Gorgon Gas Development

Response to Submissions: Gorgon Gas Development Revised and Expanded Proposal, Public Environmental Review

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RESPONSE TO SUBMISSIONS: GORGON GAS DEVELOPMENT REVISED AND EXPANDED PROPOSAL, PUBLIC ENVIRONMENTAL REVIEW

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1.0 INTRODUCTION

1.1 Proposal

Chevron Australia is the Proponent and operator for the Gorgon Gas Development (the Development), on behalf of the Gorgon Joint Venturers (GJVs). Chevron Australia proposes to develop the gas reserves of the Greater Gorgon Area. To date it has received approval to construct facilities on Barrow Island for the processing of gas from the Greater Gorgon Area, and to extract gas from the Gorgon gas field. Mobil Australia Resources Company Pty Limited has separately received approval to extract gas from the Jansz–Io gas field and associated works to transport it the Gorgon Barrow Island facilities for processing.

Subsea gathering systems and subsea pipelines will be installed to deliver feed gas from the Gorgon gas field to the west coast of Barrow Island. The feed-gas pipeline system will be buried as it traverses from the west coast to the east coast of the Island where the system will tie in to the Gas Treatment Plant located at Town Point. The Gas Treatment Plant will comprise Liquefied Natural Gas (LNG) trains capable of producing a nominal capacity of five million tonnes per annum (MTPA) per train. The Gas Treatment Plant will also produce condensate and domestic gas. Carbon dioxide (CO_2), which occurs naturally in the feed-gas, will be separated during the production process. As part of the Gorgon Gas Development, Chevron Australia will inject the separated CO_2 into deep formations below Barrow Island. The LNG and condensate will be loaded from a dedicated jetty offshore from Town Point and then transported by dedicated carriers to international markets. Gas for domestic use will be exported by a pipeline from Town Point to the domestic gas collection and distribution network on the mainland.

The Gorgon gas field is located approximately 130 km off the north-west coast of Western Australia. Barrow Island is located off the Pilbara coast 85 km north-north-east of the town of Onslow and 140 km west of Karratha. The Island is approximately 25 km long and 10 km wide and covers 23 567 ha. It is the largest of a group of islands, including the Montebello and Lowendal Islands.

State environmental approval for the Gorgon Gas Development was granted by the Western Australian (WA) Minister for the Environment on 6 September 2007 (with conditions of approval described in Ministerial Implementation Statement (Statement) No. 748). The then Commonwealth Minister for the Environment and Water Resources granted approval on 3 October 2007 (EPBC Reference: 2003/1294). In May 2008, the Environmental Protection Authority (EPA) approved some minor changes to the Approved Development, under section 45C of the *Environmental Protection Act 1986* (EP Act).

Since then, the GJVs have determined the need for additional changes to the previously approved development. The changes were considered to be of sufficient magnitude that they could not be addressed under section 45C of the EP Act, and were therefore required to be assessed as a new proposal under both State and Federal environmental legislation. These changes are detailed in the Public Environmental Review (PER) prepared for the Gorgon Gas Development Revised and Expanded Proposal (Revised Proposal), and are summarised as follows:

- addition of one 5 million tonnes per annum (MTPA) liquefied natural gas (LNG) train, increasing the number of LNG trains from two to three in order to generate a greater volume of clean-burning natural gas sooner in a rapidly growing global energy market
- changes to the Reservoir CO_2 Injection System to allow for an increased injection rate associated with the addition of one LNG train, increasing the number of injection wells and surface drill centre locations

- revision of the design of the causeway and the Materials Offloading Facility (MOF) to allow access to deeper water to be achieved while avoiding hard rock material and the need for an extensive drilling and blasting program.

1.2 Assessment Process

The State and Commonwealth assessment processes are described below.

1.2.1 Western Australian Environmental Impact Assessment Process

The Revised Proposal was referred to the Western Australian EPA under section 38 of the EP Act on 22 February 2008. On 17 March 2008, the EPA assigned the Revised Proposal a PER level of assessment with an eight week public review period. A PER document was prepared which described the proposal and its likely effects on the environment (Chevron Australia 2008). The PER was submitted to the EPA for endorsement for release for public review and was subsequently released for an eight week public review period commencing on 15 September 2008 and closing on 10 November 2008.

1.2.2 Commonwealth Environmental Impact Assessment Process

The Revised Proposal was referred to the Commonwealth (Cth) Minister for the Environment, Water, Heritage and the Arts, under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) on 21 April 2008. On 23 May 2008, the Department of the Environment, Water, Heritage and the Arts (DEWHA) advised that the action was considered a 'controlled action' under the EPBC Act (EPBC Reference: 2008/4178) due to the potential significant impacts on the following controlling provisions:

- listed threatened species and communities (sections 18 and 18A)
- listed migratory species (sections 20 and 20A).

As the Revised Proposal will be assessed by the WA Government at the PER level of assessment, the Western Australian/Commonwealth Assessment Bilateral Agreement has been applied to the Revised Proposal. Figure 1.1 outlines the bilateral agreement procedure for a PER level of assessment under the EP Act and EPBC Act.

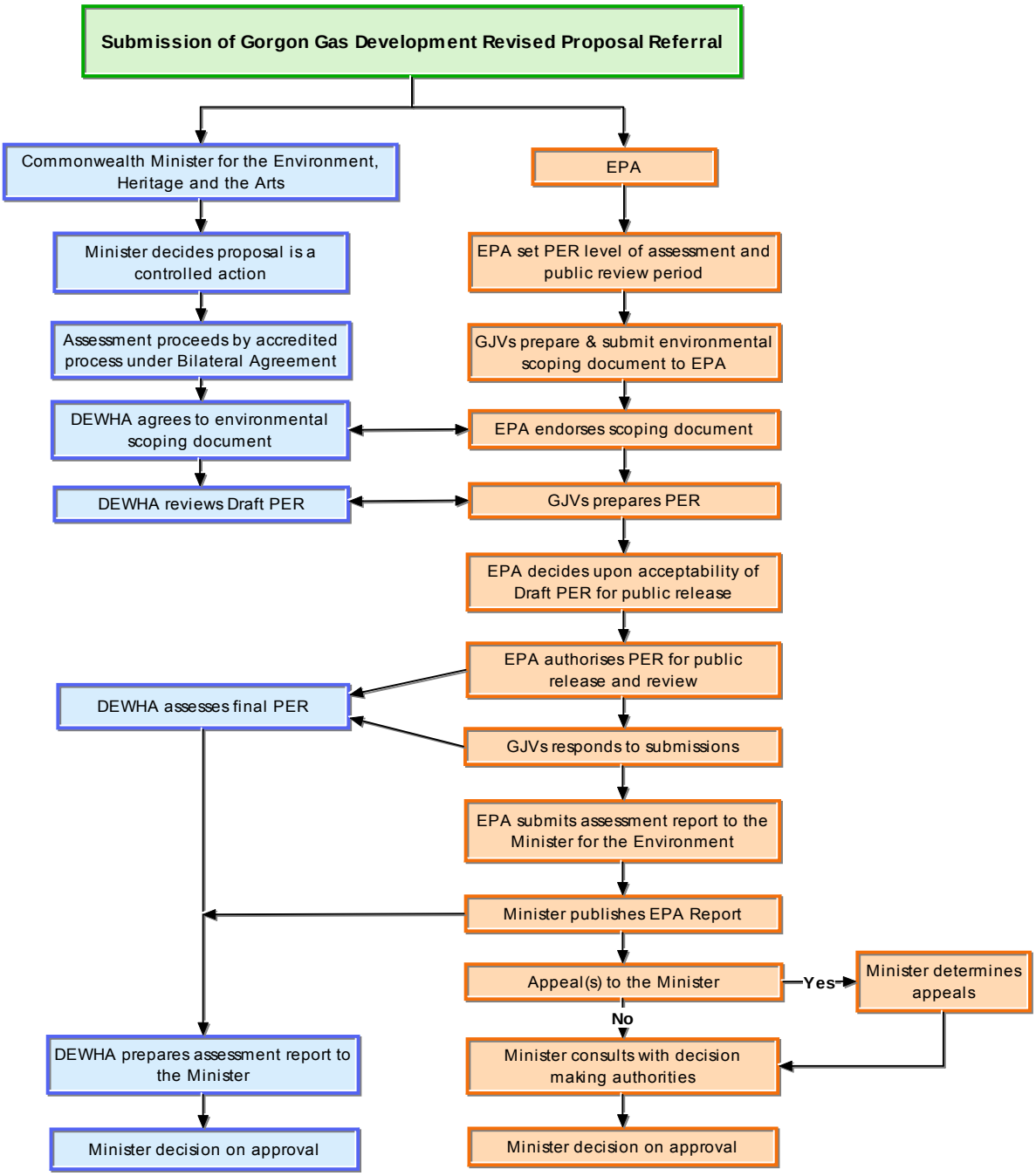

Figure 1.1: Parallel Processing of EP Act (WA) and EPBC Act (Cth) Approvals Process for the Gorgon Gas Development Revised Proposal

1.3 Purpose and Scope of Document

The Environmental Impact Assessment (Part IV Division 1) Administrative Procedures (2002) state that the Proponent is required to:

- prepare a summary of the pertinent issues raised in public and government agency submissions
- respond in writing to the summary of issues and any other issues the EPA may consider need to be addressed
- amend the proposal and change environmental commitments where appropriate.

An interim summary of submissions was prepared and provided to the EPA Service Unit on 20 November 2008. This summary covered submissions received to November 20. Additional submissions were received following this date. All submissions have been addressed in this Response to Submissions document.

The purpose of this Response to Submissions document is to provide the summary and the GJVs response to key issues raised in public and government agency submissions received in relation to the Revised Proposal PER. Submissions were grouped according to the environmental factor they addressed (e.g. terrestrial fauna, marine fauna, air emissions), and a response has been prepared for each factor. Where similar issues are addressed, a cross reference is made to direct the reader to a common response.

This document also outlines changes to the Revised Proposal that have occurred subsequent to the release of the PER for public review.

The summary and response to submissions will be considered by the EPA and DEWHA during their assessment of the proposal. They will also be considered when deciding whether or not to approve or set conditions on the Proposal.

1.4 Structure of Document

The Response to Submissions document has been structured as follows:

- **Section 1 – Introduction**: provides background on the Gorgon Gas Development, the environmental assessment process and the purpose and structure of this document.
- **Section 2 – Project Updates**: outlines changes to the Revised Proposal that have occurred since the release of the PER for public review, and provides an assessment of the revised environmental impacts of these proposed changes.
- **Section 3 – Public Submissions**: outlines the submissions received on the PER.
- **Section 4 – Response to Submissions**: provides responses to all issues raised during the public submission period. The responses to submissions have been structured according to the categories and environmental factors identified in the PER.

2.0 PROJECT UPDATES

2.1 Changes to the Project

Refining the design of the Gorgon Gas Development is an ongoing process and a further change to optimise the design of the Approved Development and Revised Proposal has occurred since the Revised Proposal PER was released for public review. The change involves minor realignment of the Domestic Gas Pipeline at the Barrow Island take-off point (moved from causeway to jetty) and minor repositioning of the pipeline to avoid sensitive benthic primary producer habitat within the Barrow Island Port (see Figure 2.1 in this document).

Domestic Gas Pipeline – Modification

The Domestic Gas Pipeline design has been further modified since the release of the PER, owing to changes in engineering design with the aim of reducing the impact of the development on the marine environment. The off-take point has been moved from near the MOF on the causeway to a location on the jetty that is approximately 1.4 km further offshore. There has also been a minor repositioning of the pipeline to avoid sensitive benthic primary producer habitat within the Barrow Island Port (see Figure 2.1 in this document).

The total area of coral habitat that will be lost as a result of the Domestic Gas Pipeline realignment will remain unchanged. However, the realignment allows highly valued high relief subtidal and bombora coral communities that were previously affected as part of the Revised Proposal to be avoided (see Figure 2.1 in this document).

Anode Wells – Clarification

It should be noted that the anode well requirement was described incorrectly in the PER. The PER stated, “Four shallow drilled anode wells are required for each CO_2 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 Proposal will require 4 anode wells per drill centre for the CO_2 injectors (total of 12 across the three drill centres) 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 drill centre) will also be required. The total anode well requirement will therefore necessitate 19 wells, which will represent an associated land take of 3.61 ha (to be confirmed in the final Cathodic Protection design).

Boil Off Gas Flare – Clarification

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 Approved 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 – Clarification

In the EIS/ERMP for the Approved Development (Chevron Australia 2005) it was stated that: “On the east coast of Barrow Island construction activity will take approximately 3 years and will occur 24 hours per day” (page 496). However, the PER (Chevron Australia 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). In order to remove ambiguity it should be noted that the GJVs intend to construct the marine facilities on the east coast of Barrow Island in accordance with the methodologies listed in Table 2.1. These methodologies are necessary to ensure compliance with relevant safety standards and regulations and to meet project schedule requirements. The GJVs recognise the sensitivities relating to the potential impacts of offshore artificial lighting on marine turtles.

The GJVs are committed to managing these construction activities in a way that reduces the potential impacts of the identified stressors to marine turtles. A summary of the stressors and proposed mitigation measures is provided in Table 2.1.

Table 2.1: East Coast Marine Facilities Construction Methodology

	Dredging		MOF		Jetty
Activity	Dredging (including reclamation)	Marine Drill and Blast	MOF Causeway (within 500 m from Town Point)	MOF and Causeway (greater than 500 m from Town Point)	All construction activities
Hours of Construction	24 hrs	♦ Drilling: 24 hrs ♦ Blasting: Dayshift	Dayshift (occasional nightshift may be required to shore up protection to partially constructed works in the event of approaching cyclones or other potentially destructive marine conditions)	24 hrs	24 hrs
Expected Duration of Construction Activity	18 months (Campaign may be in two stages separated by several months depending on progress of other dredging program commitments of the dredging contractor)	Any period within the 18 months duration of the dredging campaign	12 months	36 months	30 months
Marine Turtle Stressors	♦ Artificial Light ♦ Vessel Movement ♦ Noise and Vibration (non blasting)	♦ Noise and Vibration (blasting) ♦ Artificial Light	♦ Noise and Vibration (non blasting)	♦ Artificial Light ♦ Vessel Movement ♦ Noise and Vibration (non blasting)	♦ Artificial Light ♦ Vessel Movement ♦ Noise and Vibration (non blasting)

Stressor	Mitigations Measures
Artificial Lighting: Turtles being attracted to lights of vessels and construction activities.	♦ Contractors will be required to develop Lighting Management Plans that incorporate mitigation strategies to minimise artificial light spill ♦ Lighting will be directed away from natural environment and reflective surfaces where possible ♦ Acceptable lighting types and wattages will be prescribed to contractors ♦ Light spill will be reduced through treatment measures and artificial lighting kept to a minimum ♦ Regular inspections of vessels for compliance with Lighting Management Plans, with targeted inspections during turtle hatching season to ensure that light management measures are in place and effective
Vessel Movement:	♦ Contractors will be required to develop Marine Fauna Monitoring Plans, which include a requirement to record sightings of key receptor species (marine turtles, cetaceans and dugong) ♦ A visual look out will be maintained for key receptor species (marine turtles, cetaceans and dugong) during vessel movement and construction activities ♦ Vessel speed limits will be established ♦ Construction workforce and vessels will be restricted to designated areas ♦ The use of turtle-excluding devices on the dredge head will be investigated with the dredge contractor
Noise and Vibration (non Blasting)	♦ Vessels, plant, equipment, and machinery will be operated in accordance with appropriate industry and equipment standards that reduce noise, with particular focus in the nearshore areas.

Noise and Vibration (Marine Blasting)	Blast Design: ♦ A maximum allowable charge of 50 kg per delay ♦ Sequential charges requested to minimise cumulative impacts of the explosives ♦ Drill method and detonation system selected to avoid sympathetic detonation between blast holes ♦ Stemming drill holes to concentrate the explosive force within the bedrock. Avoidance Management: ♦ 500 m avoidance radius for key receptor species (marine turtles, cetaceans and dugong) [to be confirmed in consultation with the Marine Turtle Expert Panel (MTEP)] ♦ Marine fauna observers on vessels ♦ Blasting delayed if key receptor species are seen within the avoidance area ♦ Blasting undertaken during daylight hours ♦ Removal of surface fish kill following each blast.

A comparison of the elements of the Approved Development with the Revised Proposal is provided in Table 2.2. Note: shaded rows indicate elements that have changed from that described previously for the Approved Development [Statement No. 748 and Attachment 1 - section 45C Approval (EPA 2008)].

Table 2.2: Comparison of the Approved Development with the Revised Proposal

Aspect	Element	Description of Approved Gorgon Gas Development Elements	Description of Revised Proposal Elements (PER)
Terrestrial Infrastructure			
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 NOx (DLN) gas turbines	6 x approximately (nominal) 80 MW dry low NOx (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 35 000 ^{3} (net) (Note: Change in tank size will not change land take requirement)
	Volume of earthworks	Details not specified in Statement No. 748 (estimated to be approximately 3 million m^3)	Up to approximately 6 million m^3
Associated Terrestrial Infrastructure			
	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 *EP Act 1986* 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

Aspect	Element	Description of Approved Gorgon Gas Development Elements	Description of Revised Proposal Elements (PER)
	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 *EP Act 1986* for Change to Proposal (EPA 2008).	No change
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.
	Anode wells	Details not specified in Statement No. 748	Four shallow drilled anode wells are required for each CO_2 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).

Aspect	Element	Description of Approved Gorgon Gas Development Elements	Description of Revised Proposal Elements (PER)
			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 CO_2e per tonne of LNG shipped.		
	"*Beyond No Regrets Measures"*		
	Underground injection of reservoir carbon dioxide		No change
	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
	"*No Regrets Measures*"		
	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
	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 *EP Act 1986* for Change to Proposal (EPA 2008).	No change

Aspect	Element	Description of Approved Gorgon Gas Development Elements	Description of Revised Proposal Elements (PER)
	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
Marine Facilities			
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, Channel dredged to approximately 6.5 m (relative to chart datum) Berthing Pocket dredged to approximately 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])
	Offshore route	Essentially direct line	Minor changes – see description in Section 2.0 of this document
LNG Jetty	LNG jetty design	Open pile structure	No change
	LNG jetty length	Approximately 2.7 km	Approximately 2.1 km
	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 2.1. 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)

Aspect	Element	Description of Approved Gorgon Gas Development Elements	Description of Revised Proposal Elements (PER)
	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)	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.

