periodically update the EPA as to whether increasing the injection rate to 85% within five years of the commencement of operations and to 95% within seven years of the commencement of operations is feasible to achieve.

Summary

It is the EPA's opinion that the proposal is likely to marginally increase the level of risk of carbon dioxide leaks affecting flora and fauna on Barrow Island but finds that this level of risk is likely to be sufficiently low as to meet the EPA's objective for this factor.

A significant annual increase in the rate of carbon dioxide equivalent emissions would occur from the extra venting of reservoir carbon dioxide and the processing of LNG in the proposal. The life of project volume of emissions would remain the same if the proposal uses the same sources and volumes of reservoir gas as the approved project. The EPA finds that the proposal would increase annual carbon dioxide equivalent emissions but that the emissions rate per tonne of product would essentially be unchanged from that of the approved project.

While noting that significant volumes of reservoir carbon dioxide would be stored underground, the EPA considers, however, that residual emissions of the magnitude planned for this proposal should be mitigated or offset via appropriate mechanisms consistent with government policy at the time.

The EPA notes that sequestration of carbon dioxide is required by conditions applied to the approved project.

3.6 Air quality and noise

Description

The proponent advises that the modelled ground level concentrations of air pollutants for the approved project are not comparable to those of the proposal due to changes in engineering design and the use of different computer models to predict emissions. The proponent advises that the PER considers the cumulative effects of the proposal and other existing approved emission sources in the region.

Maximum predicted ground level concentrations modelled by the proponent for the nearest human residences at the proposed Gorgon construction camp are set out in Table 3 below.

Table 3. Maximum predicted ground level concentrations of air pollutants at nearest human habitation.

Pollutant	Circumstance	Averaging period	Percentage of standard
NO ₂	Cold start	1 hour averaging period	33.3%
O ₃	CO ₂ venting	1 hour averaging period	93.5%
SO ₂	Routine	1 hour averaging period	1.1%
PM ₁₀	CO ₂ venting	24 hour averaging period	1.6%

Source : Chevron, 2008

The PER provides deposition rates for sulphur dioxide (0.16 kg/ha/yr) and nitrogen dioxide (0.61 kg/ha/yr). These are respectively eight times and close to double those predicted for existing and approved sources in the modelled area. While there are no published standards for deposition of these chemicals on native vegetation, the proponent notes that they are respectively less than one fortieth and one eighth of World Health Organisation standards (WHO, 2000) for deposition on vegetation.

The addition of a third LNG train also results in noise levels received at staff accommodation areas rising from a range of 36 to 54 dB(A) for the approved project to 42 to 61 dB(A) for the current proposal (Chevron, 2008). Noise levels at the plant boundary are projected to increase by 35 dB(A). Comparison of noise diagrams in the ERMP (Chevron, 2005) and the PER (Chevron, 2008) indicates that noise levels during routine operations at turtle nesting beaches on the east coast may rise from a range of 50 to 55 dB(A) to a range of 55 to 60 dB(A).

Submissions

Key issues raised in submissions were :

- The assessment of PM₁₀ concentrations ignores background concentrations. The overall increment of PM₁₀ concentrations from the proposed development is minimal, but it is not acceptable to overlook this issue.
- The concentrations of ozone during CO₂ venting can be high. It appears that venting will occur for 20% of the time. It can not be said that attaining the modelled peak is 'highly improbable'. Consideration of the fifth or sixth highest ozone concentration might have been worthwhile.
- Predicted H₂S concentrations, particularly during CO₂ venting, are significant. A commonly quoted odour threshold for H₂S is 200µg/m³, which corresponds to a considerable fraction of the island surface.

Assessment

The EPA's objective for this factor is to ensure that emissions, by meeting statutory requirements and acceptable standards, do not adversely affect environmental values or the health, welfare and amenity of people and land uses.

Conditions applied to the approved project contain a number of provisions designed to assist in the management of air quality and the EPA considers that proper management of this issue remains important.

The pollutants listed are well within relevant standards for human receptors, except for ozone. Noting the proponent's advice that modelling was conservative, predicted ozone concentrations are close to the limit at 93.5% for worst case conditions which may occur up to 20% of the time. The EPA considers that approaching so close to the limit for ozone, essentially from one source, is not good practice. The EPA advises that such a level of precursor emissions of NO_x and VOCs is undesirable and considers that all practical efforts should be taken to reduce significantly the formation of ozone and hence its concentration where people reside. The EPA also notes press reports that there may be future plans to expand LNG production on Barrow Island and cautions that there may be insufficient air-shed space to accommodate the resultant air emissions if they were to occur at rates similar to those planned for this proposal.

The EPA notes there may be a material risk that H₂S emissions may exceed the odour threshold over a significant fraction of Barrow Island.

There are no data available on the effects of these pollutants on the fauna and flora of Barrow Island. In the absence of such standards, the EPA considers that the limit for humans is the only available surrogate for mammals and the WHO deposition limits are the only available surrogate for vegetation.

While the noise levels received at workers' accommodation remain within the relevant human exposure standards, they are nonetheless significant in magnitude and warrant appropriate management effort to make them as low as reasonably practicable.

There are no standards for noise levels received by fauna, however the available data indicates that noise levels received at the plant boundary would rise by 35 dB(A) and at turtle nesting beaches may rise by about 5 dB(A) over those expected for the approved project. The effect of this level of noise on turtle nesting is unknown.

Summary

It is the EPA's opinion that the proposal is likely to meet acceptable standards for air emissions generally but that photochemical smog formation arising from precursor emissions may be sufficiently close to the national standards as to present a risk that they may on occasions exceed the standard for ozone and thus not meet the EPA's objective for the ozone component of this factor.