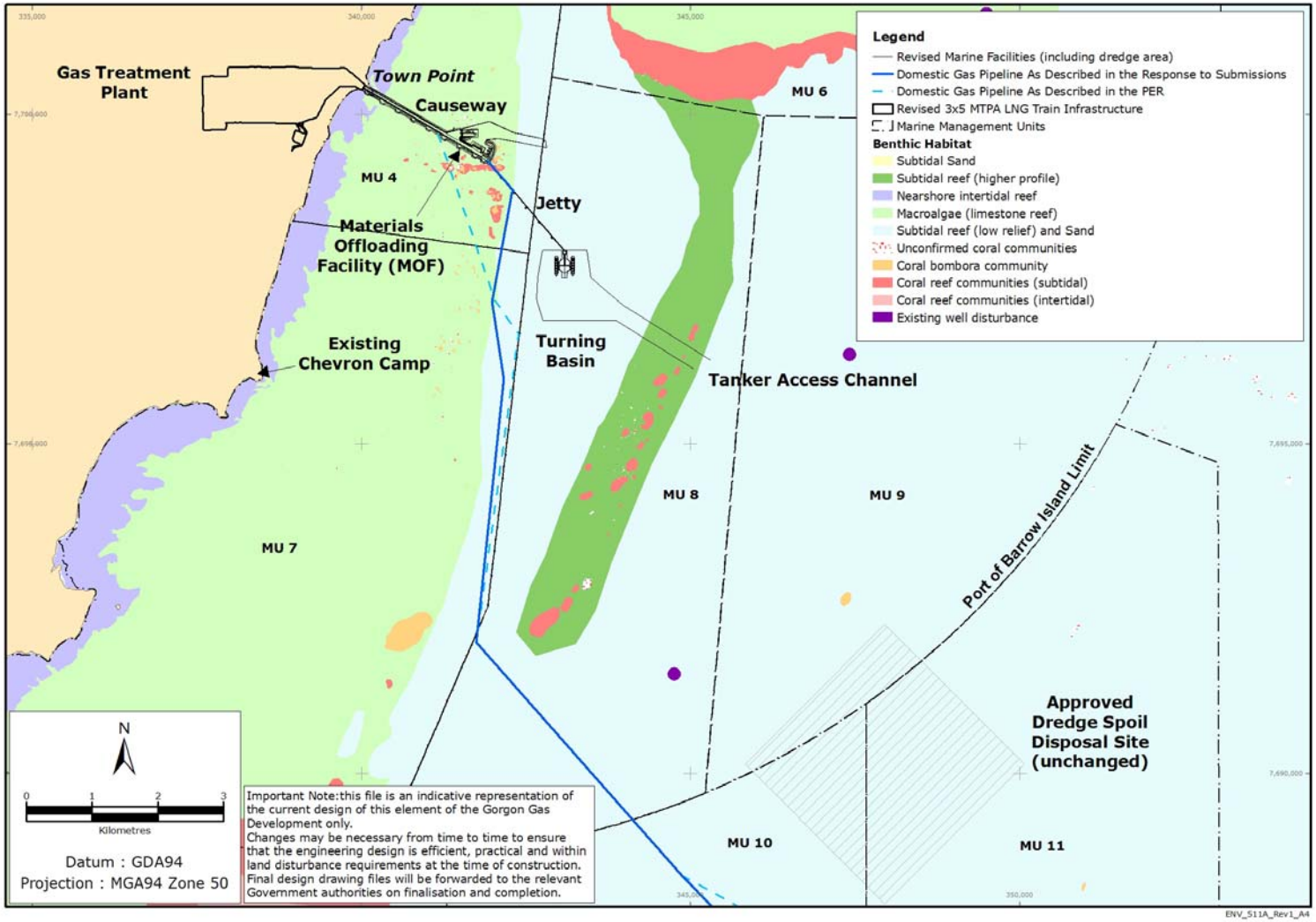

Figure 2.1: Location of the Approved and Revised Domestic Gas Pipeline (as presented in the PER) and Currently Proposed Pipeline Route

2.2 Revised Environmental Impacts

The Domestic Gas Pipeline realignment optimisation has the potential to affect the marine and coastal environment, specifically:

- marine physical environment and coastal processes
- marine water and sediment quality (during pipeline installation)
- marine fauna and benthic primary producers.

No additional adverse impact is expected as a result of these modifications. The potential impacts to these receptors are discussed in the following sections.

2.2.1 Marine Physical Environment and Coastal Processes

Realignment of the Domestic Gas Pipeline will alter the location of the marine disturbance footprint to the subtidal and intertidal seabed. However, the total area of potential impact of the Domestic Gas Pipeline will remain the same as that assessed as part of the Approved Development and the Revised Proposal (approximately 22 ha). The realignment will change the seabed profile in some areas; however, this is not expected to adversely affect the ecological integrity of the surrounding physical habitats. Rather, the realignment allows highly valued high relief subtidal and bombora coral communities that would have been affected as part of the Revised Proposal to be avoided.

Realigning part of the pipeline further offshore will not cause any additional impacts on coastal processes (as outlined in the PER).

2.2.2 Marine Water Quality and Sediment Quality

The area of direct and indirect disturbance associated with the realigned Domestic Gas Pipeline is the same as that assessed as part of the Revised Proposal. The changes are consequently not expected to result in any additional or different impacts to water or sediment quality outside the zones assessed in the PER.

2.2.3 Marine Fauna and Benthic Primary Producers

There will be no change to the total area of marine habitat disturbance associated with the pipeline realignment. However, there will be a reduced impact on coral habitat. Realignment of the Domestic Gas Pipeline will move the pipeline away from coral habitats within Management Units 4 and 7 at the Barrow Island end of the pipeline, into areas dominated by low relief reef and sand. The previous pipeline alignment passed through predominantly macroalgae communities on limestone reef, with scattered coral habitat. The new alignment passes through areas of low relief subtidal reef and sand (Table 2.3 of this document). This results in the overall percentage of permanent coral habitat loss from east coast activities including dredging, the WA Oil Pipeline and the Domestic Gas Pipeline is reduced from 3.21% to 3.18% for the Revised Proposal (Table 2.3 of this document).

There will be no change to the total area of habitat disturbance. It is anticipated that the changes to the Domestic Gas Pipeline alignment will not have any additional adverse impact on marine fauna. There will be a reduced impact on coral habitat.

Table 2.3: Comparison of Approved vs Revised Development Predicted Coral Loss, within Barrow Island Management Units

	Original Domestic Gas Pipeline Alignment	Revised Domestic Gas Pipeline Alignment
Total coral habitat (ha)	699	699
Predicted coral loss from dredging activities (ha)	22.06	22.06
Predicted coral loss from all east coast activities including pipelines (ha)	22.44	22.22
Predicted coral loss (%)	3.21	3.18

Table 2.4 of this document allows for a detailed examination of where the reduction in permanent coral habitat loss has occurred.

Table 2.4: Detailed Breakdown of Predicted Benthic Primary Producer Habitat Disturbance, within Barrow Island Management Units, as a Result of the Revised Proposal

Benthic Primary Producer Habitat (BPPH) Type	Total Area of BPPH Before Disturbance (ha)	Predicted* Permanent BPPH Loss (%)	Predicted Temporary BPPH Loss (%)	Cumulative Loss Threshold
Management Unit 4				
Coral habitats	220.04	7.21	4.02	10%
Macroalgae dominated limestone reef	2647.29	1.88	17.90	10%
Nearshore intertidal reef	433.37	0.22	7.60	10%
Subtidal sand	32.41	0.00	1.08	10%
Subtidal reef (higher profile)	2.99	0.00	0.00	10%
Subtidal reef platform (low relief) and sand	951.92	0.62	14.79	10%
Total Size	4288.03			
Management Unit 6				
Coral habitats	259.57	0.00	0.00	10%
Macroalgae dominated limestone reef	3265.44	0.00	0.00	10%
Subtidal sand	1.78	0.00	0.00	10%
Subtidal reef (higher profile)	28.42	0.00	0.00	10%
Subtidal reef platform and sand	1765.6	0.00	2.90	10%
Total Size	5320.8			
Management Unit 7				
Coral habitats	169.37	0.00	0.00	10%
Macroalgae dominated limestone reef	3998.48	0.00	0.05	10%
Nearshore intertidal reef	509.5	0.00	0.00	10%
Subtidal sand	1.06	0.00	0.00	10%
Subtidal reef (higher profile)	1.3	0.00	0.00	10%
Subtidal reef platform (low relief) and sand	471.73	4.34	6.31	10%
Total Size	5150.99			
Management Unit 8				
Coral habitats	42.35	14.50	2.85	10%

Benthic Primary Producer Habitat (BPPH) Type	Total Area of BPPH Before Disturbance (ha)	Predicted* Permanent BPPH Loss (%)	Predicted Temporary BPPH Loss (%)	Cumulative Loss Threshold
Subtidal reef (higher profile)	767.21	3.24	19.52	10%
Subtidal reef platform (low relief) and sand	3298.75	3.61	17.39	10%
Total Size	4108.33			
Management Unit 9				
Coral habitats	2.58	8.18	19.08	10%
Subtidal reef platform (low relief) and sand	4985.64	3.22	7.06	10%
Total Size	4988.21			
Management Unit 10				
Subtidal reef platform (low relief) and sand	4923.86	4.75	3.45	2%
Total Size	4923.86			
Management Unit 11				
Coral habitats	5.21	0	0	5%
Subtidal reef platform (low relief) and sand	4987.61	10.17	8.81	5%
Total Size	4992.82			

** Permanent coral loss has been calculated using the entire Zone of High Impact plus 30% of the Zone of Moderate Impact. BPP loss (other than coral) has been calculated using the disturbance area associated with the direct placement of infrastructure and the spoil ground.*

3.0 PUBLIC SUBMISSIONS

3.1 Submissions Received

A total of eighteen submissions related to the PER were received as follows:

- Government agencies (13):
  - Conservation Commission of Western Australia
  - Department of Environment and Conservation (DEC) – Environmental Management Branch
  - DEC – Marine Ecosystems Branch
  - DEC – Air Quality Management Branch
  - Department of Fisheries (DoF)
  - Department of Health (DoH)
  - Department of Industry and Resources (DoIR)
  - Department for Planning and Infrastructure (DPI) – Climate Change and Coastal Planning Branch
  - Department of Water (DoW)
  - Fire and Emergency Services Authority of Western Australia (FESA)
  - Marine Parks and Reserves Authority (MPRA)
  - National Offshore Petroleum Safety Authority (NOPSA)
  - Western Australian Museum.

- Non-government and/or community group organisations (4):
  - Chamber of Commerce and Industry Western Australia (CCI)
  - Conservation Council of Western Australia
  - Cape Conservation Group (CCG)
  - World Wide Fund for Nature Australia (WWF).

- Individual (private) (1):
  - Anonymity requested.

The GJVs have responded to each question raised in the submissions with the most accurate information currently available in relation to the issues. The GJVs would like to acknowledge all groups that chose to forward a submission to the EPA as part of this environmental impact assessment process.

A summary of the issues raised by submitters is provided in Appendix A of this document, with a reference to where in the Response to Submissions document the comments are addressed.

4.0 RESPONSE TO SUBMISSIONS

4.1 Description of Revised Proposal

Table 4.1: Description of Revised Proposal

Table 4.1		Description of Revised Proposal	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
1.1	Chamber of Commerce and Industry Western Australia	CCI continues to be a strong supporter of the Gorgon Gas Development, and urges the Environmental Protection Authority to approve the project's revised and expanded proposal. CCI believes this project will further cement Western Australia's position as an internationally significant supplier of liquefied natural gas and deliver enormous economic and social benefits for both our State and the nation. CCI strongly supports the establishment of competitive markets and the consequent benefits of competition that provides greater customer choice and ensures that resources are allocated effectively. CCI continues to support structural reform of the State's energy markets that we believe will encourage competition and provide lower energy prices. CCI strongly advocates that the Environmental Protection Authority should approve the Gorgon Gas Development Revised and Expanded Proposal Public Environmental Review.	The GJVs welcome recognition of the economic and social benefits of the Revised Proposal, and notes the Chamber's support for the Gorgon Gas Development.
1.2	Chamber of Commerce and Industry Western Australia	Based upon these prior approvals, CCI strongly asserts that the Environmental Protection Authority should only be considering aspects of the project that were not included in the previous approval process.	The scope of the PER as agreed with the EPA is to assess the significance of the environmental impacts of the Revised Proposal that are in addition to, different from, or cumulative with those of the Approved Development, and whether these impacts can be avoided (where possible). Where impacts are unavoidable, the PER includes information to limit and/or manage the impact. The relationship of the Revised Proposal to the Approved Development is further discussed in Section 2.0 of this document and in the PER itself.
2.1, 2.2, 2.4 & 2.19	Conservation Council of Western Australia	EPA Must Recommend Again: No Gorgon on Barrow. The EPA must restate their opposition to the Gorgon project's preferred location on Barrow Island, as outlined in Bulletin 1221. The Conservation Council strongly supported this position from the EPA and nothing has changed in the environmental arguments against massive industrial development on Barrow Island A-Class Nature Reserve, and in the surrounding waters – including the Marine Park and ecosystems of equal value to those within the	The EPA recommended against the Approved Development in Bulletin 1221. Subsequent to this recommendation, and following determination of appeals, the Western Australian Minister for the Environment and the Commonwealth Minister for the Environment and Water Resources approved implementation of the Gorgon Gas Development on Barrow Island on 6 September 2007 and 3 October 2007 respectively. The Approved Development, other than the minor components that will change as a consequence of the Revised Proposal,

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		Marine Park. The reasons for the EPA opposing this project have not changed; rather have increased in their scale for this new proposal. The EPA must be consistent in its opposition to major industrialisation in an A-Class nature reserve and Marine Park.	is not being assessed as part of the Revised Proposal. The relationship of the Revised Proposal to the Approved Development is further discussed in Section 2.0 of this document and in the PER. The GJVs have made considerable progress in addressing the existing environmental conditions and are continuing to work to address all conditions
7.10	Cape Conservation Group	CCG requests that the EPA restate its opposition to the Gorgon projects on Barrow Island and the unacceptable environmental impacts they will have on this A-Class nature reserve and Marine Park.	The environmental risks posed by the Revised Proposal are not considered by the GJVs to be greater than the risks identified for the Approved Development, for which the required environmental approvals under Part IV of the State EP Act (Statement No. 748) and the Commonwealth EPBC Act (EPBC Reference: 2003/1294) have been granted.
2.3	Conservation Council of Western Australia	The argument – applied to the Jansz pipeline proposal – that a State Government approval of the original Gorgon proposal means that the EPA can no longer recommend against further proposals for the expansion of the LNG facility only supports the Conservation Council's argument that the original proposal was the 'thin end of the wedge'; that is, that by allowing some development on the Island further development would inevitably follow and receive a lower level of scrutiny. It is also an indefensible position; more so in this case that involves a massive scale up of the existing facilities than in the Jansz pipeline case.	The *Barrow Island Act 2003* and the Gorgon Gas Processing Infrastructure Project Agreement (the Agreement) limited the area allowed for new disturbance on Barrow Island to a total of 300 ha. As part of the Approved Development, the GJVs gained access to 200 ha of this land allotment. The remaining 100 ha was reserved for future gas development and included a provision for the GJVs to have temporary access to this 100 ha during construction. The impact assessment undertaken for the Approved Development was conservatively based on the entire 300 ha limit. The Revised Proposal seeks the long-term use of 40 ha of this 100 ha already set aside for gas development.
2.5	Conservation Council of Western Australia	Additionally, the new LNG train and the drastically changed economics of the proposal demonstrate that the economic arguments against placing the LNG plant on the mainland were flawed. The EPA must recommend that expansion of the facility is more unacceptable than the placement of the facility on the Island in the first place. If this project is to go ahead, the expansion should be a trigger for a new, independently verified, site assessment based on current realities that will inevitably result in the project moving to another, less unacceptable, location.	As described in Section 1.3.2 of the PER, the requirement for a Revised Proposal is based largely on the need to improve project economics due to cost increases. An extensive and detailed assessment as recorded in the Environmental, Social and Economic (ESE) Review (ChevronTexaco Australia 2003) identified Barrow Island as the only location that offers an internationally competitive project. This was confirmed by the Western Australian Government's independent study (Allen Consulting Group 2003). This position is only strengthened in light of the current costs and project economics. The scope of the PER is to assess the significance of the environmental impacts of the Revised Proposal that are in addition to, different from, or cumulative with those of the Approved Development, and whether these impacts can be avoided (where possible). Where impacts are unavoidable, the PER includes information to limit and/or manage the impact. The environmental risks posed by the Revised Proposal are not

Table 4.1		Description of Revised Proposal	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
			considered by the GJVs to be greater than the risks identified for the Approved Development, for which the required environmental approvals under Part IV of the State EP Act (Statement No. 748) and the Commonwealth EPBC Act (EPBC Reference: 2003/1294) have been granted. See comments on Item 2.6 below regarding ESE review process.
2.6	Conservation Council of Western Australia	The recent decision by Inpex to pipe gas with high CO_2 content over 800 km from the Icthys field to Darwin also makes a mockery of Chevron's argument that the economics of transporting the Gorgon/Jansz gas is uneconomic.	The GJVs cannot comment on the commercial aspects of other projects. Each project has its own characteristics, requirements and priorities in terms of location, design, gas and liquids composition and access to sites. In the case of the Gorgon Gas Development, an additional consideration in site selection was that Barrow Island offered a unique opportunity to inject large volumes of separated reservoir CO_2, which would otherwise be vented into the atmosphere. In the ESE review process (ChevronTexaco Australia 2003), comparative cost information for other locations was provided to underpin the conclusion that the development would only be internationally competitive if located on Barrow Island. Commercially sensitive cost information was provided under a Confidentiality Agreement to the Western Australian Government's independent consultants, the Allen Consulting Group. The Allen report (2003) observed that despite examining a number of development concepts in detail 'Devising a commercial strategy to "unstrand" the Gorgon gas resource has proved, over the years to be an onerous and expensive task.' The Allen Report concluded that based on all the available information '… Barrow Island represents the only commercial option for monetising the substantial national asset represented by the Gorgon resource' (Allen Consulting Group 2003).
3.1	Department of Industry and Resources	The Revised Proposal is clearly consistent with the intent of the Approved Development, and the Revised Proposal states that the environmental risks for both are similar. On this basis, the Department considers that the existing conditions for the Approved Development should apply to the Revised Proposal and that any differences in environmental risk should be addressed via changes to the environmental management plans.	Comment noted. The GJVs believe that the implementation of conditions consistent with those prescribed for the Approved Development, will effectively manage the environmental aspects of the Revised Proposal. The management plans/systems/programs required to be prepared for the Approved Development under Statement No. 748 and EPBC Reference: 2003/1294 can be amended to include the changes attributable to the Revised Proposal.