The EPA considers that it is undesirable for ozone concentrations to approach 93.5% of the emission standard at residences, especially from a single source, when other developments may be proposed in future for the balance of the 300ha allocated to industrial development by Government on Barrow Island. All practicable steps should be taken to reduce the rate of precursor emissions to make them as low as reasonably practicable to prevent photochemical smog formation.

Noise levels experienced by human receptors would rise but remain within the relevant standards. No standards exist for fauna but levels would be about 5 dB(A) higher at turtle nesting beaches than those for the approved project.

The EPA considers that noise levels would be within relevant standards but that management effort should be directed to making the levels at sensitive receptor locations as low as reasonably practicable.

3.7 Environmental principles

In preparing this report and recommendations, the EPA has had regard for the object and principles contained in s4A of the *Environmental Protection Act (1986)*. Appendix 3 contains a summary of the EPA's consideration of the principles.

The principles considered were as follows:

1. The precautionary principle:
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 application of this precautionary principle, decisions should 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.
2. The principle of intergenerational equity:
The present generation should ensure that the health, diversity and productivity of the environment is maintained and enhanced for the benefit of future generations.
3. The principle of the conservation of biological diversity and ecological integrity:
Conservation of biological diversity and ecological integrity should be a fundamental consideration.

3.8 Matters of national environmental significance

This proposal is a controlled action under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and is being assessed subject to the Bilateral Agreement on Assessment by the Western Australian EPA. The controlling provisions relevant to the EPBC Act are Listed Threatened Species and Communities, and Listed Migratory Species.

Listed Threatened Species and Communities

The key listed threatened species that are likely to be affected by the additional impacts of the proposal are marine turtles, specifically the flatback turtle that nests on the beaches either side of Town Point on the east coast of Barrow Island. This factor is dealt with in detail in Section 3.1 and Appendix 3 of this report. The EPA has found that the proposal as presented does not provide a reasonable prospect for the long term viability of the Barrow Island flatback turtle rookery.

Following the receipt of independent specialist advice on marine turtles, the EPA has concluded that the primary method of achieving its objective for this factor would be

by way of a condition having the objective of the achievement of an *unaltered light horizon* (compared with the current natural conditions) from the perspectives of both gravid female flatback turtles and hatchlings. This condition should apply to those beaches and waters adjacent to Town Point that are used for nesting and by resultant hatchlings in their initial journey to the ocean.

Certain taxa of subterranean fauna are also listed threatened species. The factor of subterranean fauna is dealt with in detail in Section 3.4 and Appendix 3 of this report. The EPA has found that its objectives for the protection of the factor ‘subterranean fauna/ short range endemics’ cannot be met for the proposal as currently presented and surveys for species confined to the plant site should continue, ideally until these species are found elsewhere.

Other listed threatened species are present in the vicinity of the proposal. The main threatening processes to terrestrial listed species are the introduction of non-indigenous species which may compete with or directly threaten listed threatened species and the permanent clearing of an additional 40ha on Barrow Island. The EPA has concluded that it is likely that the quarantine system proposed, subject to it being implemented as proposed, would approach the limits of what is practical in terms of quarantine control. Threat levels to listed species are not likely to be materially increased by the additional clearing proposed.

Migratory Species

The key migratory species that are likely to be affected by the proposal are also marine turtles, specifically the flatback turtle that nests on the beaches on the east coast of Barrow Island. As mentioned above, the factor of marine turtles is dealt with in Section 3.1 and Appendix 3 of this report. The EPA has found the proposal as presented does not provide a reasonable prospect for the long term viability of the Barrow Island flatback turtle rookery and has made recommendations for addressing this matter. Other migratory birds and marine animals are not likely to be affected significantly beyond what has previously been assessed and authorised for the existing Gorgon project.

4. Other Advice

Use of Barrow Island

Gas from the Gorgon field is high in carbon dioxide. A fundamental justification by the proponent for using Barrow Island was the need for access to a suitable aquifer beneath the island for long term carbon dioxide storage. The EPA notes that sequestration of carbon dioxide is required by conditions applied to the approved project. If injection and long term storage of carbon dioxide produced with gas that is processed at the Gorgon plant is not achieved (for whatever reason, including the introduction of carbon markets) then the decision to permit gas processing on Barrow Island nature reserve should be reconsidered.

Defining marine environmental impacts associated with dredging

The EPA has previously outlined that predictions of potential environmental impacts from dredging has been defined in the context of three spatially-defined ‘zones’ –zone of high impact, zone of moderate impact and zone of influence. The process by which

these zones are defined is described in the ERMP prepared for the now approved project and the PER and associated documentation for this current proposal.

Within the zone of high impact the proponent predicts mortality of all benthic biota. Predictions for the zone of influence are for some potential physical effects of dredging (e.g. dredging-related turbidity above background turbidity levels) but the intensity and persistence of these effects would not be sufficient to cause ecological effects (e.g. no effects on corals or coral communities). Predicted impacts in these zones are generally consistent with the EPA's contemporary approach to the assessment of large-scale marine dredging proposals.

In the zone termed "moderate impact" the proponent predicts that all biota, with the exception of 70% of *Porites* coral present, would be killed as a result of exposure to dredging-related pressure in the zone of moderate impact. There is no expectation that *Porites* coral killed in this zone would recover for at least 30 years. For the purpose of assessment these impacts are considered irreversible. The proponent predicts that impacts to all other benthic biota in the zone of moderate impact represent a "temporary loss" because recovery is anticipated within 2-5 years after completion of construction.

Impacts predicted by the proponent for the zone of moderate impact are very severe, wide-spread and carry considerable uncertainty with respect to full recovery. The term 'moderate impact' in the context of this proposal could be interpreted as understating the severity of predicted and allowable impacts within this zone. The EPA's expectation for zones of moderate impact is that impacts within these zones would be sub-lethal, temporary and reversible within a reasonable timeframe. The EPA's preference is that zones of moderate impact are defined on the basis of sub-lethal effects, from which there is a demonstrable potential for biota to recover, within a reasonably short timeframe, of less than about five years.