Table 4.1		Description of Revised Proposal	
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4.1 & 4.8	Marine Parks and Reserves Authority	The Authority has considered the Gorgon Gas Development Revised and Expanded Proposal PER, and the Authority is particularly concerned in relation to potential impacts on the Marine Conservation Reserves for which the MPRA is responsible. The MPRA expressed substantial concerns regarding the scale and location of the initial Gorgon Gas Development proposal in 2005 and hold similar and increased concerns in regard to the Revised and Expanded Proposal. Increasing the scale of this facility will consequently increase the impact on the marine environment of the Barrow Island Reserves.	The GJVs have undertaken extensive modelling of dredging impacts for both the Approved and Revised Proposal. This modelling indicates that no impact is predicted to occur in areas supporting coral within the Marine Management Areas (external to the Barrow Island Port Limit). Limited impact is anticipated to areas in the Marine Management Areas near the spoil ground, but these predominantly support subtidal reef (low relief) and sand. The zone of influence will extend into the Marine Management Areas beyond the Barrow Island Port limit; however dredge-related sedimentation and turbidity in this zone is not anticipated to be severe enough, nor sustained for long enough to adversely affect corals. For additional information and responses relating to marine fauna, including marine turtle, please refer to Section 4.9 of this document. The Western Australian Minister for the Environment and the Commonwealth Minister for the Environment and Water Resources approved implementation of the Gorgon Gas Development at Barrow Island and the surrounding Marine Management Area on 6 September 2007 and 3 October 2007 respectively. As confirmed through dredge modelling, the environmental risks posed by the Revised Proposal are not considered by the GJVs to be greater than the risks identified for the Approved Development, for which the required environmental approvals under Part IV of the State EP Act (Statement No. 748) and the Commonwealth EPBC Act (EPBC Reference: 2003/1294) have been granted. The Revised Proposal will result in some additional impacts on the marine environment of the Barrow Island Reserves. However, the assessment of these impacts (as presented in the PER and this document) demonstrates that they are limited and manageable in nature.
7.1	Cape Conservation Group	The members of CCG are extremely concerned about the industrial development and associated environmental repercussions of the Gorgon Project (see Bulletin 1221), particularly the revised and expanded proposal. We believe that the EPA must restate its position that the Gorgon project should not proceed on Barrow Island. Cape Conservation Group (CCG) supports the EPA's original decision regarding the Gorgon projects on Barrow Island (see Bulletin 1221). There have been no new changes to the Gorgon proposal that would reduce any impacts on the Island's nature reserve, the marine ecosystem, and the endangered turtles that nest, forage, and mate in and around Barrow Island. We request that the EPA restate their opposition to the new State Government.	
5.1	Department of Health	The Proponent has proposed to construct a desalination plant to provide potable water to construction/staff facilities. The applicant needs to be aware that a Drinking Water Protection Management Plan must be developed as part of this proposal. The management plan details the requirements for regular chemical and microbiological analysis of the drinking water, with results to be submitted to the Water Unit for auditing purposes.	Construction of a desalination plant to provide potable water to construction/staff facilities was not described in the PER as part of the Revised Proposal, as it is part of the Approved Development and is not proposed to be changed. The requirement for a Drinking Water Management Plan is noted; the GJVs will comply with the 2004 National Health and Medical Research Council Australian Drinking Water guidelines and incorporate Department of Health guidance and directions to ensure a safe drinking water supply.
5.3	Department of Health	The Public Environmental Review (PER) refers to the disposal of effluent from wastewater treatment plants through deep well injection. It should be noted that this is not a standard effluent disposal option approved under the Health (Treatment of Sewage and Disposals of Effluent and Liquid Waste) Regulations 1974.	Disposal of effluent from wastewater treatment plants through deep well injection was not described in the PER as part of the Revised Proposal, as it is part of the Approved Development and is not proposed to be changed.

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		While the Executive Director Public Health may consider an alternative proposal, applications would need to be sufficiently detailed to enable an informed assessment. It is not clear if Chevron is already disposing of effluent on Barrow Island in this way or if any prior DoH approvals have been given. It is not clear if one or two wastewater treatment plants are proposed and, in addition to aquifer disposal, the PER makes reference to waste water ponds. Again it is not clear if these are existing infrastructure. Each proposal will require an approval under the Health (Treatment of Sewage and Disposal of Effluent and Liquid Waste) Regulations. Given the potential for a large number of personnel, substantial area may be required for above ground effluent disposal areas. For above or below ground disposal options, proposals should include full technical details for the wastewater treatment plant and sizing calculations for the effluent disposal option. Applications will need to be lodged via the Local Authority.	A new permanent Gorgon Gas Development-specific Wastewater Treatment Plant (WWTP) utilising biological processing will be used to treat sewage. During the construction phase, the permanent WWTP will operate in combination with a Bridging (temporary) WWTP to meet the demands imposed by peak construction period personnel. The Gorgon Gas Development will be applying for approval of these facilities under the Health (Treatment of Sewage and Disposal of Effluent and Liquid Waste) Regulations in due course. WA Oil currently operates a Produced Water Disposal facility on Barrow Island for the disposal of formation water co-produced with crude oil. The produced formation water (PFW) is injected into four disposal wells (WDW1–4) that are drilled into the Barrow Group (~1000 m deep). It is the GJVs' intention to use the WDW1 and WDW2 wells for the disposal of treated effluent from the WWTP. Approval for the disposal of PFW by this means was obtained through the Department of Industry and Resources and since there was no requirement for disposal of treated effluents, the Department of Health was not involved/consulted. The requirement to submit an alternative proposal for approval to the Department of Health in relation to this method of disposal of treated effluent is acknowledged. The wastewater ponds referred to in the PER relate to stormwater holding ponds which will be new permanent infrastructure. The GJVs will follow due process (with appropriate agencies) in relation to effluent disposal management to ensure applicable regulatory requirements are met, including Works Approvals and licences under Part V of the EP Act.
6.1 & 6.2	WWF	Our conclusion during these deliberations was that the project – at its previously assessed scale – was of unacceptably high risk to the natural values of Barrow Island and the marine environment surrounding it (and well beyond too, given the likely impacts on Flatback Turtles, for example). We concur largely with the concerns that the Environmental Protection Authority has raised consistently about this project. We believe that our conclusions are even more relevant now, as we consider this latest iteration of the project, given the current proposal to expand the project. Furthermore, our examination of options for LNG development in the Pilbara and Kimberley in the years since we first engaged in the Gorgon assessments has made us even more resolute in our opinion that development of this project on Barrow Island is	The EPA recommend against the Approved Development in Bulletin 1221 (EPA 2006). Subsequent to this recommendation, and following appeals, the Western Australian Minister for the Environment and the Commonwealth Minister for the Environment and Water Resources approved implementation of the Gorgon Gas Development on Barrow Island and the surrounding Marine Management Area on 6 September 2007 and 3 October 2007 respectively. Since then, the GJVs have undertaken considerable work on improving the understanding of key environmental aspects, the potential impacts of the Approved Development and how they can be mitigated and managed to ensure they are within acceptable limits. The relationship of the Revised Proposal to the Approved Development is further discussed in Section 2.0 of this document and in the PER. The environmental risks posed by the Revised Proposal are not

Table 4.1		Description of Revised Proposal	
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		unnecessary and unjustified. In light of many subsequent discussions with a range of Proponent, as well as governments, consultants and beyond, it seems that the original justifications for siting the project on Barrow Island – many of which were subsequently contested, as you know – are now gone. We have long urged governments and industry to review the original site selection process. Such a review would be bolstered with the lessons learned from subsequent assessment processes which built on and improved the original 'ESE' model. Importantly, some of the Gorgon Proponent have participated in these more recent, superior processes. We have not received responses from Governments to these requests. The arguments around this are outlined in the correspondence and submissions attached which I urge you to read, particularly in light of recent approaches to LNG project assessment and deliberation.	considered by the GJVs to be greater than the risks identified for the Approved Development, for which the required environmental approvals under Part IV of the State EP Act (Statement No. 748) and the Commonwealth EPBC Act (EPBC Reference: 2003/1294) have been granted. The Revised Proposal will result in some additional impacts. However, the assessment of these impacts as presented in the PER and this document demonstrates that they are limited and manageable in nature. See response to submission 2.5 above with respect to selection of a new site.
6.5	WWF	WWF-Australia believes that the global importance of island biotas as 'havens' of biodiversity, and the irreplaceable nature of the endemic and island biota of Barrow Island, mean that no further development should be permitted. Existing development should be phased out and the Island rehabilitated to its former natural condition. WWF-Australia maintains that Barrow Island would likely rank among the top ten most important islands for biodiversity in Australia, and it is difficult to overstate the global importance of the marine and terrestrial ecological values of Barrow Island. That the Island is situated within one of WWF' s Global Ecoregions – the two hundred 'richest, rarest and most distinctive' places on Earth – adds to our concern about the Gorgon Gas proposal. In March 2006, parties to the Convention on Biological Diversity will ratify a Program of Work on Island Biodiversity, focusing attention on the growing importance of islands for biodiversity conservation. WWF believes Barrow Island is a unique and irreplaceable biodiversity feature as recognised by its status as an A-class Nature Reserve.	This comment was actually made in regards to the EIS/ERMP for the Approved Development (Chevron Australia 2005; Chevron Australia 2006), however it has been responded to in regards to the Revised Proposal. The GJVs recognise the importance of the original site selection process (as part of the Approved Development) and the conservation significance of Barrow Island. Approval for restricted access to the Island was only made after exhausting all other development locations. An extensive and detailed assessment as recorded in the ESE Review (ChevronTexaco Australia 2003) identified Barrow Island as the only location that offered an internationally competitive project. This was confirmed by the Western Australian Government's independent study (Allen Consulting Group 2003). The environmental risks posed by the Revised Proposal are not considered by the GJVs to be greater than the risks identified for the Approved Development, for which the required environmental approvals under Part IV of the State EP Act (Statement No. 748) and the Commonwealth EPBC Act (EPBC Reference: 2003/1294) have been granted. These extensive conditions are designed to ensure that the risks posed by the proposal are mitigated to acceptably low and acceptable levels. The Revised Proposal will result in some additional impacts. However, the assessment of these impacts as presented in the PER and this document demonstrates that they are limited and manageable in nature.

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6.7	WWF	We would also like to confirm that WWF-Australia is not opposed to LNG production in the Pilbara. Quite the contrary; we see LNG as an important source of energy as the global economy begins its transition to sustainable sources of energy. We are interested in minimising the footprint of development in this region and would encourage the Western Australian and Australian Governments to help Proponent better achieve this.	This comment was made by the submitter in regards to the EIS/ERMP for the now Approved Development; however, it has been responded to in regards to the Revised Proposal as the comments on the EIS/ERMP have been repeated by WWF in their submission on the Revised Proposal. The GJVs welcome recognition from WWF that LNG is an important source of energy. The *Barrow Island Act 2003* (WA) and the Gorgon Gas Processing Infrastructure Project Agreement (the Agreement) limited the area allowed for new disturbance on Barrow Island to a total of 300 ha. As part of the Approved Development, the GJVs gained access to 200 ha of land. The Revised Proposal will involve additional long-term utilisation of approximately 40 ha of the remaining 100 ha. The total area utilised is therefore 240 ha out of a possible 300 ha. This equates to approximately 1.3% of Barrow Island. Additionally, the design of the marine components has been modified as part of the Revised Proposal to reduce the impacts on the surrounding marine environment, specifically marine benthic primary producers (refer to Section 2.2.3 of this document). The length of the causeway and the positioning of the MOF have been adjusted to reduce the need for a significant drilling and blasting operation to remove hard rock within the Port of Barrow Island. The design length of the causeway/MOF structure has been increased from approximately 1320 m to approximately 2120 m, an increase of approximately 800 m. The dredge volumes for the MOF access channel, turning basin and berthing pockets are anticipated to remain at approximately 1.1 million cubic metres. As a result of this revision, the length of the LNG Jetty has been reduced from 2700 m to approximately 2100 m. The LNG Jetty offloading facilities have been redesigned in accordance with safety regulations, however this component is located (geographically) very close to the offloading facilities described in the EIS/ERMP for the Approved Development. The dredge volumes for the LNG access channel, turning basin and berthing pockets are anticipated to remain at approximately 7.5 million cubic metres.
7.2	Cape Conservation Group	CCG also opposes the Gorgon projects as they currently stand as the EPA will have no further power to evaluate the environmental impacts of any future development or expansion of the projects	The submitter's comment is not supported by the legislative provisions. The Revised Proposal is an expansion of the Approved Development and is being assessed by the Western Australian EPA and Commonwealth DEWHA at the level of a PER, under the bilateral agreement. In accordance with the EP Act, a 'significant proposal' is to be referred to the EPA for a decision as to whether the proposal is to be assessed or

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			not. A 'significant proposal' is defined in the EP Act as a proposal likely, if implemented, to have a significant effect on the environment. The Gorgon Gas Approved Development or the Revised Proposal do not in any way, diminish the power of the EPA to evaluate the environmental impacts of any future development or expansion of these projects. Should further development or expansion of the project be contemplated, which may have significant impacts on matters of NES, a new referral would also be required under the EPBC Act.
10.1	FESA	We also wish to advise that we have no information or comment to provide at this time.	Comment noted.
11.1	Individual	There is not an analysis of alternatives. As the original proposal has not been implemented, the analysis of alternatives to development at Barrow Island should be evaluated. Section 1.3.1 of the PER claims that one has not been undertaken in this PER due to the requirement under the existing approval to reinject CO_2 at Barrow Island. This is not a valid reason and a ridiculous notion given that construction has not commenced for the original gorgon proposal and CO_2 can be reinjected at locations remote to the LNG plant by using compression and pipelines to transport the CO_2 gas). The requirement to conduct a proper alternatives analysis as required under the EPA PER/ERMP Guidelines and the EPBC Act Regulations should be enforced upon the Proponent by the regulator. As such the PER assessment by the regulator cannot be completed until a proper re-evaluation of alternatives. Given Chevron's conflict of interest and clear haste to push this expansion through, they should not be allowed to conduct the analysis under their own process or timeframe. They have shown they cannot follow guidelines and Regulations requiring the analysis and the EPA should therefore set the terms of reference in consultation with the Commonwealth Minister for environment for the evaluation of options for processing Gorgon gas, similar to the process established for the Browse basin. Why should Chevron and its partners be any different? One of the cornerstones of environmental impact assessment is the assessment of alternatives to the proposed actions. This is enshrined within EPBC Regulations and the Environmental Protection Authority PER/ERMP guidelines. It is also consistent with standard practice that is legitimately expected of project Proponent. Therefore believes that any impact assessment and approval	The Western Australian Minister for the Environment and the Commonwealth Minister for the Environment and Water Resources approved implementation of the Gorgon Gas Development on Barrow Island and the surrounding Marine Management Area on 6 September 2007 and 3 October 2007 respectively. As part of the Approved Development assessment process, an ESE Review (ChevronTexaco Australia 2003) identified Barrow Island as the only location that offered an internationally competitive project. This was confirmed by the Western Australian Government's independent study (Allen Consulting Group 2003). An additional consideration in the site selection process was that Barrow Island offered a unique opportunity to inject reservoir CO_2 at a location close to the gas processing facility. The Revised Proposal incorporates changes to some characteristics of the Approved Development (i.e. revision of the causeway and MOF) and changes to the Reservoir CO_2 Injection System) and expansion of the Approved Development by the addition of one 5 MTPA LNG train and associated changes to the Reservoir CO_2 Injection System). Therefore, the PER for the Revised Proposal did not reassess any other aspects of the Approved Development, including its location on Barrow Island and the surrounding Marine Management Area. The relationship of the Revised Proposal to the Approved Development is further discussed in Section 4.1.1 of this document and in the PER itself. Given the location of the Approved Development, the siting of a third LNG train and its associated infrastructure allows facilities to be shared (e.g. administration buildings, construction campsites etc.), which would otherwise have been required to be built again on land elsewhere. Additionally, the GJVs intend to manage the CO_2 emissions from the third train in the same manner as for the Approved Development, by injecting reservoir CO_2. Sharing of existing Barrow Island oilfield infrastructure, such as laydown

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		process is flawed without a robust analysis of alternatives. The question of whether viable alternatives provide better environmental outcomes has not been revisited in recent times and are not covered in this PER, with the exception of reference to the 2005 ERMP/EIS evaluation and the claim that re-consideration of alternative locations have not been undertaken due to the requirement to re-inject CO_2 at Barrow Island as part of the already approved development. This is not a valid justification for the failure to re-visit an alternatives analysis for the siting of the LNG plant as construction has not commenced on the approved development and the reinjection of CO_2 can still be conducted at Barrow Island by transporting CO_2 by pipeline. This concept is being contemplated by similar LNG developments such as the Woodside-operated Browse LNG Development, of which I understand Chevron Australia is a joint venture partner (www.woodside.com.au/browse). The fundamental consideration of LNG plant-siting has not been contemplated since the Environmental, Social and Economic (ESE) Review completed in 2003. The Western Australian State Government's Standing Inter-Agency Committee of CEOs' (SIAC) advice on the Gorgon ESE Review at that time highlighted that: .. from an environmental point of view, alternative sites to Barrow Island could be found acceptable in the sequence (most to least desired location) of brown-fields mainland sites, green-fields mainland sites and Thevenard Island… Decision-makers must therefore reject the assessment of the environmental acceptability presented in the Expanded and Revised Gorgon PER in the light of alternatives previously identified by the EPA and now likely to be viable given the changes in LNG market. The analysis of alternatives is critically absent from the assessment currently presented by Chevron and in need of re-evaluation since the issue of-the ERMP in 2005 and the ESE Review even earlier. Supporting information – Requirement for Analysis of Alternatives: Consideration of alternatives is a matter of process under law. A PER assessment is required to include evaluation of alternatives as defined in the EPBC Regulations Schedule 4 Matters to be addressed by draft public environment report and environmental impact statement, Section 2.01 (g) and Section 4.1 of the Environmental Protection Authority's PER/ERMP Guidelines –	areas, roads, airport, barge landing facilities, accommodation, wastewater and solid waste management facilities is occurring for the purpose of the pre-construction preparatory works, and will continue into the construction and operations phases of the Gorgon Gas Development. Post-construction, the Gorgon Gas Development MOF and accommodation facilities will be made available for use by the existing oilfield operations.

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		Guidelines for Preparing a Public Environmental Review/ Environmental Review and Management Programme. The expanded Gorgon proposal currently under consideration does not contemplate or analyse alternatives as required as part of a Public Environmental Review/Public Environmental Report (PER) assessment. Consequently, the opportunity to significantly minimise environmental impacts by progressing an alternative have been overlooked and cannot be evaluated by decision-makers. The reasons provided by Gorgon in the original ESE review and ERMP for not going to an area already set aside for industrial development (e.g. in Karratha) largely seemed to be the fact that it wouldn't be economic to run such a long pipeline that was made of expensive corrosion minimising alloys. This is now not the case. Gorgon are now using standard carbon steel pipeline and although the distance to somewhere like the Burrup is longer, other projects such as the Pluto oil and gas facility have been committed to over similar longer distances. Inpex is considering even longer distances. This fact plus the reason that oil prices and LNG prices have increased substantially mean that the viability of alternatives would look different. There was never any discussion of the need to be close to where the CO_2 was reinjected, which is the reason now given in the PER (section 1.3.1) for not re-evaluating alternatives. As discussed above, CO_2 can be removed at the LNG plant, wherever it is located, and transported by pipeline to the reinjection location. A friend saw a presentation by Woodside where they are considering doing this in the Browse basin and the reinjection site is more than 300km away! How can this therefore be a valid reason not to revisit the alternatives analysis. The real reason that Gorgon have not revisited their alternatives analysis is that it will probably show that there are viable alternatives and that the Government would prefer to consolidate LNG processing into one location for a basin, similar to the process in the Kimberley. Previous EPA advice that there were better alternatives from an environmental perspective, plus the conclusion that the development shouldn't be allowed to proceed indicate that an alternatives analysis is a crucial piece of information to allow a decision to be made.	