Removing ambiguity from conditions to regulate and manage dredging

The EPA is cognizant of the set of conditions established in Ministerial Statement 748 to manage and regulate environmental effects of dredging for the project. On face value, it would appear that some key conditions may be considered to be internally inconsistent and there may be residual risk that such conditions would not limit impacts on coral assemblages off the east coast of Barrow Island to the intended area of 22 ha. The EPA draws the attention of the Expert Panels to Conditions 18, 20, and 22 in particular and requests that the relevant Expert Panels review them and recommends how to remove inconsistencies and ensure measurability.

Modelling in the ERMP for the now approved project predicted dredging-related impacts to the south of Town Point, disconnected from the marine infrastructure. The most recent modelling does not predict dredging-related impacts disconnected from the marine infrastructure to benthic communities south of Town Point. Given that zones of impact and influence are spatially defined in the Ministerial Statement for the project, if a decision is made by Government to allow the proposal to be implemented, then the changes to, and reduction in, areas of impact should be reflected in any Ministerial conditions that may be imposed on the revised and expanded Gorgon LNG proposal.

The terms ‘corals’ and ‘coral assemblages’ would profit from proper definition of what is meant by each term in each condition.

To properly control the risk of excess coral mortality occurring, sub-lethal triggers for management action should be considered for inclusion in conditions relevant to the dredging management plan.

Improving capacity to predict and manage environmental impacts of dredging

Residual predictive uncertainties are not unique to this proposal and similar issues present challenges for other dredging assessments in WA. In recognition of this, the Government required Woodside Energy Limited (WEL), as a ‘contributory offset’ associated with approval for the Pluto LNG project, to contribute towards scientific research to “improve the capacity of Government and industry to manage the impacts of dredging on tropical coral reef communities”. It is understood that a Research Plan is being prepared to address the overarching aim above.

The EPA expects that there would be overlap between research priorities identified in this Research Plan and sources of uncertainty in the prediction of marine environmental impacts associated with dredging for this proposal. The EPA recommends that the proponent explores options for contributing to, and participating in, this research work and request the relevant Expert Panel to advise both the proponent and the Minister on this matter.

Review of Performance

The EPA draws the attention of the Expert Panels to the limited focus on measurable outcomes in existing conditions, together with the level of uncertainty remaining with the impacts of the proposal on important environmental values over the 60+ year duration of the proposal. To address these matters, environmental management performance should be reviewed against the requirements of conditions on the proposal on a regular basis. Provisions should also be made for a periodic review of performance against conditions to determine whether the conditions are meeting their objectives and remain current, in the light of new knowledge and experience gained over time. Such a review process could be modeled on the approach that is taken with Forest Management Plans, where the EPA reviews performance on a five year cycle. The EPA recommends that this occur.

Expert panels

A number of Expert Panels have been mandated for the project. The EPA considers that these panels are required to play a significant and pivotal role in providing advice on how best to manage challenging issues of fundamental importance so as to provide the best protection possible for the critical environmental values of Barrow Island and its surroundings. The EPA recommends that these panels meet on a regular basis with the EPA.

Environmental Quality Management Framework

The *National Water Quality Management Strategy* provides a nationally-agreed framework for the management of waste discharges and other long-term development-related activities which have potential to impact on environmental quality. The *State Water Quality Management Strategy (SWQMS) Document 6* was prepared by the EPA and endorsed by Cabinet in 2004 to provide the framework for

WA's implementation of guidelines for fresh and marine water quality which are set out in the *National Water Quality Management Strategy* documentation.

Establishing and spatially-defining Environmental Values (EVs) and Environmental Quality Objectives (EQOs) are fundamental elements of this framework. EVs, EQOs and associated levels of ecological protection have been established and spatially-defined for State marine waters off the Pilbara coast (DoE, 2005) through a consultative process consistent with SWQMS Document 6. The EPA has endorsed these EVs, EQOs and levels of ecological protection, and their spatial applications, as 'interim' to guide environmental impact assessment, regulation of discharges and natural resource management in the Pilbara marine environment.

Development and operation of the marine infrastructure associated with the Gorgon proposals would have implications for the spatial application of EQOs and associated levels of ecological protection off the east coast of Barrow Island. Limited attention was given to addressing the EQMF during the environmental impact assessment process for the approved project.

The EPA is of the view that if Government was to approve the proposal, then conditions should be included in an appropriate implementation statement that require the project to be managed in the context of the EQMF.

Lighting guidance

The EPA is aware that there is a lack of policy guidance on the impacts of artificial lighting on native fauna. The impacts of artificial lighting are particularly relevant to the reproductive success of marine turtles, which are variously listed as threatened and endangered at state and national level. Turtle nesting on beaches in Queensland has declined significantly as development there has increased artificial lighting along the coast.

Western Australia currently has relatively few developments along the Gascoyne, Pilbara and Kimberley coasts where marine turtles nest. It will be particularly important to have access to appropriate policy guidance as major new developments are planned in these regions. The EPA is aware that the Department of Environment, Water, Heritage and the Arts (DEWHA) is collecting information which may assist in providing such guidance and the EPA will liaise with DEWHA with a view to assessing the need to develop guidance on this important matter.

Appendix 1

List of submitters

Organisations:

Cape Conservation Group
Chamber of Commerce and Industry WA
Conservation Commission of WA
Conservation Council of WA
Department of Environment and Conservation (DEC)
DEC - Marine Ecosystems Branch
DEC - Air Quality Branch
Department of Fisheries
Department of Health
Department of Industry and Resources
Department of Planning and Infrastructure
Department of Water
Fire and Emergency Services Authority of WA
Marine Parks and Reserves Authority
National Offshore Petroleum Safety Authority
Western Australian Museum
World Wide Fund for Nature Australia

Individuals:

Anonymous

Appendix 2

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Appendix 3

Summary of key environmental factors and principles

Analysis of Key Factors for Gorgon Revised and Expanded Proposal

Factor/ stressor	EPA objective	Different or additional effects	Data / advice	Capacity of existing conditions and offsets to enable EPA objectives to be met for additional impacts?	Could new conditions assist EPA objectives to be met for additional impacts?
Turtles Light	Maintain the abundance, diversity, geographic distribution and productivity of marine fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.	<p>50% increase from 2 to 3 LNG trains.</p> <p>Additional lighting to illuminate extra train¹. Lighting equivalent to full to quarter moon².</p> <p>3 to 6 month extra construction period overall³ 36 months for causeway/MOF⁴</p> <p>50% increase in non-routine flaring events⁵.</p> <p>Additional lighting for ~25%</p>	<p>Likely material increase in lighting and glow visible from nesting beaches. (Modelling of existing project and current proposal not comparable because proponent used different light models).</p> <p>Significant increase in duration of lighting over water likely to significantly increase predation of hatchlings.</p>	<p>Light and glow from plant, causeway and shipping probably cannot be reduced further using existing conditions.</p> <p>Capacity of offsets to mitigate losses at Barrow Island not known and uncertain. Nesting on Barrow Island may be important at population level due to likely cooler nest conditions</p>	<p>Unaltered, natural light horizons required. Lighting management plan would assist to codify all practical actions. Barrier erected behind beach may assist; may not be regarded as practical. Relocation of flares inland, opaque shielding of lighting on plant, marine infrastructure and ships would assist. Seek advice from Marine Turtle Expert Panel.</p> <p>Additional research could assist in understanding relevant questions about light impacts on turtles over the long term.</p> <p>Proposal as presented does not provide reasonable prospect for long term viability of listed turtle population.</p> <p>Significant additional impacts require stringent management.</p>

Factor/ stressor	EPA objective	Different or additional effects	Data / advice	Capacity of existing conditions and offsets to enable EPA objectives to be met for additional impacts?	Could new conditions assist EPA objectives to be met for additional impacts?
		<p>to 50% more ship movements⁶.</p> <p>800m extra causeway length requires more lights.</p>	<p>Turtles respond to horizons lit by star light alone (no moon).</p> <p>Increased light would lead to reduced reproductive success, increased hatchling disorientation and increased hatchling predation.</p> <p>Significant additional population level effects possible over 60+ year project life.</p>	<p>providing gender balance for hatchlings emerging from warmer mainland nests.</p>	<p>Obtain advice of MTEP.</p>
Noise/ blasting	Maintain the abundance,	35+ dB(A) increase at plant	Increased noise at plant boundary is	Existing conditions	Practicality of reducing significant increases in noise unknown but unlikely,

Factor/ stressor	EPA objective	Different or additional effects	Data / advice	Capacity of existing conditions and offsets to enable EPA objectives to be met for additional impacts?	Could new conditions assist EPA objectives to be met for additional impacts?
	diversity, geographic distribution and productivity of marine fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.	boundary ⁷ . Additional flares, up to 70-75+ dB(A) at turtle nesting beach from ground flare upsets ⁸ . Noise levels increase from between 50 and 55 dB(A) to between 55 and 60 dB(A) ⁹ for a ~5 dB(A) increase at turtle beach south of causeway. 50,000m ³ marine blasting ¹⁰ . ~25-50% increase LNG vessel movements ⁶ . Proportional increase in	significant. Ground flare noise levels are significant; (up to 10 times/yr) Increased noise at nesting beaches, based on modelling. No standards exist and effects of noise on nesting behaviour unknown. Turtle deaths reported within ~10s of metres to 100+metres of blasting; loss of consciousness	unlikely to further reduce increased noise levels from expansion.	especially for plant and ground flares. Additional research could assist in understanding relevant impacts of noise on turtles over the long term. Significance of additional impacts not known. Ability to mitigate further may be limited.

Factor/ stressor	EPA objective	Different or additional effects	Data / advice	Capacity of existing conditions and offsets to enable EPA objectives to be met for additional impacts?	Could new conditions assist EPA objectives to be met for additional impacts?
		support vessel movements.	>900m away. Turtles seem to habituate to vessel noise.		
Drilling/ piling percussion	Maintain the abundance, diversity, geographic distribution and productivity of marine fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.	Decrease in drilling/piling because jetty shortened from ~2.7km to ~2.1km ¹² .	Percussion noise significant within 100m; physical injury possible at this range.	Duration of impacts expected to be reduced.	Reduced impact.
Vibration	Maintain the abundance, diversity, geographic	50 % increase from 2 to 3 LNG trains. Additional vibration from	Vibration effects expected to increase significantly from	Existing conditions unlikely to further reduce	Practicality of reducing increased vibration unknown but unlikely, especially for plant.

Factor/ stressor	EPA objective	Different or additional effects	Data / advice	Capacity of existing conditions and offsets to enable EPA objectives to be met for additional impacts?	Could new conditions assist EPA objectives to be met for additional impacts?
	distribution and productivity of marine fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.	extra train; reduced jetty piling; 50,000m ³ marine blasting ¹⁰ .	plant but impacts on turtles at population level unknown. Evidence that vibration caused mis-orientation in hatchlings.	increased vibration levels from expansion.	Additional research could assist in understanding relevant impacts of vibration on turtles over the long term. Increased impact. Significance of additional impacts not known. Ability to mitigate further may be limited.
Vessel strike	Maintain the abundance, diversity, geographic distribution and productivity of marine fauna at species and ecosystem levels through the avoidance or management of	~25-50% increase LNG vessel movements ⁶ . Proportional increase in support vessel movements.	~25-50% increase in vessel strike likely from tankers operating in channels with limited draft. Turtles resting at channel toe sucked into propellers. Proportional increase in	Limited ability to manage vessel strike from large tankers in confined channels	No effective change likely to be possible. Increased chronic impacts. Significance of impact may be limited at population level. Ability to mitigate further may be limited.