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11.2	Individual	Finally, although an assessment of broader sustainability principles is not directly required under the EPBC Act or EPA Act, it would be reasonable for the Proponent to undertake alternatives analysis that incorporated sustainability considerations. These broader considerations may present alternatives more attractive over a range of factors, including reduction in social impacts, recognition of publicly owned infrastructure investments, economic benefits of existing industrial infrastructure, contribution to regional development and the fact that substantially increased government revenues would result from more efficient industrial development. These matters must be considered by the Government and therefore addressed by the Proponent.	An ESE Review (ChevronTexaco Australia 2003) was undertaken as part of the Approved Development. The location of the Revised Proposal is not considered by the GJVs to be different to the location of the Approved Development, for which the required environmental approvals under Part IV of the State EP Act (Statement No. 748) and the Commonwealth EPBC Act (EPBC Reference: 2003/1294) have been granted. The siting of the Revised Proposal adjacent to the Approved Development's facilities would affect a smaller footprint compared to an alternative location.
11.3	Individual	Precedents of allowing an even bigger LNG plant on an island that is an A class nature reserve status should not be allowed.	The *Barrow Island Act 2003* (WA) and the Agreement limit the area allowed for new disturbance on Barrow Island to a total of 300 ha. The impact over 300 ha was assessed in both the EIS/ERMP and PER. The Revised Proposal does not exceed the total 300 ha allowed and assessed for new disturbance on Barrow Island.
12.1	DEC – Marine Ecosystems Branch	The PER is not a stand-alone document. To make a comprehensive appraisal of the PER, it needs to be considered in the context of a number of other documents prepared previously by, and for, the Proponent. The PER also fails to acknowledge the tenor of the EPA's previous advice on the Gorgon LNG proposal. It is very disappointing that despite a central plank of the EPA's advice on the original proposal being 'predictive uncertainty' and the considerable length of time that has passed since the EPA's assessment of the original proposal, little in the way of new information is provided in the PER. Furthermore, there appears to be little evidence that a number of implied/explicit commitments that were made by the Proponent both during and after the original assessment to address predictive uncertainty, particularly for dredging impacts, have been implemented. It is disappointing other changes to the original development, such as the offshore brine discharge, have not been included into the scope of the PER. Inclusion of this revised component of the project into the PER would allow the EPA to provide more comprehensive advice on the application of the Environmental Quality Management Framework (EQMF) to the proposal. More detailed advice on the EQMF and its application is provided later in this memorandum.	The PER is a stand-alone document required to enable assessment of the Revised Proposal, with reference to the Approved Development EIS/ERMP where necessary and appropriate. The PER was prepared to assess the significance of the environmental impacts of the Revised Proposal that are in addition to, different from, or cumulative with those of the Approved Development, and whether these impacts can be avoided (where possible). Where impacts are unavoidable, the PER includes information to reduce and/or manage the impacts. A number of investigations have been undertaken by the GJVs since gaining approval to implement the Approved Development. These investigations provided new information relevant to the Revised Proposal. The list of investigations undertaken is presented in Section 6 of the Environmental Scoping Document (Chevron Australia 2008b). The investigations undertaken were in accordance with the program agreed upon with the EPA in its acceptance of the Environmental Scoping Document (Chevron Australia 2008b). The EPA recommend against the Approved Development in Bulletin 1221. Subsequent to this recommendation, and following appeals, the Western Australian Minister for the Environment and the Commonwealth Minister for the Environment and Water Resources approved implementation of the Gorgon Gas Development on Barrow Island and the surrounding Marine Management Area on 6 September 2007 and 3 October 2007 respectively. Some minor changes to the original Approved Development

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			have since been made and these were approved by the EPA under section 45C of the EP Act in May 2008. The scope of the PER for the Revised Proposal was determined during preparation of the Environmental Scoping Document (ESD). The ESD was endorsed by the EPA on 10 July 2008, following EPA review and comment. The requirement for a reverse osmosis plant and the associated need for brine disposal was included in the assessment for the Approved Development. Schedule 1 of Statement No. 748 (for the Approved Development) which stipulates that the reverse osmosis brine disposal will be via deep well injection or ocean outfall (east coast of Barrow Island) and Condition 30.2 (ii) which states that *'…discharges from any waste water treatment plant, reverse osmosis plant, or other process water are disposed of via deep well injection, unless otherwise authorised by the Minister'*. Whilst there appears to be a discrepancy in the requirements, in accordance with the condition, the GJVs intend to seek authorisation from the Western Australian Minister for the Environment for reverse osmosis plant brine disposal via ocean outfall. The GJVs are not clear on what other changes to the original development the DEC–Marine Ecosystems Branch sought to have included in the PER. Application of the Environmental Quality Management Framework will be addressed in the request for authorisation of the ocean outfall of reverse osmosis plant brine.
12.3a	DEC – Marine Ecosystems Branch	Marine Blasting Tables of Key Characteristics in the Minister's Statement and the PER make no reference to marine blasting. This should be redressed if blasting is proposed and approved under the PER. The EPA considered it was not supplied with sufficient information in the original ERMP to properly assess potential impacts of, or efficacy of proposed management for, marine blasting. A limited amount of new information is supplied in the PER. The PER contends that the drilling and blasting program for the revised MOF access channel has been reduced significantly compared with the original proposal (from 500 000 m^3 down to 50 000 m^3). The blasting element of the revised and expanded proposal could only be considered to have reduced compared to the original proposal if it were clear that Proponent had approval to undertake 500,000m^3 of marine blasting as part of the marine construction program. There uncertainty about the status of any approval to undertake this activity. The lack of clarity around	The Environmental Impact Statement/Environmental Review and Management Programme (EIS/ERMP) for the Approved Development (Chevron Australia 2005) included the potential requirement for marine drill and blast due to the variability in the geotechnical information available at that time. Additional marine geophysical and geotechnical information of the near shore area off Town Point acquired after Statement No. 748 was published indicates the rock substrate in the vicinity of the MOF location is significantly harder and more extensive than the previous data indicated. This would have resulted in the need to drill and blast approximately 500 000 m^3 of material in coastal waters for the construction of the MOF access channel and berthing pockets that were proposed for the Approved Development. With the extension of the MOF structure into deeper water (the Revised Proposal) the need for marine blasting in the near-shore area off Town

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		marine blasting is increased further when the Proponent's position on blasting during the assessment of the original proposal is considered. In Bulletin 1221, the EPA quoted the Proponent's response to submissions which stated: *"indications from geo-technical investigation, laboratory testing and discussions with dredge contractors suggest that there is no need to do any drilling and blasting"* (from responses to submissions). Clarification on the Proponent's needs for blasting and any related approval is required. The Proponent recently briefed the EPA on marine blasting and through this briefing it was evident that the Proponent's risk assessment and proposed management for marine blasting is based largely on experience from Dampier (Woodside Energy Limited (WEL) Train V expansion project). Two deficiencies associated with the Proponent's approach have been identified that warrant a response: 1. The fact that the marine environmental setting (e.g. types, abundance and regional significance of sensitive receptor species) at Barrow Is. Is not comparable with that of Dampier; and 2. That the evaluation of the extent and severity of impacts from blasting in Dampier was based on observations of fauna (mainly finfish) floating on the water surface after detonation. There were no investigations by WEL or Gorgon into whether some fauna do not float to the water surface if killed or injured by marine blasting. In the absence of such investigations, the potential for underestimating actual impacts and risk is high.	Point is significantly reduced. The proposed drill and blast program under the Revised Proposal is anticipated to assist in the removal of up to approximately 50 000 m^3 of hard rock at the western end of the revised MOF Access Channel. The use of data and discussion of experiences from other Northwest WA drill and blast programs during the presentation to the EPA was considered appropriate to provide an understanding of the technical aspects of such a program. The GJVs aimed to use the best available information that was (and still is) available at the time of the presentation. Refer to Section 4.8.1.2 for further discussion of the information provided to the EPA.
12.3b	DEC – Marine Ecosystems Branch	If blasting were approved, how does the Proponent propose to manage drilling activities that would be associated with marine blasting? It is also noted that while Condition 17 does provide scope to require the Proponent to demonstrate impact avoidance and management for marine blasting, it does not apply to dredging related turbidity and sediment deposition effects. This is a problem because blasting (if it occurs) would be explicitly linked to the dredging program and itself has potential to generate fines that impose similar pressures to those generated by dredging. A potential shortfall in the numerical modelling used to inform impact prediction is that no estimates have been given of the fines yield	The dredge plume modelling assumes 100% release of fines as a result of the cutter suction dredging, excavation and disposal activities. Some portion of this material may be too hard and will therefore require drilling and blasting. However, as the model accounts for 100% release of fines, any fines associated with the drilling and blasting will be accounted for. It is likely that the drilling and blasting will result in the release of less fines than the action of the cutter suction dredge as the cutter suction dredge cuts and grinds the rock resulting in the generation of smaller particles of rock material. If hard rock is encountered the cutting rate decreases due to the strength of the rock and the production of finer material is anticipated to increase as a result of a less efficient cutting action. Through the use of explosives, blasting results in larger fragments of rock

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		from the material that may be drilled or blasted.	and therefore the release of less fines into the water column
12.3c	DEC – Marine Ecosystems Branch	Summary: Some new information in the form of a verbal briefing has been provided to the EPA in relation to marine blasting, however due to some shortfalls with this information, there remains considerable uncertainty about the potential impacts and manageability of marine blasting operations off the east coast of Barrow Island.	The EPA Board expressed their appreciation at the briefing and neither the EPA Chairman nor the DEC representatives advised the GJV representatives of "*considerable uncertainty*" at the briefing. Section 4.8.1 provides additional information relating to the potential impacts and proposed management measures for the marine drill and blast program.
12.7	DEC – Marine Ecosystems Branch	Seismic data acquisition EPA considered it had been provided with insufficient information to assess the impacts of this activity in the nearshore marine environment at Barrow Island. There was significant uncertainty about this activity, in terms of how it might occur and in turn what its potential environmental impacts might be. The PER indicates that seismic activities are proposed, however no new information is provided in the PER and no Conditions specific to the management of this activity have been set by the Minister. The Proponent should provide further information about this activity and its potential environmental impacts. Bulletin 1221 suggests that information should include "a scientifically robust environmental monitoring and management programme which sets out the measures and schedules to avoid key ecological windows (e.g. sea turtle and marine mammal breeding seasons)".	Additional information regarding the marine component of the CO_2 seismic monitoring program is provided in Section 4.8.3 of this document.
12.12	DEC – Marine Ecosystems Branch	Kellogg JV presentation 12 August 2008 refers to 7.8 million m^3 dredging compared to 6.5 million m^3 approved.	The GJVs are not sure what KJV presentation is referenced in the comment and whether it is related to the Revised Proposal PER. The Approved Development dredging volume is 1.1 million m^3 in the MOF area and 6.5 million m^3 in the LNG area.
13.1	DoW	The Department of Water (DoW) has no legislative responsibilities for the land on which the proposal is based. Water management issues associated with the project are currently being addressed by the Department of Environment and Conservation (DEC). The DoW will provide technical information to the DEC on water impact management issues as required.	Comment noted.
17.3	DPI	Coastal Setback Requirements With respect to the setback requirements for physical processes under SPP2.6 (Section 5.1(xxii) and (xxiii); Schedule One), Schedule One prescribes the guidelines for the siting of development. The specific objective is to provide a setback that protects development from coastal processes by absorbing the impact of severe storm sequence; allowing shoreline movement;	The Gas Treatment Plant site is set back behind the primary dunes and the coastal vegetation. Development levels are well above 100 year storm surge levels as required by the referenced guidelines. The marine facilities necessary for the construction and operation of the Gas Treatment Plant need access to the sea to meet their functional requirement and therefore need to be situated on the foreshore and the adjacent marine environment. These facilities include the MOF for

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		allowing for global sea level rise; and allowing for the fluctuation of natural coastal processes. The coastal processes setback prescribed in Schedule One is applied to all coastal developments, with a number of exemptions, including industrial and commercial development that is demonstrably dependant on a foreshore location (Schedule One). In this regard, the Proponent must sufficiently demonstrate that the development is dependent on a foreshore location. While some types of development may be considered exempt, structures that do not require a direct interface with tidal areas or placement in the foreshore, are not generally included in this exemption.	importing construction materials and equipment, the LNG export lines, the LNG vessel berths, and the cyclone haven and mooring facility for the LNG vessel tugs.
17.7	DPI	With regards to the work provided within the PER, we provide the following comments on the Dredge Plume Modelling (Appendix E): The dredging methodology should be expanded to: a) Provide supporting information for the assumptions on the release rates of fines and turbidity generation from dredging; b) Provide estimates of the overflow generated during the MOF dredging and hopper barge filling; c) Clarify if allowance for downtime due to environmental stoppages has been considered in determining the dredging durations; and d) Clarify if dredging of MOF and LNG will be undertaken consecutively or simultaneously. Insufficient information is provided on model set-up, or model inputs to provide an assessment of its suitability. Section 3.4 identifies that modelling has been undertaken for the "base" case under "normal" meteorological conditions, it is unclear what these means and how they relate to the historic record. It does not appear that local metocean conditions (winds, waves, currents) have been recorded or incorporated into the model. Without these recordings it may not be possible to accurately model local water quality. If undertaken, no details are provided of the model calibration. It is recommended that the model be checked for its accuracy by calibration of results against the background conditions both prior to commencement of dredging, against background conditions, and soon after commencement of dredging, against dredging conditions. Calibration should be against the local metocean	1a) Refer to Section 4.8.2 of this document, which includes a discussion of the dredging methodology to be used expanded upon in Section 4.8.2.1. 1b) The model shows overflow generated during the MOF dredging and hopper barge filling is 35% fines. Ministerial Statement 748 requires dredging to cease before and after specified predicted coral spawning events. 1c) Statement No. 748 requires dredging to cease before and after specified predicted coral spawning events. In the construction schedule the GJVs have allowed time for environmental stoppages due to coral spawning and management of dredge plume impacts. In the dredge plume modelling the GJVs have not allowed for any environmental stoppages as this is a more conservative approach as it does not allow additional time for the plumes to dissipate. 1d) There will be some activities that are simultaneous but generally the activities will be consecutive. However, one of the dredge management strategies is to maintain the flexibility to switch the dredge between the MOF and LNG locations to reduce localized impacts if necessary. 2) Refer to Appendix E of the PER. The dredge plume model is essentially the same model that was used during the preparation of the approved EIS/ERMP allowing for the relocation of the MOF turning basin into deeper water and a minor realignment of the LNG channel. The basis of the modelling that was undertaken is presented in EIS/ERMP Additional Information Package, October 2005 (Chevron Australia 2005a) and in the final EIS/ERMP response to submissions (Chevron Australia 2006). 3) Detailed information on how historical and measured metocean data were included in the model is presented in the EIS/ERMP Additional Information Package.

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		conditions (waves, currents), water quality (turbidity) and sedimentation. It is recommended that the monitoring requirements of waves and currents be included within the project's environmental conditions. It is noted that the modelling assumes that dredging will be completed before the construction of the MOF. Accordingly approval should be conditional on this requirement. The requirements for future maintenance dredging, and associated environmental impacts, do not appear to have been considered.	4) Field validation of the hydrodynamic modelling was conducted in 2005. The results confirmed that the model was a reliable simulation of the regional hydrodynamics. This information is presented in EIS/ERMP Additional Information Package. 5) Dredging will be managed to maintain the impacts within the approved Ministerial Statement 748 conditions. Further conditions on relative scheduling of work will not improve environmental outcomes and may restrict opportunities to manage the work. The modelling assumes that dredging is completed before the MOF causeway construction is completed. Other parts of the MOF such as the reclaimed area will be under construction during dredging. 6) Refer to Sections 6.3.8, 11.3.1 and 11.5.1 of the Final EIS/ERMP Response to Submissions (Chevron Australia 2006). The coastal process report (MetOcean Engineers 2005) reviewed by the DPI concluded that the potential for siltation leading to the requirement for maintenance dredging is expected to be low.
18.1	Department of Fisheries	The concerns that the DOF has with the proposed expansion of the Gorgon Gas Development are discussed below under three broad categories: ♦ Dredging ♦ Marine biosecurity ♦ The resource implications for the Department.	The GJVs believe that the implementation of conditions consistent with those prescribed for the Approved Development will effectively manage the environmental aspects of the Revised Proposal. Specific responses to DOF concerns in relation to each of the categories are addressed in this document in Table 4.11:, Table 4.15, Table 4.17 and Table 4.20: (dredging), Table 4.21 (marine biosecurity) and Table 4.28 (resource implications).

4.1.1 Further Information on How the Revised Proposal Compares to the Approved Development

The location of the Gorgon Gas Development, on Barrow Island and within the surrounding marine areas, was formally assessed and the Western Australian Minister for the Environment issued an approval to implement the Development at this location, as did the Commonwealth Minister for the Environment and Water Resources, in late 2007. As agreed with the EPA, the PER for the Revised Proposal did not address any aspects of the Approved Development that have not changed.

The Revised Proposal comprises:

- addition of one 5 MTPA LNG train, increasing the number of LNG trains from two to three in order to generate a greater volume of clean-burning natural gas sooner in a rapidly growing global energy market
- changes to the Reservoir CO_2 Injection System to allow for an increased injection rate associated with the addition of one LNG train, increasing the number of injection wells and surface drill centre locations
- revision of the causeway and the MOF designed to access deeper water to avoid hard rock material and the need for an extensive drilling and blasting program.

The Revised Proposal incorporates changes to a number of characteristics of the Approved Development (i.e. revision of the causeway and MOF) and the expansion of the Gorgon Gas Development (i.e. addition of one 5 MTPA LNG train and associated changes to the Reservoir CO_2 Injection System). While the Revised Proposal is an expansion of the Gorgon Gas Development, it has been assessed as a new proposal because the resulting changes to the Gorgon Gas Development were considered significant in terms of potential environmental impacts.

4.2 Stakeholder Consultation

Table 4.2: Stakeholder Consultation

Table 4.2		Stakeholder Consultation	
Item	**Submission from**	**Comment**	**GJVs' Response**
5.2	Department of Health	Whilst the Chevron Regulatory Specialist recently met with A/Manager Water Unit, the DoH was not included in early consultation and the *Health Act 1911* was omitted from Table 1.1: Key Commonwealth and Western Australian Legislation Relevant to the Revised Proposal.	The Department of Health was consulted as part of the EIS/ERMP and Social Impact Management Plan process related to the Approved Development. The Revised Proposal was not considered to involve any matters that would be relevant to the Department of Health that had not been addressed by the approval process associated with the Approved Development.
5.5	Department of Health	Given the potential for environmental concerns, and Department of Environment and Conservation (DEC) discharge licences, the aquifer disposal option should also be discussed with the DEC.	Disposal of surplus treated effluent via deep well injection was not described as part of the Revised Proposal; it was considered as part of the Approved Development (and is outlined in Schedule 1 of Statement No. 748). The GJVs will follow due process (with appropriate agencies) in relation to aquifer disposal to ensure applicable regulatory requirements are met.
5.7	Department of Health	The Aboriginal Environmental Health Section of the EHD wishes to reiterate to the Proponent that there are enormous economic opportunities that may be available to the Aboriginal people in Roebourne or Onslow if they can be involved somehow, under the Woodside's Indigenous Employment program.	The people of Onslow have expressed their desire to participate in the long-term benefits of major regional projects, including the Gorgon Gas Development. With this in mind, various programs have been implemented to build the capacity of this community so that it is better equipped to take advantage of these opportunities. As participants in the North West Shelf Venture (NWSV), the GJVs contribute to NWSV programs. These programs include the Roebourne breakfast program, Kids Matter childcare program, Roebourne Pathways project, Yinjaa Barni Arts Group, Mingullatharndo Tourism and Arts initiative and Gumula Minurwarni (Indigenous TEE program), as well as the $3 million Karratha Education Initiative. Chevron Australia in its own right also provides support to the Pilbara community. In Onslow, this support includes partnering with the Telethon Institute for Child Health Research on the Australian Early Development Initiative, supporting the Onslow Early Childhood Program, and the Onslow Youth Outreach Program that saw juvenile crime in Onslow fall by 85% within 12 months of its inception. This program also involves the Shire of Ashburton, BHP Billiton and the Department of Child Protection. The GJVs are currently examining options to partner with others to deliver long-term Indigenous employment opportunities in the Onslow area, with this partnership anticipated to commence prior to Final Investment Decision. This will allow local people to develop work history and skills ahead of any major Gorgon Gas Development mobilisation, such that they

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			can aspire to higher level roles during construction, and potentially seek careers, including with Chevron Australia, during the Development's operations phase. In addition to community programs, Chevron Australia is developing its organisational capability related to Indigenous issues, including beneficial employment programs.