Factor/ stressor	EPA objective	Different or additional effects	Data / advice	Capacity of existing conditions and offsets to enable EPA objectives to be met for additional impacts?	Could new conditions assist EPA objectives to be met for additional impacts?
	adverse impacts and improvement in knowledge.		support vessel strike risk but likely to be limited for small vessels. Deaths likely on a routine basis but may not have population level effects.		
Turbidity	Maintain the abundance, diversity, geographic distribution and productivity of marine fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in	Causeway/MOF extended 800m from ~1320m to ~2120m ¹³ . Increased duration of turbidity induced by rock and fill dumping during construction. MOF construction duration 36 months. Significant increase in extent	Unknown effects on nesting and hatchling turtles due to turbidity generated during construction. May disrupt two or three nesting seasons, depending on seasonality of construction. May have detectable effect at population level	Existing conditions rely on limiting turbidity to defined zones. Require change to deal with altered zones.	High and moderate impact zones increased significantly around causeway/MOF. Impact zones reduced elsewhere. Redefine zones. Real time monitoring and sub-lethal triggers for dredge management would assist. Additional research could assist in understanding relevant impacts of turbidity on turtles over the long term. Significance of additional impacts around causeway/MOF not known.

Factor/ stressor	EPA objective	Different or additional effects	Data / advice	Capacity of existing conditions and offsets to enable EPA objectives to be met for additional impacts?	Could new conditions assist EPA objectives to be met for additional impacts?
	knowledge.	of high and moderate impact zones around causeway ¹⁴	in 2-3 decades when lost hatchlings would have reached nesting age. >70% of functional population required to ensure long term viability (Limpus, pers. comm.)		Ability to mitigate further may be limited. Reduced impacts around LNG channel and spoil ground.
Energy expenditure	Maintain the abundance, diversity, geographic distribution and productivity of marine fauna at species and ecosystem levels through the avoidance or management of adverse impacts	Increased energy expended by nesting and hatchling turtles when swimming around 2km long causeway.	Impacts unknown but may have some affect on overall reproductive success if extra energy use by adult females and dispersal of hatchlings is biologically significant.	Conditions unlikely to influence outcome.	Effective and practical additions to conditions unlikely. Significance of additional impact unknown but may be chronic rather than acute at population level.

Factor/ stressor	EPA objective	Different or additional effects	Data / advice	Capacity of existing conditions and offsets to enable EPA objectives to be met for additional impacts?	Could new conditions assist EPA objectives to be met for additional impacts?
	and improvement in knowledge.				
Dredging and marine infrastructure Habitat removal Permanent coral loss	Maintain marine ecological integrity and biodiversity and ensure the criteria in EPA Guidance Statement 29 are met.	Increase from 206.4ha to ~211.9ha direct footprint of channels, causeway, MOF and jetty Additional 6.5ha (~3%) direct habitat removal ¹⁵ Some coral bombora avoided (no data on area). Slight increase in permanent loss from 22.0 to 22.6ha off east coast ¹⁶	Proportional increase in direct habitat loss	Loss fixed – require change to condition to deal with expanded footprint.	Loss fixed – no additional management possible. Additional direct loss not likely to be significant at regional level.
Smothering	Maintain marine ecological	100% increase in area of high	Significant (100%) increase	Existing conditions rely	High impact zone increased significantly around causeway/MOF – to within

Factor/ stressor	EPA objective	Different or additional effects	Data / advice	Capacity of existing conditions and offsets to enable EPA objectives to be met for additional impacts?	Could new conditions assist EPA objectives to be met for additional impacts?
	<p>integrity and biodiversity and ensure the criteria in EPA Guidance Statement 29 are met.</p>	<p>impact zone around MOF (from 148ha to 298ha) due to revisions to causeway/MOF extent and construction method.</p> <p>18% increase in high impact zone around LNG channel (from 411 to 483ha).</p> <p>Net effect of changed channel length & width results in approx. same dredged volume of ~7.6M m³ dredging.</p> <p>Significantly</p>	<p>in extent of smothering of benthos around causeway/MOF likely.</p>	<p>on limiting impacts to defined zones.</p>	<p>350m of Lowendal Shelf.</p> <p>Revise condition to redefine impact zones.</p> <p>Real time monitoring and sub-lethal triggers for dredge management would assist.</p> <p>Additional field monitoring and research could assist in understanding turbidity generation and relationship of turbidity generated to extent and impacts of smothering.</p> <p>Significance of additional loss due to smothering undefined but non-trivial.</p>

Factor/ stressor	EPA objective	Different or additional effects	Data / advice	Capacity of existing conditions and offsets to enable EPA objectives to be met for additional impacts?	Could new conditions assist EPA objectives to be met for additional impacts?
		reduced extent of impact zones elsewhere.			
Turbidity	Maintain marine ecological integrity and biodiversity and ensure the criteria in EPA Guidance Statement 29 are met.	<p>Revised causeway/MOF extended 800m;</p> <p>100% increase in area of high impact zone around MOF (from 148ha to 298ha);</p> <p>67% increase in moderate impact zone around MOF (from 385ha to 644ha).</p> <p>Reduced extent of impact zones elsewhere.</p> <p>Revised dredging</p>	<p>Significantly increased extent of high (+100%) and moderate (+67%) impact zones around causeway/MOF. Increased likelihood of spillover and impact on coral habitat on Lowendal Shelf with recognised high regional values under adverse weather conditions or through loss of operational control.</p> <p>Reduced extent of</p>	<p>Existing conditions rely on limiting impacts to defined footprint.</p> <p>Require change to fix inconsistency and deal with expanded footprint.</p> <p>Existing conditions are not capable of enabling EPA objective to be met.</p>	<p>Real time monitoring and setting of sub-lethal triggers for management action would provide better assurance that 22ha limit would not be exceeded.</p> <p>Outcome based condition could be set to specify that moderate impact zone should not approach closer than a specified distance from the Lowendal Shelf.</p> <p>Additional research over the long term could assist in understanding relationship between turbidity levels and light attenuation and impacts of turbidity on benthos.</p> <p>Increased likelihood of impact to regionally significant corals on Lowendal Shelf.</p> <p>Additional stringent controls required</p>