4.3 Risk-based Assessment Approach

Table 4.3: Risk-based Assessment Approach

Table 4.3		Risk-based Assessment Approach	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
4.2	Marine Parks and Reserves Authority	We 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 Revised Proposal presents some new risks and increases the scale of others that were identified for, the Approved Development. In addressing each of the 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.	The Environmental Scoping Document included a statement that "*the assessment of cumulative impacts resulting from the Revised Proposal on specific receptors will be considered by Chevron Australia during the environmental risk assessment process associated with the development of the PER*". Consistent with standard environmental impact assessment practice, the cumulative impact of the Revised Proposal and all other existing and approved developments that may impact on the same factor or receptor were considered. Standard practice does not require a proponent to consider the aggregated impact of the range of potential stressors on any or all environmental receptors. Identification of the potential stressors was through the risk assessment for the Revised Proposal, which was undertaken using the same processes and format as were used for the Approved Development. This is outlined in Section 5 of the PER. The risk assessment approach was undertaken in accordance with the principles and guidelines contained in the following, and is comparable to the risk assessments presented in other major environment impact assessments: ♦ AS/NZS 4360:2004 Risk Management (Standards Australia/Standards New Zealand 2004a) ♦ HB 203:2004 Environmental Risk Management – Principles and Process (Standards Australia/Standards New Zealand 2004b) ♦ AS/NZS 3931:1998 Risk analysis of Technological Systems –

Table 4.3		Risk-based Assessment Approach	
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			Application Guide. (Standards Australia/Standards New Zealand 1998) The risk assessment presented in Appendix C of the PER was undertaken on the relevant components of the entire Development as it is now proposed. Refer to Appendix C of the PER for additional information. Section 6 of the Environmental Scoping Document does not state that any studies would be undertaken to investigate the potential aggregated impacts of the range of factors (i.e. light, noise and physical infrastructure etc.) on marine turtles or other marine communities, as being the proposed approach to assessment of cumulative impacts. This is consistent with current accepted practice for cumulative environmental impact assessment (EIA), which relates to the individual assessment of the cumulative impact of each stressor from the proposal in combination with the impact of similar stressors from other existing or approved activities, on a receptor(s). Refer to Appendix C 'Marine Risk Assessment Workshop Table – Revised Proposal', under the headings of Marine Fauna and Marine Primary Producers. In addition, comment was made on the cumulative impact of the changes to the Approved Development proposed in the Revised Proposal, in accordance with this approach. Nonetheless, it is acknowledged that the cumulative effect of several stressors on a receptor may, under certain circumstances, be higher than the effect of each stressor considered individually. The matter is complex, in terms of understanding both the instantaneous effect of multiple stressors on a receptor, and the stochastic aspect of the likely frequency, intensity and duration of exposure of a receptor to multiple stressors. The impacts of the stressors are not directly additive, and it is more likely that the combined effects of several stressors may, under certain circumstances, increase the likelihood or consequences fractionally over those resulting the assessment as undertaken in the PER. In recognition of this issue, the GJVs plan to undertake further studies and monitoring to investigate the impacts of stressors using scientifically rigorous experimental designs. Such studies will be designed in consultation with the Marine Turtle Expert Panel (MTEP). The GJVs have also agreed to fund a 30-year North West Shelf Flatback Turtle Conservation Program (Statement No. 748 – Additional Joint Venture Undertakings) which will include activities to: ♦ survey, monitor and research turtle population ♦ mitigate the loss by reducing interference to key feeding and breeding locations ♦ establish information programs to support protection.

Table 4.3		Risk-based Assessment Approach	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
			Furthermore, the North West Shelf Flatback Turtle Intervention Program, also detailed in Statement 748, will require the GJVs to take further action to improve turtle recruitment should significant impact be detected. Refer also to Table 4.20: (Item 4.2) in this document, which addresses comments received regarding marine benthic primary producers.
4.6	Marine Parks and Reserves Authority	The expansion of the facilities including the extension of the causeway will require a substantially increased movement of material both dredged and transported. Although the immediate effects of this activity will be confined to the construction phase, there is the potential for long-term damage to occur. There is also the potential for long-term dredging maintenance to be required given the marked effects the causeway is likely to have on sedimentation patterns and coastal processes. These aspects are not addressed in any substantive way.	The potential marine impacts resulting from the Revised Proposal were outlined in Section 7.2 of the PER. An additional 6.5 ha of seabed disturbance is associated with construction of the Revised Proposal's marine infrastructure in comparison to that of the Approved Development. This additional 6.5 ha of seabed disturbance represents an increase of 3.16% when compared to the seabed disturbance associated with the Approved Development (see page 168 of the PER). The volume of associated dredging is anticipated to stay within the 7.6 million m^3 volume previously approved. The Revised Proposal's causeway and MOF are in essentially the same location as that for the Approved Development. For the Revised Proposal, the seaward end of the causeway and the MOF has shifted slightly to the north and the length has increased from approximately 1300 m to approximately 2100 m. Coastal modelling was undertaken to assess the long-term impacts of the revised infrastructure on sedimentation and coastal processes. Overall, the risk of changes to the foreshore was shown to be low. The risk of adverse impact to the foreshore associated with the presence of the infrastructure can be appropriately managed and monitored. Maintenance dredging will be required; however, it is considered to be of the same scale as that for the Approved Development.
6.9	WWF	The EIS/ERMP fails to provide sufficient information in crucial respects to support the Proponent's requirement to clearly identify all threats and then to describe effective management measures to mitigate their effects. In other words, the major gaps in information mean that not only is it impossible to accurately predict the nature and scale of the development's impacts but that as a corollary, it is impossible to assess with any precision the effectiveness or otherwise of proposed management measures. This just adds to our concerns based, prima facie, as it can still only be, on the mismatch between the severity of a great number of stressors and the likely effectiveness of proposed actions to manage the impacts on receptors. Specifically, WWF-Australia finds the submitted EIS/ERMP to be	This comment was made by the submitter in regards to the EIS/ERMP for the now Approved Development; however, it has been responded to in regards to the Revised Proposal as the comments on the EIS/ERMP have been repeated by WWF in their submission on the Revised Proposal. The assessment of risks in relation to each environmental factor is provided in Appendix C of the PER. The risk assessment for the Revised Proposal was undertaken using standard risk assessment methods and the same processes and format as were used for the Approved Development; the definitions of likelihood and consequence were outlined in Section 5 of the PER. Specialist consultants were involved in the determination of risk for the ecological receptors. A number of investigations have been undertaken by the GJVs since

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		unacceptable for the following reasons: 1. The material and analysis in the draft EIS/ERMP document is deficient in several key areas of data, and provides insufficient grounds for an accurate assessment of individual and cumulative risks on key environmental and biodiversity values of Barrow Island over the lifespan of the proposed project. 2. Several assessments of impacts of stressors on receptors that represent key environmental and biodiversity values of the Barrow Island class A Nature Reserve, are considered to under-estimate levels of risk. WWF is also concerned that the EIS/ERMP fails, in important respects, to provide sufficient data for stakeholders to be able to assess with accuracy the extent of the stressors and the likely mitigating effects of proposed management actions.	approval to implement the Approved Development was granted. These investigations revealed new information relevant to the Revised Proposal and facilitated the risk assessment process. The list of investigations undertaken is presented in Section 6 of the Environmental Scoping Document (Chevron Australia 2008b). Table 15.1 (on p.296 of the PER) outlines the existing statutory and environmental management controls that may be relevant to the Revised Proposal and Table 15.2 (on p.301 of the PER) outlines the objectives, preliminary key management actions and preliminary performance criteria for each of the management plans/systems/programs to be developed to manage the impacts from the Revised Proposal on each of the ecological receptors.
6.10	WWF	WWF-Australia regards the risk assessments for key biodiversity receptors to be inaccurate. The likelihood and consequence of impacts for these receptors from the proposed development on Barrow Island are assessed as 'Almost Certain' and 'Critical'. Such an assessment would result in an overall 'High Risk' rating. WWF-Australia maintains its concern that the information already available about this project indicates convincingly that the risks are unacceptably high in a number of areas, some of which we have outlined in this submission.	This comment was made by the submitter in regards to the EIS/ERMP for the now Approved Development; however, it has been responded to in regards to the Revised Proposal as the comments on the EIS/ERMP have been repeated by WWF in their submission on the Revised Proposal. The risk assessment for the Revised Proposal was undertaken using the same processes and format as were used for the Approved Development as outlined in Section 5 of the PER. This section of the PER explains the processes undertaken to complete the risk assessment, which include: ♦ Definitions of consequence and likelihood ♦ Risk matrix ♦ Use of a specialist facilitator ♦ Participation by relevant subject matter experts. The EPA recommended against the Approved Development in Bulletin 1221. Subsequent to this recommendation, and following determination of appeals, the Western Australian Minister for the Environment and the Commonwealth Minister for the Environment and Water Resources approved implementation of the Gorgon Gas Development on Barrow Island and the surrounding Marine Management Area on 6 September 2007 and 3 October 2007 respectively. A number of investigations have been undertaken by the GJVs since approval to implement the Approved Development was granted. These investigations provided new information relevant to the Revised Proposal, which was considered in the risk assessment process. The list of

Table 4.3		Risk-based Assessment Approach	
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			investigations undertaken is presented in Section 6 of the Environmental Scoping Document (Chevron Australia 2008b). The environmental risks posed by the Revised Proposal are not considered by the GJVs to be greater than the risks identified for the Approved Development, for which the required environmental approvals under Part IV of the State EP Act (Statement No. 748) and the Commonwealth EPBC Act (EPBC Reference: 2003/1294) have been granted.
9.2	DEC – Environmental Management Branch	An important issue is the acceptability of the Proponent's approaches in the PER to offsets and risk assessment. The Proponent has presented that the original proposal, with offsets, has effectively mitigated environmental impacts and that the expanded project, with no additional offsets, poses no significant additional environmental risk. It is considered that this position is not adequately justified. The Proponent states in the PER that identified offsets from the original proposal were a factor in the calculation of residual risks (PER Section 5.1.4 pp 101). Risk assessment should identify the additional risks attributable to the proposed expansion and means to mitigate these, and then the cumulative risks should be examined, before offsets are considered. It is suggested that offsets should be considered in the accepted sequence of environmental impact mitigation, being avoidance, minimisation, rectification, reduction and then offsets. Issue: Inadequate risk and environmental impact assessment Recommendation 1: The EPA analyses the proponent's approach in using offsets from the Approved Proposal in the calculation of residual risk to critical assets. The PER states that proposed offsets were a factor in the calculation of residual risks (PER Section 5.1.4 p 101). This is considered to be a flaw of the risk assessment. Offsets required for the Approved Development should only be identified by the Proponent when arguing for/against further additional offsets due to the net change in residual risk of the Revised Proposal in comparison to the Approved Development. Recommendation 2: The EPA notes that the subjective definition of risk assessment terms used in the PER lacks precision when assessing risk to the high conservation values of Barrow Island receptors and that DEC considers that, in using these definitions, risk levels have been underestimated by the Proponent within the	Whilst the Revised Proposal will result in additional impacts to ecological receptors, these are not expected to be significant and can be managed sufficiently by implementing the management measures proposed for the Approved Development. In response to Recommendation 1, there is a misprint on page 101 of the PER; offsets were not considered in the determination of residual risk as shown in the various environmental risk tables for environmental factors in the PER and Appendix C and consistent with the EIS/ERMP. These tables and accompanying text show that mitigation practices excluding offsets were considered. The GJVs do not consider that additional offsets are required in relation to any additional impacts associated with the Revised Proposal to ecological receptors as the risk levels remain similar to those for the Approved Development, for which the required environmental approvals under Part IV of the State EP Act (Statement No. 748) and the Commonwealth EPBC Act (EPBC Reference: 2003/1294) have been granted. Recommendation 2 is addressed in Section 5 of the PER. The definitions of likelihood and consequence are the same as those used for the Approved Development and were considered by the EPA when they approved the Environmental Scoping Document (Chevron Australia 2008b) for the Revised Proposal PER. The risk assessment was undertaken by subject matter specialists using the defined scale of consequences and likelihood as accepted for assessment of the Approved Development.

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		PER. The risk assessment conclusions presented in the PER on whether to further investigate and/or address specific aspects and associated environmental factors (as listed in Appendix C, pp 3-61) in the PER are questionable. The then Department of Conservation and Land Management (CALM) provided similar advice on the original assessment (Comments on the Gorgon Gas Development ERMP/EIS, CALM Advice to EPA November 2005, pp 16-17).	
9.3	DEC – Environmental Management Branch	Determination of the cumulative risk and impact assessment of the total Gorgon project within the PER is made difficult due to the assessment and presentation of only the Revised Proposal. The Revised Proposal is essentially an expansion of the approved facilities and revision of approved infrastructure. The types of impacts associated with the proposed expansion parallel those of the approved project. The scale and duration of impacts have, however, changed and increased in most cases. The way in which the risk assessment and environmental impacts have been determined for the project and presented in the PER make it difficult to assess the cumulative impacts of the Gorgon project (as a whole) on Barrow Island conservation values. Due to the assessment and presentation of only those parts of the project affected by the revised and expanded proposal, it is believed that the scale of impact presented within the PER may be underestimated. A more rigorous approach would have included the revisions and changes in the context of the Gorgon Project proposal as a whole, in order to allow a thorough environmental assessment. Only those impacts considered to have changed in risk level from the Approved Project were further considered in the PER, which therefore doesn't convey the cumulative impact of the expanded Gorgon development as a whole. Consideration of the environmental risk posed by the entire Gorgon Project (as approved and now proposed) has been complicated and difficult to assess. As well, cumulative impacts have not been assessed at a receptor/species scale. This appears to have led to the Proponent assigning a low level of risk to several elements in the EIS/ERMP (such as impacts on turtles and subterranean fauna) which previously the EPA regarded as having unacceptably high residual	The risk assessment process used for the Revised Proposal was outlined in Section 5 of the PER. The agreed scope of this PER is to assess the significance of the environmental impacts of the Revised Proposal that are in addition to, different from, or cumulative with those of the Approved Development, and whether these impacts can be avoided (where possible). For each stressor associated with a key environmental factor, a risk assessment was undertaken based on the impacts expected from the combined Gorgon Gas Development (i.e. combination of the relevant aspects of the Approved Development and Revised Proposal). The impacts considered in the PER that are associated with the Revised Proposal are in accordance with the Environmental Scoping Document (Chevron Australia 2008b) that the EPA found to be a satisfactory basis for the preparation of the PER. With regard to the last point, relating to assessment of cumulative impacts at the receptor scale, refer to the response in Table 4.3, Item 4.2.

Table 4.3		Risk-based Assessment Approach	
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		risk. The risk of a stressor (e.g. light, physical infrastructure, shipping) impacting on a single receptor (e.g. Flatback Turtles) may be gauged low when considered in isolation. However, when combined, the cumulative risk of impact by a number of stressors on that receptor may be considerably higher. Issue: Inadequacy of the assessment of risk to and cumulative impact specific to marine turtles	
9.12	DEC – Environmental Management Branch	The key to risk assessment processes are the definitions of likelihood and consequence. The definitions used by the Proponent (pp 95–100 PER) lack sensitivity when considering impacts on receptors of particular conservation significance, and have resulted in underestimated risk levels. For example: a situation where Flatback Turtles (threatened fauna: rank vulnerable) cease to nest (behavioural change) on the beach immediately north of the causeway (local) for up to several years (short-term) is regarded as a MINOR consequence when using the Marine Consequence definitions (PER Section 5.1.2.3 p 98). What should be considered, however, is that the cessation of nesting of a vulnerable species (Flatback Turtle), for five years, at a beach that is regarded as a significant nesting site for the species, is likely to have a major detrimental impact on the species and in particular the long-term abundance of turtles utilising Barrow Island. It may not be clear immediately, given the 20+ years between birth and first female breeding, however, the impact will become apparent when the potentially missing generation of hatchlings from those five years fails to return to Barrow Island shores to continue nesting, consequently influencing future population viability. It is considered that the previously accepted offsets for turtle conservation do not adequately cover the increased potential impacts from the expanded proposal. The assessment of impacts on the Barrow Island Flatback Turtle population provides a further example of the underestimation of risk levels: A low risk level was determined by the Proponent in the EIS/ERMP. The EPA, however, considered the risk to be unacceptably high. The current cumulative residual risk assessment for the PER rates the risks to turtles no higher than medium, and considers that there are no significant additional or different risks posed compared to the Approved Development. Given the risk to turtles was considered unacceptably high by the	The definitions of likelihood and consequence are the same as those used during the risk assessment process for the Approved Development and were considered by the EPA when they approved the Environmental Scoping Document (Chevron Australia 2008b) for the Revised Proposal PER. Table 5.2 and Table 5.3 of the PER outline definitions for the scale of consequences and likelihood associated with terrestrial and marine factors, with separate definitions provided for 'general' and 'restricted' or 'listed' vegetation, fauna or marine benthic primary producer communities. The definitions have the sensitivity to address all potential impacts. In the specific example of *no nesting for 5 years*, the consequence to turtles would be Major because of reduced population viability. The risk assessment was undertaken and determined by specialist consultants with experience in wildlife management including marine turtles, using the defined scale of consequences and likelihood. The residual risk to marine fauna behavioural patterns, particularly marine turtles arising from the loss of seabed habitat (i.e. the causeway) was considered to be 'Moderate' for the combined Revised Proposal and Approved Development footprint (Table 7.2 of the PER). This was determined based on a moderate consequence because the consequences on turtles were determined by experts not to affect population viability. The residual risk of impacts to turtles from the physical presence of the Revised Proposal causeway on turtle behaviour, including nesting, was conservatively assessed as Medium as compared with the Low risk rating given for the Approved Development, due to the possibility of the additional 800 m of causeway potentially increasing the risk of disruptions to adult turtle behaviour. The causeway was considered to create a diversion to turtles in the water rather than a barrier to their swimming. This diversion was not considered to impact the turtle population at the Barrow Island or wider scale and was therefore assigned a Serious consequence. As discussed in the PER, turtles are adapted to swimming considerable distances and a diversion such as a causeway was not considered to lead to an adverse behavioural change to their