Factor/ stressor	EPA objective	Different or additional effects	Data / advice	Capacity of existing conditions and offsets to enable EPA objectives to be met for additional impacts?	Could new conditions assist EPA objectives to be met for additional impacts?
		<p>method increases fines released during MOF channel dredging by 23% to 375,000t of fines <79µm;</p> <p>Increase in construction duration.</p> <p>Moderate impact zone moves from ~1000m away from Lowendal Shelf to within ~350m of Lowendal Shelf¹⁴</p> <p>~7.6M m³ of channel dredging remains the same.</p> <p>No change in</p>	<p>impact zones elsewhere, further away from regionally important habitat.</p> <p>Existing conditions 18 and 21 are internally inconsistent. There is significant risk that the 22ha limit on “coral assemblage” loss (condition 18.1) would not be complied with because the monitoring and management framework (condition 21) utilises the least sensitive</p>		<p>to assist to manage risks.</p> <p>Apply real time monitoring and modelling against sub-lethal trigger levels with corrective action including cessation of dredging when required to protect environmental values. Obtain advice of CDEEP.</p>

Factor/ stressor	EPA objective	Different or additional effects	Data / advice	Capacity of existing conditions and offsets to enable EPA objectives to be met for additional impacts?	Could new conditions assist EPA objectives to be met for additional impacts?
		predictive capacity of dredge impacts.	component of the “coral assemblage” to trigger management responses. This would not provide advance warning soon enough to allow management responses to avoid exceeding the 22ha limit for coral assemblage loss. Expansion of the impact zones in the revised proposal may exacerbate this problem.		
Marine blasting Noise/	Maintain marine ecological integrity and	ERMP (p 506) noted “some blasting may be	Blasting can kill marine fauna. Quantity of	Ministerial conditions require	Not likely to be a significant change

Factor/ stressor	EPA objective	Different or additional effects	Data / advice	Capacity of existing conditions and offsets to enable EPA objectives to be met for additional impacts?	Could new conditions assist EPA objectives to be met for additional impacts?
percussion	biodiversity and ensure the criteria in EPA Guidance Statement 29 are met.	necessary". 50, 000 m ³ now confirmed as best estimate of amount of blasting required ¹⁰	blasting required is relatively small compared to overall volume requiring dredging.	avoidance of blasting as far as practicable and management plan if blasting is to occur. Existing requirement for management plan should be able to deal adequately with this volume of blasting.	but include plan for management.
Turbidity/ Sedimentation effects on marine fauna from drill and blast	Maintain marine ecological integrity and biodiversity and ensure the criteria in EPA Guidance Statement 29 are met.	50,000m ³ blasting, compare to 7.6Mm ³ dredging	Quantity is relatively small compared to overall volume requiring dredging.	Existing requirement for management plan should be able to deal adequately with this volume of blasting.	Not likely to be a significant change.
Marine	Maintain marine	No change.	No change	Management of	Requirement for appropriate seismic

Factor/ stressor	EPA objective	Different or additional effects	Data / advice	Capacity of existing conditions and offsets to enable EPA objectives to be met for additional impacts?	Could new conditions assist EPA objectives to be met for additional impacts?
	knowledge.	modules from foreign ports (not quantified). ~25% - 50% increase in vessel movements ⁶ . Proportional increase in support vessel movements.	of introducing (more serious) foreign non- indigenous organisms. Likelihood of introductions from this source increases if same level of control is exercised per shipment but number of shipments increases. ~25-50% increase in likelihood of introducing non- indigenous marine organisms via this pathway.	provide same level of control for additional risk Managed by existing conditions.	indigenous organism risk from shipments. Increased number of shipments from foreign ports increases overall likelihood of introductions from this source. Probably no practical additional actions that could be taken to manage overall increased likelihood of introductions from this source.

Factor/ stressor	EPA objective	Different or additional effects	Data / advice	Capacity of existing conditions and offsets to enable EPA objectives to be met for additional impacts?	Could new conditions assist EPA objectives to be met for additional impacts?
		<p>Reduced shipping of individual components from mainland - (no data provided on change in shipment numbers).</p> <p>No increase in construction workforce.</p> <p>Increased construction period of 3-6 months³</p>	<p>Reduced but un-quantified risk of introducing (less serious) NIS from mainland.</p> <p>Neutral</p> <p>Increased duration increases overall likelihood of introductions from high risk personnel, food, perishables and luggage pathways.</p>	<p>Managed by existing conditions.</p>	<p>Probably no practical additional actions that could be taken to manage overall increased likelihood of introductions from this source.</p> <p>Increased likelihood of introductions from overseas sources due to increased number of ship movements from foreign ports. Significance unknown but overall threat likely to be increased especially in marine area.</p> <p>Advice of QEP on measurable indicators and periodic review of quarantine plans by EPA would assist in ongoing scrutiny of threat level.</p>
Subterranean fauna/ short range	Maintain the abundance, diversity,	200ha permanent clearing increased to 240ha	Proportional increase in permanent habitat	Overall reduction in risk of species loss.	Some evidence that increased survey will detect restricted species.