Table 4.3		Risk-based Assessment Approach	
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		EPA for the Approved Development, and that the proposed changes lead to increased light and noise emissions, increased shipping and most importantly a major increase to the length of the solid causeway (and hence physical barrier to adult turtle and hatchling movement), DEC considers that the cumulative risk to turtles can only have increased, and have increased to significant levels. The Proponent's determination of only a medium risk and statement of no additional risk relative to the original development are fundamentally flawed.	otherwise normal swimming behaviour. The environmental risks posed by the Revised Proposal are not considered by the GJVs to be greater than the risks identified for the Approved Development, for which the required environmental approvals under Part IV of the State EP Act (Statement No. 748) and the Commonwealth EPBC Act (EPBC Reference: 2003/1294) have been granted. The conditions and Proponent commitments in Statement No. 748 will further mitigate the residual risk of the Approved Development and the Revised Proposal through the adoption of a carefully-planned impact monitoring program for Flatback Turtles.
9.30	DEC – Environmental Management Branch	The PER calculation of risks to subterranean fauna from a potential CO_2 leak may be incorrect. This is apparent in Table 6.4, Section 6.2.5 of the PER (p 130). The consequence of a CO_2 migration or release on stygofauna has moved from 1 (critical) to 5 (minor). DEC agrees that the likelihood of a release has increased but does not accept that the consequence of a migration has declined. Further information is required to clarify this disparity.	Table 10-13 in the EIS/ERMP indicated a likelihood of Remote (5) and a consequence of Critical (1) with an overall risk level of 'Medium. There is a misprint in the PER with a transposition of likelihood and consequence ratings for the Revised Proposal. The independent technical panel engaged to review the likelihood and consequence of a failure of the CO_2 injection system determined the likelihood of an event occurring leading to the release of CO_2 was 'very remote' (refer to remarks in Subterranean Fauna Table in Appendix C) which equates to a likelihood score of 5. The consequence rating would be Serious (3). This is at a lower level than the EIS/ERMP, as the effect would be localised and not at a population level, leading to a risk level of 'Low'. That is, with further understanding, it is believed the risk was incorrectly assigned in the EIS/ERMP for the Approved Development.
9.34	DEC – Environmental Management Branch	Discussion on the results of the risk assessment workshops infers that DEC, the EPA Service Unit and Commonwealth Department of the Environment, Water, Heritage and the Arts observers provided input (were included) into the assessment of whether or not to address aspects within the PER. It should be acknowledged that as "observers" these agencies did not participate in any decision-making process during the risk assessment workshops. This position was made clear to the Proponent at the time.	Section 5.1.2.2 of the PER discusses the process involved in the identification of additional and different environmental aspects and impacts associated with the Revised Proposal, and the preliminary risk-based analysis that was undertaken for inclusion in the Environmental Scoping Document (Chevron Australia 2008b). A one day workshop was conducted to undertake this analysis involving specialist consultants and relevant Gorgon Gas Development personnel. Representatives from DEC, EPASU and DEWHA attended the workshop as observers only. The GJVs acknowledges that the DEC, EPASU and DEWHA observers did not participate in, or endorse the assessment of risk ratings.
12.2	DEC – Marine Ecosystems Branch	Impacts of marine infrastructure and dredging The parts of the PER document and the associated appendices discussing the above issue are often vague, sometimes inconsistent and many questions and uncertainties have arisen	Subject matter specialists undertook the risk assessment for the Revised Proposal (and the Approved Development). The definitions of likelihood and consequence that were used for the Revised Proposal's risk assessment are the same as those used for the risk assessment for the Approved Development and were considered by the EPA when they

Table 4.3		Risk-based Assessment Approach	
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		during the course of the review of the relevant documentation. Risk assessment approach The apparent significant variance between the levels of risk assigned to dredging-related issues by the Proponent compared with those determined by the EPA in Bulletin 1221 illustrates the subjectivity of the GJVs' risk assessment. The PER is generally silent on the difference of opinion between the EPA and the Proponent with respect to risk associated with various marine impacts. At least some part of the difference in views may be attributable to the EPA and the Proponent assigning different levels of importance to various parts of the environment that will be impacted or otherwise threatened by the development. For example, the Proponent focuses attention on coral communities it considers are 'regionally significant' and in doing so downplays predicted impacts on other communities which are assigned a lower importance – 'local significance'. This approach is considered to have significant deficiencies as it does not account for the roles that all parts of the ecosystem (not just the 'regionally significant' ones) play in maintaining overall ecological integrity. Furthermore, the PER is not sufficiently clear that the 'significance' ratings assigned to marine communities those of the Proponent only and do not necessarily reflect views of the EPA or DEC. The risk assessment approach reported in the PER has serious deficiencies at best and at worst could be flawed. Fundamentally, the GJV's approach has been to attempt to estimate environmental risk for the revised or expanded elements of the proposal only. A critical deficiency of this approach is that it does not consider the cumulative risk associated with the entire revised and expanded proposal and therefore most likely results in underestimation of risk ratings for some factors. Numerous elements of the risk assessment matrices have not been completed, raising uncertainty about whether issues identified as warranting further assessment represent a comprehensive or appropriate list. Summary: There are fundamental concerns about apparent subjectivity and robustness of the risk assessment approach applied to the revised and expanded Gorgon LNG proposal.	approved the Environmental Scoping Document (Chevron Australia 2008b) for the Revised Proposal PER. The definitions of likelihood, consequence and risk are clearly described in Section 5.1.2.3 of the PER and the levels assigned are clearly documented in Appendix C in a transparent manner. Note: blank cells in the risk tables of Appendix C indicate that the risk for that particular stressor and impact was deemed not to have changed from the Approved Development and was therefore not considered further in the assessment. The risk assessment approach was undertaken in accordance with the principles and guidelines contained in the following, and is comparable to the risk assessments presented in other environment impact assessments: ♦ AS/NZS 4360:2004 Risk Management (Standards Australia/Standards New Zealand 2004a) ♦ HB 203:2004 Environmental Risk Management – Principles and Process (Standards Australia/Standards New Zealand 2004b) ♦ AS/NZS 3931:1998 Risk analysis of Technological Systems – Application Guide. (Standards Australia/Standards New Zealand 1998) For each stressor associated with a key environmental factor, a risk assessment was undertaken based on the impacts expected from the Revised Proposal itself and then comment was made on the cumulative impact with that of the Approved Development. The GJVs considered the key environmental factors and addressed the scope of the impact assessment of the Revised Proposal as described in the approved Environmental Scoping Document (Chevron Australia 2008b). This included addressing those environmental factors that were considered important at a local and regional level. These factors were not only addressed from a regional representation point of view but also their importance to regional and local ecosystem function and integrity as described in the consequence descriptors. Refer also to response to Table 4.3 (Item 9.3) for comments on cumulative effects.
12.8	DEC – Marine Ecosystems	Environmental Quality Management Framework	The GJVs commit to addressing the requirements under the State Water

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	Branch	Environmental Values (Evs), Environmental Quality Objectives (EQOs) and associated levels of ecological protection have been established and spatially-defined for State marine waters off the Pilbara coast through a public consultation process (DoE 2005). The EPA has endorsed the 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. The Gorgon proposal has implications for the EQOs and spatial application of the levels of ecological protection off the east coast of Barrow Island. In view of the judgement reached by the EPA through its assessment of the original Gorgon proposal that the proposal should not be allowed to proceed, limited attention was given to addressing the environmental quality management framework (EQMF) for marine waters, which would only require modification if the proposal were to proceed. Now that a decision has been made by Government to allow original Gorgon proposal to proceed and that the proponent is currently pursuing environmental approval for its revised and expanded proposal, it is appropriate that the EQMF be addressed through this EIA process as set out in the State Water Quality Management Strategy Document No.6. Accordingly, in its responses to submissions on the PER, the Proponent should couch the environmental effects of the proposal in the context of the EQOs and associated levels of ecological protection shown in DoE (2006). Information supplied to the EPA will need to include maps that clearly show the extent to which the current EQOs and associated levels of ecological protection shown in DoE (2006) would be modified if the proposal is allowed to proceed. Summary: The Proponent should couch its proposal in the context of the EQMF – i.e. the Evs, EQOs and spatially defined levels of ecological protection described in DoE (2006) which have been endorsed by the EPA as interim to guide EIA and natural resource management in the Pilbara.	Quality Management Strategy Document No.6. The GJVs agree in principle that the delineation of a zone of modified Environmental Quality Objectives (EQOs) around the Gorgon Project Marine Infrastructure off the east coast of Barrow Island for the period of operation of these facilities is consistent with the Western Australian State Water Management Strategy. The definition of the zones of modified EQOs for operations activities around the relevant marine facilities shall be undertaken in consultation with the DEC Marine Ecosystems Branch. The GJVs suggest that this occurs during the preparation of the deliverables relating to marine environmental impacts. This could be addressed under Condition 14 of Statement 748, Coastal and Marine State and Environmental Impact Report.
12.11	DEC – Marine Ecosystems Branch	General comments On several occasions MEB expressed concern about extensive use of qualitative terms and ambiguous statements used by the proponent in the ERMP to describe the potential marine environmental impacts of the original Gorgon LNG proposal. The PER for the revised and expanded Gorgon LNG proposal also	This comment lacks specificity or examples making a response very difficult. Please refer to the GJVs' response to specific comments, including Table 4.3 (Item 9.12).

Table 4.3		Risk-based Assessment Approach	
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		contains numerous examples where qualitative terms are used to describe fundamental impacts and there are important passages of the document (some of which have been highlighted in detail in other parts of this memorandum) that are quite unclear, and in some cases, internally inconsistent. As for the ERMP, the lack of clarity around some of the key issues for EIA adds uncertainty to the assessment and decision-making processes.	
15.4	Conservation Commission of Western Australia	The Conservation Commission is concerned about the manner in which various risks have been assessed and in particular with respect to the Island's turtle population. The Barrow Island population of the Flatback Turtle (*Natator depressus*) is of regional significance and the eastern beaches are acknowledged as being very important for this species. Risks to this population are often assessed in the document as single items whereas there needs to be an assessment of the cumulative impacts of a series of impacts on the population. For example, it is often the case that the construction of a causeway structure jutting out from a coastline brings about changes to sand deposition and erosion for adjacent beaches. The scale of this needs to be modelled for possible impacts on the access and use of the eastern beaches by turtles over time rather than single specific events such as cyclones. The range of impacts, such as light impacts, movement of turtles along the coast etc. likewise need to be assessed in total. There are significant deficiencies that need to be responded to through the provision of supplementary information prior to the Environmental Protection Authority's consideration of the proposal.	Refer to Table 4.15 (Item 15.4) of this document, which addresses comments regarding marine fauna. Refer also to the GJVs' response to Table 4.3 (Item 9.3) in this document.
15.5	Conservation Commission of Western Australia	Clarification is required as to what is meant by 'significant' when discussing the actions to be undertaken if it is found that the proposal does have a significant impact on the turtle population. The point at which intervention would be considered should be outlined. The documentation provided shows that the risk assessment is poorly related to the quantification of the impact of the expanded proposal for several areas. A key requirement identified in the PER is to address the effects of the Revised Proposal on sea turtle population viability and this has not been clearly demonstrated. For the reasons mentioned, statements such as, *Overall, the impact on nesting activity is not predicted to be different from the Approved Development*, must be questioned.	Refer to Table 4.15 (Item 15.5) of this document, which addresses comments regarding marine fauna. Specific performance targets will be addressed in the Long Term Marine Turtle Management and Monitoring Plan as required under Condition 16 of Statement No. 748. Performance targets, as listed in the Plan, are related to the following stressors to marine turtles: ♦ lighting ♦ vessels ♦ dredging ♦ spills and unplanned discharges ♦ beach stability: erosion and accretion

Table 4.3		Risk-based Assessment Approach	
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			♦ noise and vibration ♦ dust ♦ beach access ♦ reverse osmosis seawater intake ♦ fishing by Gorgon Project personnel ♦ blasting ♦ human presence ♦ turbidity The Performance Targets will provide guidance to the GJVs in regard to when further investigations will be required to address Gorgon Gas Development attributable changes that occur to turtles. Importantly, the turtle monitoring program will use a statistical approach to define 'significance' in terms of power analysis i.e. when a level of change (effect size) is met; this level of change will be used to inform the GJVs to undertake further action. As specified by Condition 16 of Statement No. 748, the GJVs' monitoring methods shall have the ability to detect at a statistical power of 0.8 (or an alternative statistical power as determined by the Minister, on advice of the Marine Turtle Expert Panel (MTEP), changes or impacts on parameters related to population viability. Should monitoring detect a significant change, particularly to Flatback Turtle populations, the GJVs will be required to take or fund further action to improve recruitment to the turtle population. Refer to the Preamble of Statement No. 748 for further details of the North West Shelf Flatback Turtle Conservation Program, and associated Intervention Program (Additional GJV Undertakings).

4.4 Terrestrial Environment

Table 4.4: General Terrestrial Environment

Table 4.4		General Terrestrial Environment	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
2.18	Conservation Council of Western Australia	Other miscellaneous impacts of this proposal that do not fall into the categories discussed above also have an unacceptable level of cumulative impact on the Barrow Island A-Class Nature reserve that should be managed solely for biodiversity conservation – these include air pollution, increased visitation, light pollution, noise pollution etc. The Revised Proposal only adds to these cumulative impacts concerns.	Risks to the biodiversity values of Barrow Island from all sources have been addressed in the PER (Appendix C) and have been determined with respect to each of the receptors, using standard risk assessment methodologies, to be as follows: *Terrestrial Fauna* Risks to terrestrial fauna from atmospheric and dust emissions, noise and vibration emissions and most light emissions were determined to be Low. The potential risks to seabirds due to light emissions was considered to be a Medium risk (Section 6.1.2.4 of the PER), as were the potential impacts associated with the introduction or spreading of exotic taxa (Section 8 of the PER); these impacts have been discussed in the PER. Potential impacts to seabirds are considered to be within a localised area with the potential loss of small numbers of individuals potentially resulting without a reduction in local population viability on Barrow Island or nearby Double Islands. It is considered that there are no unacceptable cumulative risks related to quarantine as a result of the Revised Proposal, given the extensive mitigation measures that will be implemented. *Subterranean Fauna* None of the aspects (stressors) outlined in the comment are relevant to subterranean fauna. *Flora and Vegetation* Potential impacts to flora and vegetation due to light spill and noise were determined to be irrelevant. Risks to flora and vegetation from atmospheric emissions were determined to be Low as was the potential for a change in taxon dominance due to an introduction and/or spread of non-indigenous species, with impacts attributable to the Revised Proposal not anticipated to change in magnitude from the Approved Development. Monitoring of vegetation and weeds will occur and will be used to inform on the adequacy of management measures and the need for further controls. Potential impacts due to the introduction and/or spread of non-indigenous species was determined to not present a significant additional or different environmental risk versus the Approved Development, and with appropriate management, the residual risk has been assessed as being Low (Section 6.3.2.3 of the PER).
7.9	Cape Conservation Group	Other miscellaneous impacts of this proposal that do not fall into the categories discussed above also have an unacceptable level of	Refer to the GJVs' response provided in Table 4.4 (Item 2.18) in this document.

Table 4.4		General Terrestrial Environment	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
		cumulative impact on the Barrow Island A-Class Nature reserve that should be managed solely for biodiversity conservation – these include air pollution, increased visitation, light pollution etc. The Revised Proposal only adds to these cumulative impacts concerns.	
9.1	DEC – Environmental Management Branch	The proposed revised and expanded development on Barrow Island is larger than the original approved proposal. There will be additional biodiversity impacts from the proposal and it is considered that the PER has not adequately accounted for these. If the EPA is to recommend approval of the expanded development, additional offsets may be required, particularly in relation to impacts and potential impacts predicted for marine turtles.	The extent of impacts associated with the Revised Proposal is considered manageable based on the current mitigation measures in place for the Island and proposed for the Gorgon Gas Development. The environmental risks posed by the Revised Proposal are not considered by the GJVs to be greater than the risks identified for the Approved Development, for which the required environmental approvals under Part IV of the State EP Act (Statement No. 748) and the Commonwealth EPBC Act (EPBC Reference: 2003/1294) have been granted. The potential environmental impact footprint of the Approved Development as assessed in the EIS/ERMP is based on an area of 300 ha. The Revised Proposal as assessed in the PER is within this limit.
9.25	DEC – Environmental Management Branch	The increased area of land for long-term use may also lead to additional areas impacted by altered runoff, sedimentation, recharge, compaction and erosion, which may consequently affect terrestrial (including subterranean) habitat.	A response to this comment is provided in the context of terrestrial habitat; potential impacts on subterranean habitat are addressed in Table 4.9 (Item 9.25) of this document. Vegetation clearing, site disturbance/excavation, runoff and the physical presence of infrastructure associated with the Revised Proposal could potentially affect soils and landforms, surface water, groundwater and flora and vegetation. Since these incremental impacts have not been considered likely to be significant; impacts to soils and landforms, surface water and groundwater were excluded from further assessment in the PER, as outlined in the Environmental Scoping Document (Chevron Australia 2008b) endorsed by the EPA. These impacts will be addressed under the management plans/programs/systems required by the conditions outlined in Statement No. 748 and/or EPBC Reference: 2003/1294. Potential impacts to flora and vegetation associated with clearing were discussed in Section 6.3.2.1 of the PER. The potential environmental impact footprint of both the Approved Development as assessed in the EIS/ERMP is based on an area of 300 ha. The Revised Proposal as assessed in the PER is within this limit.
9.38	DEC – Environmental Management Branch	The biodiversity values of Barrow Island are unique and significant at State, national and international scales. Barrow Island contains a high diversity of flora and fauna that have not been exposed to	The comments are acknowledged, and the uniqueness and significance of the biodiversity values on Barrow Island are the reasons behind the stringent mitigation and management measures proposed for both the