Factor/ stressor	EPA objective	Different or additional effects	Data / advice	Capacity of existing conditions and offsets to enable EPA objectives to be met for additional impacts?	Could new conditions assist EPA objectives to be met for additional impacts?
endemics Clearing/ cut and fill	geographic distribution and productivity of subterranean fauna at species and ecosystems levels through the avoidance or management of adverse impacts and improvement in knowledge.	permanent clearing ¹⁷ . 7 subterranean fauna taxa and 2 terrestrial taxa not previously found outside plant footprint now reduced to 4 subterranean taxa and 1 terrestrial taxon not yet found outside plant footprint ¹⁸ .	loss. Reduction in risk of fauna extinctions due to reduction in number of taxa confined to site but 5 taxa could still be driven extinct if not subsequently found elsewhere.		Reduced number of taxa at risk but extinction of remaining taxa could still occur. Ongoing survey required.
Pollution/ spills	Maintain the abundance, diversity, geographic distribution and productivity of subterranean fauna at species and ecosystems levels through	As above.	Reduced but still present risk of species extinction.	As above.	Some evidence that increased survey will detect restricted species. Reduced number of taxa at risk but extinction of remaining taxa could still occur. Number of taxa at risk is now less. Ongoing survey required.

Factor/ stressor	EPA objective	Different or additional effects	Data / advice	Capacity of existing conditions and offsets to enable EPA objectives to be met for additional impacts?	Could new conditions assist EPA objectives to be met for additional impacts?
	the avoidance or management of adverse impacts and improvement in knowledge.				
Greenhouse gases Carbon dioxide on Terrestrial and subterranean fauna	Maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystems levels through the avoidance or management of adverse impacts and improvement in knowledge.	2-3 injection centres, with 7 injection wells increased to 3-4 injection centres, 8-9 injection wells, with delivery pipeline length increased by 5km ¹⁹ .	Increased asphyxiation likelihood to terrestrial and subterranean fauna from increased total likelihood of leaks because increased number of facilities is present. Risk of impacts at population level uncertain.	Existing conditions to manage approved level of risk.	Significance of risk at population level unknown but likelihood of leaks probably low.
Greenhouse gases on	Minimise greenhouse gas	4.0MTPA carbon dioxide	Total increased annual rate of	Total volume managed by	

Factor/ stressor	EPA objective	Different or additional effects	Data / advice	Capacity of existing conditions and offsets to enable EPA objectives to be met for additional impacts?	Could new conditions assist EPA objectives to be met for additional impacts?
Global atmosphere	emissions in absolute terms and reduce emissions per unit of product to as low as reasonably practicable; and mitigate greenhouse gas emissions, mindful of Commonwealth and State greenhouse gas strategies and programmes.	equivalent increased by 1.45MTPA to 5.45MTPA total carbon dioxide equivalent vented ²⁰ . Reservoir carbon dioxide vented increased by 0.16MTPA to 0.84MTPA reservoir carbon dioxide vented ²¹ .	1.61MTPA of carbon dioxide equivalents vented is significant but overall volume of carbon dioxide equivalents vented over the project life is unchanged.	existing approval and conditions.	Significant change in annual rate of carbon dioxide equivalent emissions but no change in life of project volume. Continue to mitigate residual emissions via contemporary government policy.
Air quality	Ensure that emissions meet statutory requirements and acceptable standards and do not adversely		Air emissions for approved project not comparable to expanded proposal due to changes in engineering		

Factor/ stressor	EPA objective	Different or additional effects	Data / advice	Capacity of existing conditions and offsets to enable EPA objectives to be met for additional impacts?	Could new conditions assist EPA objectives to be met for additional impacts?
NO ₂ on Local atmosphere	affect environmental values or the health, welfare and amenity of people and land uses.	NO ₂ is 33.3% of NEPM standard ²² (cold start, 1 hour averaging period)	design and different computer model used. Cumulative effects of expanded proposal and existing approved sources used. Meets standards for human health.	Managed by existing conditions.	Ensure properly controlled by Part V of EP Act.
O ₃	Ensure that emissions meet statutory requirements and acceptable standards and do not adversely affect environmental values or the health, welfare	O ₃ is 93.5% ²² of NEPM standard (CO ₂ venting, 1 hour averaging period)	Meets standards for human health, but approaching limit.	Managed by existing conditions	Take all practical steps to reduce to ALARP levels and ensure standard not exceeded. Capacity may not exist for any future expansion. Ensure properly controlled by Part V of EP Act.

Factor/ stressor	EPA objective	Different or additional effects	Data / advice	Capacity of existing conditions and offsets to enable EPA objectives to be met for additional impacts?	Could new conditions assist EPA objectives to be met for additional impacts?
	and amenity of people and land uses.				
SO ₂	Ensure that emissions meet statutory requirements and acceptable standards and do not adversely affect environmental values or the health, welfare and amenity of people and land uses.	SO ₂ emitted is 1.1% ²² of NEPM standard (routine, 1 hour averaging period).	Meets standards.	Managed by existing conditions.	Ensure properly controlled by Part V of EP Act.
PM ₁₀	Ensure that emissions meet statutory requirements and acceptable standards and do	PM ₁₀ level is 1.6% ²² of NEPM standard (CO ₂ venting, 24 hour averaging period).	Meets standards.	Managed by existing conditions.	Ensure properly controlled by Part V of EP Act.