Table 4.4		General Terrestrial Environment	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
		the same intensity of threatening processes that impact on mainland flora, fauna and ecosystems. Thousands of years of isolation have resulted in the evolution of species and subspecies endemic to Barrow Island. Many reptile and invertebrate species on Barrow Island appear to be genetically distinct from mainland populations of the same species. Due to its isolation from threats present on the mainland, such as inappropriate fire regimes, introduced predators, grazing and many species of weeds, Barrow Island is an important refuge for significant biodiversity values. It hosts seven fauna species listed as threatened under both State and Commonwealth legislation and is considered significant for subterranean fauna at the regional, State and national scales. Barrow Island is an internationally important site for migratory shorebirds, hosting 14 seabird species and 25 wetland/littoral species listed under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*. Barrow Island is a significant nesting site for four species of sea turtles, and is considered a regionally important nesting area for Green and Flatback Turtles. Barrow Island was set aside as a nature reserve in 1910 in recognition of these outstanding flora and fauna values. It is currently reserved as a class A nature reserve for the purpose of 'Conservation of Flora and Fauna'. The Island is vested in the Conservation Commission of Western Australia and is managed by the Department of Environment and Conservation (DEC). In December 2004, the Government established the Barrow Island Marine Park on the western side of Barrow Island and the Barrow Island Marine Management Area surrounding the remainder of the Island (excluding the Barrow Island port area). Barrow Island Marine Park protects the significant Biggada fringing reef and Turtle Bay, an important breeding area for Green Turtles. Barrow Island Marine Management Area includes important and diverse coral, macroalgal and seagrass communities, with the latter two community types occurring on extensive limestone platforms and forming important refuges and feeding areas for a number of marine turtle species and dugong.	Approved Development and Revised Proposal. In order to protect the biodiversity values of Barrow Island, the GJVs have planned the implementation of a Quarantine Management System. The GJVs' commitment to the Quarantine Management System (QMS) was articulated in Chapter 12, Section 12.6 of the EIS/ERMP. This commitment has been formalised in Statement No. 748. Pursuant to Condition 10.1 for the Approved Development, *"…the Proponent shall submit the QMS to the Minister, taking into account the advice of the QEP* [Quarantine Expert Panel] *that meets the aim and objectives set out in Condition 10.3 and the requirements of Condition 10.4, as determined by the Minister, unless otherwise allowed in Condition 10.2."* Condition 10.4 refers to Schedule 4 of Statement No. 748, which contains the specific details of the elements to be addressed in the QMS. Therefore, both the content of the QMS and the role of the QEP in providing advice to the Minister are already well established. The Revised Proposal requires exactly the same elements, since the stated expectations for the QMS are for it to be scalable to any size project on Barrow Island. The GJVs are committed to limiting land disturbance and rehabilitating disturbed land where facilities are no longer required. In order to reduce the environmental disturbance and impacts on Barrow Island, the Gorgon Joint Venturers are committed to sharing facilities with the Barrow Island Joint Venture. Opportunities for sharing include the airport, accommodation, supply base, access roads and some production and maintenance facilities, training facilities and utilities such as water, power and waste disposal. The GJVs will ensure that no facilities are shared that could adversely impact safety or environmental performance, or impose a limitation on either party's production capability. A commercial agreement between the Gorgon Joint Venture and Barrow Island Joint Venture parties was executed in September 2008. It includes details regarding responsibilities and obligations of each party to the Barrow Island Coordination Council. The GJVs have undertaken extensive modelling of dredging impacts for both the Approved Development and the Revised Proposal. This modelling indicates that no adverse impact is predicted to occur to areas supporting coral within the Marine Management Areas (external to the Barrow Island Port Limit). Limited impact is anticipated to areas in the Marine Management Areas near the spoil ground but these predominantly support subtidal reef (low relief) and sand. The zone of influence will extend into the Marine Management Areas but this is only a low-level

Table 4.4		General Terrestrial Environment	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
			turbidity plume at concentrations not expected to cause an adverse impact at all and will be limited to the dredging period.
17.5	DPI	Terrestrial and Marine Environment In regard to significant natural features and significant flora and fauna it is acknowledged that the proposal must comply with the *Environmental Protection Act 198*6 as per the Agreement Section 2 (3). However in regard to drainage, we would like to add, for your consideration, that any development located on or adjacent to the coast should not discharge waste and/or storm-water in a manner that may degrade the coastal environment including coastal and marine waters and ecosystems (SPP2.6 Section 5.1(xiii; xiv)).	Wastewater discharge was not described as part of the Revised Proposal; it was considered as part of the Approved Development (and is outlined in Schedule 1 of Statement No. 748). The preliminary risk assessment for the Revised Proposal (as presented in Appendix C of the PER) stated that for the aspect of runoff and the associated environmental factor of surface water the "*Revised Proposal may result in some additional and/or different impacts to…from the Approved Gorgon Gas Development, but these impacts are not likely to be significant*". The drainage philosophy for the Gas Treatment Plant as reflected in the Gorgon Environmental Basis of Design (Chevron Australia 2008d) and the Gorgon Project Venting and Drainage Basis of Design (Kellogg Joint Venture Gorgon [KJVG] 2008a) aims to return to the natural environment any uncontaminated stormwater captured onsite or intercepted by the Gas Treatment Plant perimeter drains from offsite flows, in a manner consistent with the natural flow of stormwater through the pre-development environment. This will be achieved in a variety of ways, namely: ♦ stormwater infiltration onsite will be maximised through keeping concrete paved areas limited to the necessary areas as well as allowing structures and clean equipment to be submerged in stormwater for short periods of time to prevent overflowing and over sizing of the Class 3 (clean stormwater) drains. ♦ stormwater will be released back to the environment by allowing the perimeter Class 3 stormwater drains to overflow rather than discharge at specific discharge locations in order to ensure that the water moves as a sheet flow avoiding channelling and erosion. ♦ no stormwater will be discharged into the foreshore dune system, which will be replenished through direct rainfall. ♦ the perimeter drains on the north-west corner of the plant site will intercept flow from the environment and capture it to prevent erosion. ♦ the Class 3 clean stormwater drains on the site will be constructed such as to maximise infiltration into the ground (e.g., through perforated piping). These drains may need to be installed as closed drains to limit land take or open U-shaped recessed drains. Design options for these are currently under review.

Table 4.4		General Terrestrial Environment	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
			Drains design will also take into account personnel access and trapped fauna escape, groundwater levels, erosion control, sediment control etc. The plant site will also have a Class 1 (always contaminated, closed drains) system, a Class 2A (potentially hydrocarbon contaminated, open drains system and a Class 2B (potentially chemical-contaminated, open drains) system designed to the requirements of the Gorgon Environmental Basis of Design (Chevron Australia 2008d) and the Gorgon Project Venting and Drainage Basis of Design (KJVG 2008a). The GJVs will follow due process (with appropriate agencies) in relation to managing the discharge of waste/stormwater to ensure applicable regulatory requirements are met.

4.5 Terrestrial Fauna

Table 4.5: Terrestrial Fauna

Table 4.5		Terrestrial Fauna	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
5.8	Department of Health	The description of the quarantine management system in the PER is fairly general/generic. Nuisance and disease vector quarantine and impacts will need to be considered as part of' the quarantine strategy. Stormwater and wastewater infrastructure should be located, designed and maintained in a manner that does not create or exacerbate breeding of nuisance and disease vector arthropods. All earthworks, topography changes should be done in a manner that does not create breeding habitat for nuisance/disease vector insects. Employee accommodation both on the Island and on the mainland should be located well away from known disease/nuisance insect breeding habitat. The Proponent should liaise with the Shire of Roebourne for advice on this.	Refer to Table 4.21 (Item 5.8) of this document, which addresses matters regarding quarantine. The GJVs sought subject matter advice on the matter of disease, disease vectors and other micro-organisms and the risk of introducing such organisms to Barrow Island. The GJVs obtained advice on potential threats of disease to conservation values via desktop studies, as recommend by the past QEP. Micro-organism threats to terrestrial vertebrate fauna were assessed by the School of Veterinary and Biomedical Science at Murdoch University. Plant pathogen threats were assessed by the Curator of the Plant Pathology Herbarium of the Department of Primary Industries and Fisheries, Queensland. This advice was published in the Technical Appendices D8 Pathogenic Microorganism Threats to the Terrestrial Vertebrate Fauna of Barrow Island (Chevron Australia 2005). While it is impossible to completely exclude the introduction of micro-organisms to Barrow Island, the subject matter experts held the view that the risk is low. The most likely pathway in which micro-organisms could reach the island is via people, as all the other pathways are set up to treat items physically (by cleaning and heat treatment) or chemically (by

Table 4.5		Terrestrial Fauna	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
			treating goods with residual insecticides and fumigants). These options are not applicable to people, and as such measures have been put in place to prevent the unintentional transfer of micro-organisms from people to the native environment. Waste will be managed in a closed waste management system. Food waste will be double bagged, sewage will be contained and vessel waste will be prohibited from being discharged within the marine quarantine zones. Personnel will be restricted to approved work areas which limit contact with the native environment and field personnel will be required to use formal ablution facilities that are linked to the waste management system. These measures further limit the likelihood of nuisance and disease vectors adversely impacting Barrow Island.
9.10	DEC – Environmental Management Branch	There is a potentially increased risk of detrimental impact on fauna, including subterranean fauna, from possible failure of the expanded CO_2 injection system. Recommendation 24: More information is required regarding how the risks and impacts associated with a leak or release of CO_2 at the greater rate of production (vegetation/fauna/human) have altered, including clarification of the calculation of risks to subterranean fauna from a potential CO_2 escape. The accelerated rate at which reservoir CO_2 is proposed to be injected will require additional injection wells and drill centres, with a corresponding increase in pipelines, and as the pressure is expected to increase more rapidly in this Revised Proposal, a number of pressure release wells and associated ancillary infrastructure are required. Given the increase in the rate of CO_2 production and requirement for injection, failure of the injection system may lead to larger volumes of CO_2 being leaked/vented/released to the atmosphere. Additional information is required regarding how the risks and impacts associated with a leak or release of CO_2 at the greater volume of production (impacts on vegetation/fauna/human) have altered. Greater rates of injection also may reduce any response time in the case pressure reaches peak levels within the formation. It is not clear that the mitigation and management of the CO_2 sequestration operations are adequate.	Refer to Table 4.25 and Table 4.9 of this document, which provide responses regarding the expanded reservoir CO_2 injection system and potential impacts on subterranean fauna respectively. Risks to flora and vegetation and humans are discussed in this document in Table 4.10 and Table 4.28 respectively. The failure modes and effects studies that underpin the assessment of environmental risk considered the GJVs' uncertainty management plans including the ability to detect and respond to a deviation from anticipated reservoir behaviour. The residual risk to terrestrial fauna from unplanned CO_2 releases is considered by the GJVs to be low, with a number of management measures being implemented including a wellhead maintenance program, development of a Pressure Management Strategy and a shallow surface (soil) Carbon Dioxide Monitoring Program. Further information is provided in Section 4.17.1.
9.23	DEC – Environmental Management Branch	Recommendation 23: The EPA to note that short-range endemic and subterranean fauna (troglofauna and stygofauna) survey and monitoring work remain incomplete. Information in relation to	Refer to Table 4.9 (Item 9.23), of this document, which provides a response in relation to subterranean fauna. This response specifically addresses terrestrial invertebrate short-range endemics (SREs).

Table 4.5		Terrestrial Fauna	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
		survey methodology, sample locations, distribution of individuals and the taxonomy of specimens found during ongoing surveys is required before an assessment of impacts can be made. There are still a number of subterranean fauna and short-range endemic taxa that are yet to be found outside the disturbance footprint (see Table 3.5 p 62). The PER commits to further monitoring work (as required under Ministerial Statement 748) for these species until they are located outside the disturbance footprint. Information provided in the PER suggests that some species previously thought to be restricted to the plant footprint are now found beyond the plant, however, there is no substantial discussion of this. There is no discussion on where the additional individuals were located, nor how many were located, and therefore there is no clarity on the range, distribution and potential impacts on these species. More information is required on the findings of sampling and taxonomic work and how future results are to be reported to DEC. Many statements on the locality and distribution of stygofauna species remain unproven. For example, the PER states that several species of Bathynellidae occur outside the impact area, however, these specimens are yet to be identified fully to species level. To further confuse the data and interpretation, the reference to table numbers throughout the discussion is incorrect. Stating that specimens of higher taxa (the same genus) are widespread is not a valid substitute for determining the status of a species. It is hoped that the proposed taxonomic work will provide clarification on this issue. Similar interpretations using high taxonomic groupings is evidenced in the PER Section 3.3.3.2, p 61, where Amphipoda have been found in the Robe Valley. There is insufficient information in the PER to assess the short-range endemic and troglofauna surveys. The risk of impacts on short-range endemics and troglofauna therefore cannot be adequately assessed.	Terrestrial invertebrate SREs have been surveyed using various search methods (black light, litter hand searches, pitfall traps), targeting different taxa (snails, scorpions, mygalomorph spiders) known to be SREs elsewhere in WA. Searches were conducted on the additional vegetated areas comprising the Revised Proposal portion of the Development footprint. Preliminary results from taxonomists suggest that there are unlikely to be any terrestrial invertebrate SRE species restricted to the Revised Proposal area, although final identification at the species level (based on morphology classification) is being completed by the Western Australian Museum and Curtin University (Majer and Edwards 2008). It has been confirmed that two taxa, formerly believed to be restricted to the Gorgon Gas Development footprint (see the EIS/ERMP), have wider distributions on Barrow Island, as discussed in more detail below. This wider distribution supports contentions that there should be no risk of impacts on these short-range endemic taxa. *Urodacus sp.* Searches for the scorpion *Urodacus* sp. were undertaken by Curtin University during the day and at night during the wet season of 2008. These surveys were conducted using pitfall traps placed at suspected burrow entrances and utilising black lights (torches modified with ultraviolet light-emitting diodes), which result in the scorpions being easier to detect because they fluoresce. Day searching involved looking for burrows. Dry pitfall traps were dug into the ground at the entrance of suspected scorpion burrows and were removed at the end of each night. Night searches were undertaken in the week leading into the new moon phase and involved scanning for scorpions using a portable black light under which scorpions fluoresce. The driving surveys were conducted in vehicles travelling at approximately 5-10 km/hr along roads, with the passenger holding the black-light out the window and scanning along the roadside and adjacent vegetation. These surveys were timed to coincide with the new-moon phase of the month because scorpions are more easily detected during this period. This method was highly effective with 13 *Urodacus* '*linneai*' found during night surveys. The previously utilised technique of pitfall trapping proved to be ineffective, with only one scorpion being captured using this method. Fourteen individuals of the scorpion *Urodacus* '*linneai*' were confirmed at nine locations across Barrow Island, with a further three specimens reported by Chevron Australia staff. Of the 17 *Urodacus* '*linnea*i' recorded, 12 were submitted to the Western Australian Museum as voucher specimens for identification and genetic analysis. The collection

Table 4.5		Terrestrial Fauna	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
			locations included limestone ridges, limestone flats, red earth flats, drainage lines and the southern escarpment. The species is widely distributed at low densities all around Barrow Island, and it seems that this species is not restricted in distribution or habitat type on the Island. Whilst more specimens were recorded from the southern areas of Barrow Island, this reflects the biases of the survey. *Synsphyronus sp. Nov. 'barrow'* Another SRE, a pseudoscorpion *Synsphyronus* sp. Nov. '*barrow*', was subsequently collected in 2006 by Curtin University (Majer *et al.* 2008) at eight of the 12 sites surveyed outside the Approved Development site. Identifications were confirmed by Mark Harvey of the Western Australian Museum (Majer *et al.* 2008). The risks of impacts on SRE are addressed in Section 6.1 of the PER.
9.26	DEC – Environmental Management Branch	Vegetation associations to be impacted have changed slightly from the Approved Development, including additional impact on associations consisting of *Melaleuca cardiophylla*, which are known to be favoured by the White-winged Fairy-wren for habitat. The Revised Proposal increases the clearing of vegetation associations containing *Melaleuca cardiophylla* from 35 to 48.4 hectares. This equates to 11.67 per cent of the mapped extent of vegetation associations containing this species. Although these areas are not exclusive habitat of the Fairy-wren, further clearing is likely to have some additional impact on the species.	Refer to Section 4.5.1 of this document.

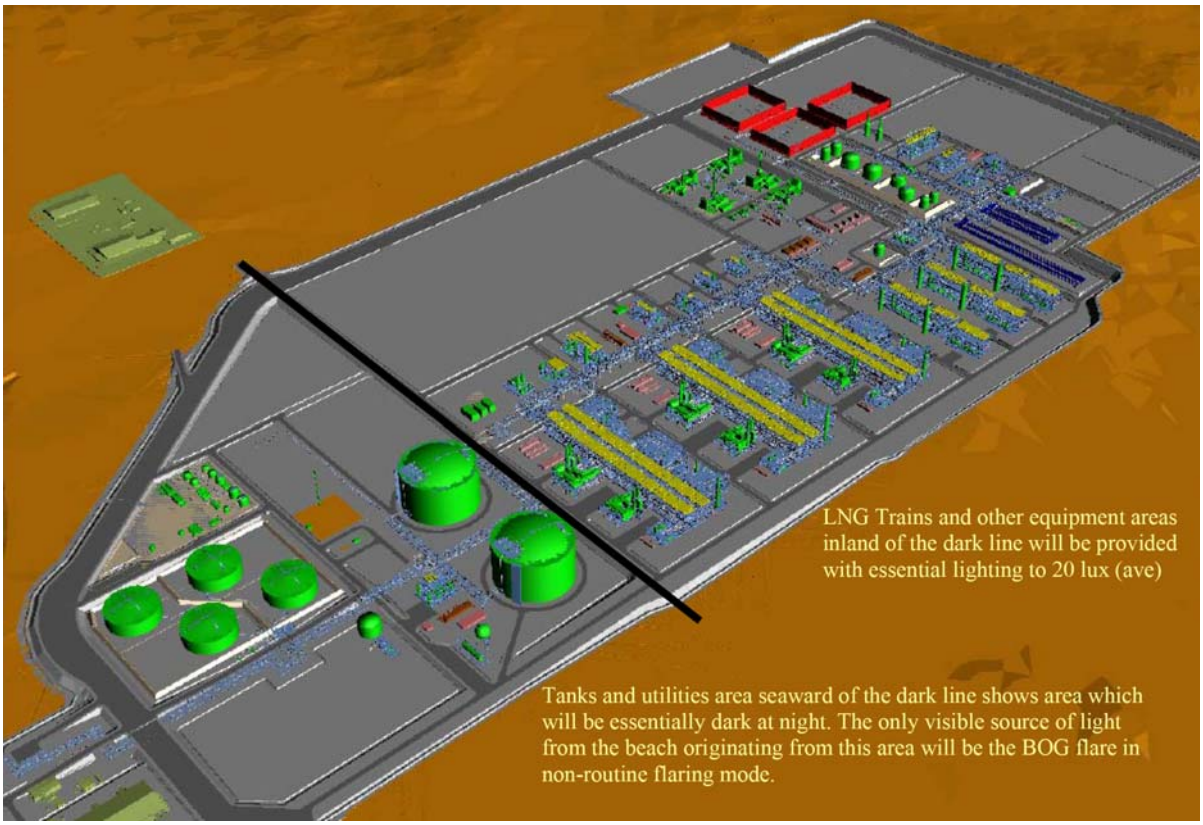

Figure 4.1: Proposed Lighting Levels Across the Gas Processing Plant

4.5.1 Further Information Regarding the White-winged Fairy-wren

Please note that there is an error in Table 6.8, page 140 of the PER; the calculation included vegetation association V1d, when it should have included V1m. Table 4.6 in this document outlines the correct vegetation associations and associated areas affected by the Revised Proposal.

Table 4.6: Revised Proposal Impacts to Restricted Flora

Restricted Flora Species	Vegetation Association with Restricted Flora species density >2%	Revised Proposal Footprint	Total Area of Vegetation Associations within Survey Area
Erythrina vespertilio	F4b	No Change from Approved Development	
Grevillea pyramidalis subsp. *leucadendron*	L6b	No Change from Approved Development	
Grevillea pyramidalis subsp. *leucadendron*	L6c	No Change from Approved Development	
Grevillea pyramidalis subsp. *leucadendron*	L6d	No Change from Approved Development	
Melaleuca cardiophylla	L7a, L7b, V1k, V1m	Increase from 53.2 ha to 70.2 ha	524.4 ha

This represents a change from clearing of 10.14% of vegetation associations mapped for the Gorgon Gas Development that contain greater than 2% coverage of *Melaleuca cardiophylla* (Approved Development) to clearing of 13.39% (Revised Proposal). It is acknowledged that the Revised Proposal will therefore result in an increase in clearing of L7a, L7b, V1k and V1m associations by 3.24% of the mapped area for those associations.