Factor/ stressor	EPA objective	Different or additional effects	Data / advice	Capacity of existing conditions and offsets to enable EPA objectives to be met for additional impacts?	Could new conditions assist EPA objectives to be met for additional impacts?
	not adversely affect environmental values or the health, welfare and amenity of people and land uses.				
SO ₂ on local vegetation	Ensure that emissions meet statutory requirements and acceptable standards and do not adversely affect environmental values or the health, welfare and amenity of people and land uses.	0.02 kg/ha/yr max. predicted deposition for approved project increased to 0.16 kg/ha/yr max predicted deposition now estimated for 3 train proposal.	Meets standards ($<1/40^{\text{th}}$ of standard).	Managed by existing conditions.	Ensure properly controlled by Part V of EP Act.
NO ₂ on local	Ensure that	0.34 kg/ha/yr	Meets standards	Managed by	Ensure properly controlled by Part V

Factor/ stressor	EPA objective	Different or additional effects	Data / advice	Capacity of existing conditions and offsets to enable EPA objectives to be met for additional impacts?	Could new conditions assist EPA objectives to be met for additional impacts?
vegetation	emissions meet statutory requirements and acceptable standards and do not adversely affect environmental values or the health, welfare and amenity of people and land uses.	max. predicted deposition for approved project now estimated as 0.61 kg/ha/yr max. predicted deposition for 3 train proposal.	(<1/8 th of standard).	existing conditions.	of EP Act.
Noise Plant noise on Gorgon staff	Protect the amenity of residents at nearby habitation from noise impacts resulting from activities associated with the proposal by ensuring that	Additional plant increases noise at habitation from between 36 and 54 dB(A) to between 42.3 and 60.6 dB(A) ²³ for a 6 to 9 dB(A) increase in noise levels but still meets human	Meets standards	Can be managed by existing conditions	

Factor/ stressor	EPA objective	Different or additional effects	Data / advice	Capacity of existing conditions and offsets to enable EPA objectives to be met for additional impacts?	Could new conditions assist EPA objectives to be met for additional impacts?
	noise levels meet the statutory requirements and acceptable standards	exposure standards ; 50% increase in non-routine flaring events			
Plant noise on terrestrial fauna	Maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystems levels through the avoidance or management of adverse impacts and improvement in knowledge.	Routine operating noise levels increase 35+ dB(A) at plant boundary.	No standards exist and levels are significant. Effects of noise on terrestrial fauna unknown. Fauna may habituate or sites close to plant may no longer be viable habitat.	Increased noise levels unlikely to be further mitigated by existing conditions.	Further noise reduction desirable but unlikely to be regarded as practical by proponent. Impact not known but may not be significant at population level.
Shipping noise impacts on marine fauna	Maintain the abundance, diversity,	~25 – 50% increase in occurrence of	Marine turtles are believed to habituate to	Can be managed by existing conditions.	Impact not known but may not be

Factor/ stressor	EPA objective	Different or additional effects	Data / advice	Capacity of existing conditions and offsets to enable EPA objectives to be met for additional impacts?	Could new conditions assist EPA objectives to be met for additional impacts?
	geographic distribution and productivity of fauna at species and ecosystems levels through the avoidance or management of adverse impacts and improvement in knowledge.	noisy events due to increased ²⁴ tanker off-take events and associated support vessel activities	shipping noise (Limpus, pers. comm.). Impacts on whales and dugong unknown but limited numbers expected to frequent east coast of Barrow Island.		significant at population level.

1 Lighting levels for approved project not comparable to expanded proposal due to different computer models used.

2 p226 PER

3 p111 PER

4 p10 Response to Submissions (12 months within 500m of Town Point)

5 p227 PER

6 p150 PER; p 46 Appendix C

7 Sect 2.4 p8 Appendix D PER

8 Table 11.5 p242 PER

9 Interpreted from Figure 11.1 p240 PER

10 p34 PER

11 p150 PER

11a p46 Appendix C PER

12 Table 7.1 p149 PER

13 Table 2.1 p25 PER

14 Fig 7.6 p189 PER
15 Table 7.4 p168 PER
16 p202 PER
17 Table 6.3 p124 PER
18 Chevron pers. comm. 16 Jan 2009.
19 Table 2.1 p24 PER
20 p253 PER
21 Table 2.2 p32 PER
22 Highest Maximum Predicted Percentages of Assessment Criteria modeled at accommodation locations for human receptors from Tables 9.2 and 9.3 p221 PER
23 Table 11.4 p239 PER
24 p 235 PER

PRINCIPLES		
Principle	Relevant Yes/No	If yes, Consideration
<p>1. The precautionary principle <i>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.</i> <i>In application of this precautionary principle, decisions should be guided by –</i> (c) <i>careful evaluation to avoid, where practicable, serious or irreversible damage to the environment; and</i> (d) <i>an assessment of the risk-weighted consequences of various options.</i></p>		
	Yes	<p>In considering this principle, the EPA has been aware that there is a degree of uncertainty around the likely impacts associated with a number of factors considered in this assessment. Where the level of uncertainty is sufficiently high and the significance of the environmental values associated with a factor is also high, then the EPA has taken a precautionary approach to its assessment. This approach has been applied in particular to:</p> <ul style="list-style-type: none"> - marine turtles, and - turbidity generated by dredging and marine construction.
<p>2. The principle of intergenerational equity <i>The present generation should ensure that the health, diversity and productivity of the environment is maintained and enhanced for the benefit of future generations.</i></p>		
	Yes	<p>In considering this principle the EPA notes that:</p> <ul style="list-style-type: none"> - this proposal has a life of 60+ years that extends over more than one human generation; - Barrow Island is a class A nature reserve which demands that particular attention is given to this principle; - the biodiversity and reserve status of Barrow Island and the surrounding waters are considered relevant environmental factors and are discussed in the body of this report.
<p>3. The principle of the conservation of biological diversity and ecological integrity <i>Conservation of biological diversity and ecological integrity should be a fundamental consideration.</i></p>		
	Yes	<p>In considering this principle the EPA notes that:</p> <ul style="list-style-type: none"> - Barrow Island is a class A nature reserve which demands that particular attention is given to this principle; - the conservation and ecological values of Barrow Island and the surrounding waters are considered relevant environmental factors and are discussed in the body of this report.

Appendix 4

**Summary of Submissions and
Proponent's Response to Submissions
(see CD inside back cover)**