Currently 2483 ha of vegetation on Barrow Island has been mapped for the Gorgon Gas Development, which represents just over 10% of the total area of the Island (23 567 ha). It is highly likely that other areas containing greater than 2% coverage of *Melaleuca cardiophylla* occur outside of the mapped area, therefore the clearing calculations do not represent the total proportion of White-winged Fairy-wren habitat on the Island. It is also important to note that the intent of Table 6.8 in the PER is to demonstrate the change in clearing to vegetation associations supporting greater than 2% coverage of restricted flora. It is not intended to demonstrate change in White-winged Fairy-wren habitat.

Surveys for White-winged Fairy-wren nesting sites were undertaken in August 2005 and September 2005. These surveys recorded White-winged Fairy-wren nests in vegetation types that do not necessarily support *Melaleuca cardiophylla*, including vegetation containing *Triodia* species with mixed scattered shrubs, *Triodia* species with *Acacia coriacea* and *Triodia* species with *Acacia bivenosa* (RPS Bowman Bishaw Gorham [BBG] 2006). These surveys concluded that while White-winged Fairy-wrens favour vegetation associations that include *Melaleuca cardiophylla* shrubs, they also occur and breed in vegetation associations where this species is not present (e.g. tall *Triodia angusta* within roadside vegetation).

Table 4.7 in this document shows the vegetation associations that supported White-winged Fairy-wren nests in August 2005 and September 2005, with five nests recorded within the Revised Proposal footprint and five nests outside the footprint. The vegetation associations described in Table 4.7 are the same as the vegetation associations used in the Revised Proposal PER (Chevron Australia 2008).

Table 4.7: Revised Proposal Impacts to Vegetation Associations Supporting White-winged Fairy-wren Nests in 2005

Vegetation Association	No. of Nests Recorded (RPS BBG 2006)	Revised Proposal Footprint	Total Area of Vegetation Associations within Survey Area	Increase in Clearing of Area Mapped
D1c	1 (outside Revised Proposal footprint)	Not being cleared	4.8 ha	No Change from Approved Development
F8a	3 (all within Revised Proposal footprint)	Increase from 58.3 ha to 59.1 ha	190 ha	0.4%
F8c	1 (within Revised Proposal footprint)	Not being cleared	41.4 ha	No Change from Approved Development
L5c	1 (outside Revised Proposal footprint)	Not being cleared	1.7 ha	No Change from Approved Development
L7b	1 (outside Revised Proposal footprint)	Increase from 1.7 ha to 7.8 ha	203.1 ha	3.0%
L9d	1 (outside Revised Proposal footprint)	Not being cleared	63.7 ha	No Change from Approved Development
V1m	2 (1 outside Revised Proposal footprint and 1 within Revised Proposal footprint)	Increase from 32.8 ha to 39.8 ha	191.4 ha	3.7%

The cumulative change in clearing of vegetation associations D1c, F8a, F8c, L5c, L7b, L9d and V1m is an increase in clearing, from 15.88% to 18.25% of the area mapped.

The description of vegetation associations in Table 4.7 are presented in Table 4.8 of this document.

Table 4.8: Description of Vegetation Associations

Vegetation Association	Description
D1c	Open Shrubland of *Stylobasium spathulatum, Pentalepis trichodesmoides* with *Trichodesma zeylanicum* over Closed Hummock Grassland of *Triodia angusta* and *Triodia wiseana* over Low Open Shrubland of *Acacia bivenosa* and *Acacia gregorii* in some locations on lower slopes, drainage flats and wide drainage lines.
F8a	Low Open Shrubland to Open Shrubland of *Acacia bivenosa,* with occasional scattered *Pentalepis trichodesmoides, Stylobasium spathulatum* and *Acanthocarpus verticillatus* shrubs over Hummock Grassland to Closed Hummock Grassland of *Triodia wiseana* with occasional *Triodia angusta* on flats and valley floors.
F8c	Scattered tall *Acacia coriacea* shrubs over Low Open Shrubland of *Acacia bivenosa* and *Pentalepis trichodesmoides* with scattered *Trichodesma zeylanicum, Indigofera monophylla* and *Solanum lasiophyllum* shrubs over Hummock Grassland to Closed Hummock Grassland of *Triodia wiseana* with patches of *T. angusta*. This community contains occasional scattered *Codonocarpus cotinifolius* and *Clerodendron* sp. Shrubs, *Cynanchum floribundum* herbs and very occasional emergent *Ficus brachypoda* trees.
L5c	Scattered *Hakea lorea* shrubs to Open Shrubland over Low Shrubland of *Acacia gregorii*, *Hannafordia quadrivalvis* and *Scaevola* sp. over Open Herbland of *Acanthocarpus verticillatus* over Hummock Grassland of *Triodia wiseana* with patches of *T. angusta*.
L7b	Low Shrubland of *Melaleuca cardiophylla* over Hummock Grassland of *Triodia wiseana* with occasional *Triodia angusta* over Low Scattered Shrubs to Low Open Shrubland of *Acacia gregorii* on limestone upper slopes and ridges.
L9d	Hummock grassland of *Triodia wiseana* with scattered, sometimes open, low shrubs of *Pentalepis trichodesmoides*. There are scattered (<2%) *Ficus brachypoda* low trees and *Acacia bivenosa* low shrubs.
V1m	Low Open Heath of *Melaleuca cardiophylla* with *Acacia bivenosa, Sarcostemma viminale* subsp. *Australe* over Hummock Grassland of *Triodia wiseana* and *Triodia angusta* on limestone ridges and slopes.

The surveys undertaken by RPS BBG (2006) show White-winged Fairy-wren nesting in a variety of vegetation associations, of which only two associations (L7b and V1m) are recorded as having more than 2% coverage of *Melaleuca cardiophylla*. This is consistent with the observations of Sedgwick (1978) and Pruett-Jones and Tarvin (2001) and supported by the comparison of distributions of White-winged Fairy-Wrens and *Melaleuca cardiophylla* on Barrow Island (Figure 4.2 of this document).

Studies by Bamford (RPS BBG 2006) also support the context that *Melaleuca cardiophylla* does not represent any more significant nesting habitat for the White-winged Fairy-wren on Barrow Island than other plant species. The Gas Treatment Plant Area will not be surveyed for this species given that the area will be cleared. However, adjacent equivalent vegetation types will be surveyed to provide baseline data on bird abundance, and this survey effort will lead to a monitoring program for this species on the Island. White-winged Fairy-wren nests have been found in various plants on Barrow Island (RPS BBG 2006). That said, the species is considered significant for the Island and a monitoring program will be in place to understand abundance and investigate any significant changes in the abundance of this species, and to understand the context of these changes (anthropogenic vs natural). The design of this program is underway and includes the development of a protocol that can soundly assess population size inside the area at risk (impact area), as compared to reference sites. Monitoring of White-winged Fairy-wrens will commence in quarter one 2009, and continue through the construction period and into the early operations timeframe; at this time the program will be reviewed.

Based on the information above, it is acknowledged that clearing of some vegetation associations used by the White-winged Fairy-wren will increase slightly as a result of the Revised Proposal; however as the species uses a variety of habitats to nest, and is spatially widespread across the Island, the impact of the Revised Proposal on this bird species is not considered to be significantly different to that of the Approved Development.

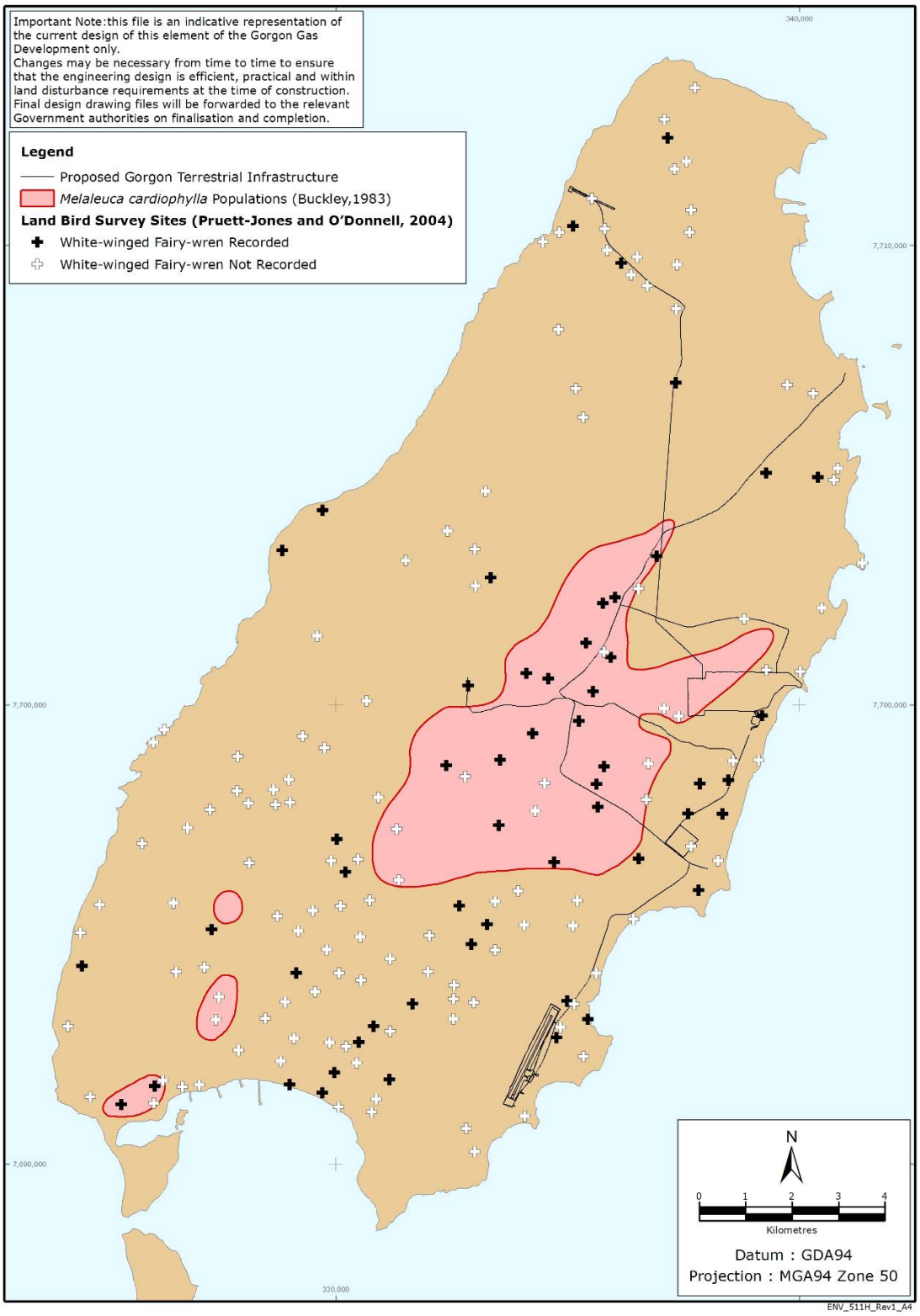

Figure 4.2: Comparison of White-winged Fairy-wren Occurrence and *Melaleuca cardiophylla* Distribution

4.6 Subterranean Fauna

Table 4.9: Subterranean Fauna

Table 4.9		Subterranean Fauna	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
2.8	Conservation Council of Western Australia	Subterranean fauna impacts remain unacceptable and will increase with this proposal. In this PER the Proponent has done nothing to further the understanding of the importance of the habitat included within the project footprint on troglofauna and stygofauna. Sampling has demonstrated that some species (although not *Thysanura Trinemura*) have been found outside of the footprint, but the Proponent has not even attempted to characterize the importance of the disturbed habitat in terms of the distribution of appropriate habitat for troglofauna; nor have they attempted to identify any features of habitat in the project footprint that may differentiate it from other habitat on the Island. It is suspected that, as stated in Bulletin 1221, this is because the habitat is significant. Barrow Island is recognised as having high conservation values of international significance for subterranean fauna.	The PER acknowledges that Barrow Island is recognised as being of high conservation significance for subterranean fauna communities. The Revised Proposal is not considered by the GJVs to pose any significant new or additional risks to subterranean fauna in comparison to the Approved Development, for which the required environmental approvals under Part IV of the State EP Act (Statement No. 748) and the Commonwealth EPBC Act (EPBC Reference: 2003/1294) have been granted. Section 3.3.3.1 of the PER discusses subterranean fauna habitat and concludes that subterranean fauna are highly unlikely to be restricted to the footprint of the Revised Proposal. Sections 3.3.3.2 and 3.3.3.3 of the PER provide information regarding the distribution of subterranean fauna species on Barrow Island. There is no evidence for geological barriers to the movement and distribution of subterranean fauna species on Barrow Island. The most commonly collected specimens (cyclopoid copepods) have an extensive distribution across the Island and are not restricted to any particular areas or landforms. The area of disturbance of the Gorgon Gas Development has been categorised through studies of the geological and hydrogeological nature of this area, as well as a substantial sampling effort for both stygofauna and troglofauna across this area with comparisons against reference areas elsewhere on the Island. Of all the subterranean fauna species found on Barrow Island (10 true troglobitic species and 24 stygal species) four taxa remain to be found outside the footprint area; the reason is that only single individuals have been collected to date, and these require genetic comparisons with other individuals (when these may be collected), or alternatively adult forms are required for positive identification by morphological analysis. Based on distribution evidence from the other subterranean fauna collected on Barrow Island, there is no reason to suspect that these taxa are restricted to the Revised Proposal's footprint. There are further surveys planned for subterranean fauna to try to collect more specimens of these four taxa and better understand their numbers and distribution both inside and outside the area of disturbance.

Table 4.9		Subterranean Fauna	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
			In the interest of providing as much information as possible relating to this issue, the GJVs present some additional explanation relating to potential restriction of subterranean fauna on Barrow Island in Section 4.6.1 below.
2.9	Conservation Council of Western Australia	The increased risk to subterranean fauna, including the EPBC listed Blind Gudgeon, from potential leaks of injected CO_2 into subterranean habitat on the Island appears not to have been considered. This risk will have increased with increased injection rates. It still appears to be an unknown as to what the impacts of increased acidity in the ground water due to a CO_2 leak would have on the Blind Gudgeon, and how long a leak would take to start harming the population. The three months allowed for a response in the environmental conditions does not appear to be based on any science.	Although an increased CO_2 injection rate is planned as part of the Revised Proposal, additional management strategies (such as the early implementation of a pressure management strategy) mean that the risk of an unplanned CO_2 release to the surface or near surface from the CO_2 Injection System Plant facilities or an unplanned migration of CO_2 via deep faults is considered by the GJVs to be low. The risk assessment relating to subterranean fauna was updated to consider new environmental impacts attributable to the Revised Proposal. This process consisted of a review of the CO_2 injection uncertainty management plans developed for the Revised Proposal followed by an assessment of failure modes and effects by an independent technical panel of experts. Representatives of Western Australian and Commonwealth Government Agencies participated in this process as observers. The resulting likelihood and consequence of a failure of the CO_2 injection system were then provided to the environmental specialists who used these data to assess the level of risk to subterranean fauna. This process determined that there are no unacceptable cumulative risks to subterranean fauna as a result of the Gorgon Gas Development (Approved Development and Revised Proposal). The Approved Development is subject to a number of environmental approval conditions that regulate emissions from the Gorgon Gas Development and these address issues such as the leakage of injected CO_2 into near surface cave systems on Barrow Island (the environment inhabited by the Blind Gudgeon). It is recommended that the Revised Proposal be subject to similar conditions. The injection of CO_2 will occur into a reservoir that is over 2 km below ground, and this injection process forms part of a carefully managed program to dispose of reservoir CO_2, that features monitoring of the progress and spread of the injected CO_2. At the same time, there will be a monitoring program for groundwater and shallow soil surfaces where CO_2 concentration and pH will be parameters measured in time and space. The GJVs acknowledge that there is no science currently available to understand the effects of CO_2 concentrations explicitly on the Blind Gudgeon, among other stygofauna. This work would, however, require invasive methods (LD_{50} tests) to understand the minimum concentrations of CO_2 that would impact 50% of tested individuals. Such experiments are not recommended and would not alter the approaches to how injected

Table 4.9		Subterranean Fauna	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
			reservoir CO_2 will be managed should it reach shallow surface aquifers. The EIS/ERMP acknowledges that the Blind Gudgeon has been collected on Barrow Island. Records from the Western Australian Museum show that this specimen has been collected from the centre of the Island, a location that is outside the 1000-year CO_2 plume (Fig 12.2 of the PER). Based on hydrogeological evidence (Campbell and Wedepohl 2005), the aquifer is expected to be highly inter-linked and it is unlikely that these species of subterranean fauna would be restricted to the Gorgon Gas Development's footprint.
5.4	Department of Health	The PER includes minimal information on effluent disposal via the aquifers. Volumes have not been given and the potential impacts of disposal by recharge on the quality of the aquifer and stygofauna have not been discussed. It is noted that aquifer disposal has not been included as a stressor in Table 6.3. If disposal is to be under pressure, the potential impact of an electricity shut down on effluent disposal should be addressed.	The wastewater management system for the Revised Proposal will remain unchanged from the system already approved as part of the Gorgon Gas Development (Approved Development), and as it will not constitute a significant additional or cumulative impact, it was not considered within the scope of the Revised Proposal PER. Wastewater injection will be into formations deep beneath Barrow Island, approximately 1000 m underground, where no stygofauna are known to occur. Disposal of sludge would be to an approved waste management site off the Island. Wastewater, disposed via injection to the Barrow Group, will consist of produced water, treated sanitary effluent and occasionally contaminated stormwater from the Class 2 (potentially contaminated) surface water system. During normal operations, the wastewater volumes to the nominated produced water injection wells will be between 2000 and 2500 m^3/day. Loss of the power supply to the wastewater injection pumps and other failure scenarios have been identified in Safety and Operability Reviews and have been appropriately mitigated in the Development's design. Specifically, loss of the power supply to the injection pumps will result in locking in of the wastewater inventory between the pumps and the injection wells before the power supply to the pumps is restored. The wastewater pipeline between the wastewater injection pumps and the disposal wells will be designed for the anticipated maximum shut in pressure. Produced water injection pumps are spared and each one can handle the full volume of the produced water stream. Wastewater storage tanks upstream of the wastewater injection pumps will allow production to continue for another 24 hours before the Gas Treatment Plant is shut down (KJVG 2008c). The produced water injection wells, which are currently being operated by WA Oil, are designed such that no injected fluid can leak through the well casings into the environment normally inhabited by stygofauna. The target

Table 4.9		Subterranean Fauna	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
			injection formation, the Barrow Group, at 1000 m below surface, is not a known habitat for stygofauna and has no known conduits to the stygofauna habitats below the surface."
7.4	Cape Conservation Group	Subterranean fauna impacts remain unacceptable and will increase with this larger proposal. In the PER the Proponent has done nothing to further the understanding of the importance of habitat in the project footprint on troglofauna and stygofauna. Sampling has demonstrated that some species (although not *Thysanura Trinemura*) have been found outside of the footprint, but the Proponent has not even attempted to characterise the importance of the disturbed habitat in terms of the distribution of appropriate habitat for troglofauna and any features of habitat in the project footprint that may differentiate it from other habitat on the Island. It is suspected that, as stated in Bulletin 1221, this is because the habitat is significant. Barrow Island is recognised as having high conservation significance for subterranean fauna.	Refer to the GJVs' response to Item 2.8 in Table 4.9 of this document.
7.5	Cape Conservation Group	The increased threat to subterranean fauna, including the EPBC listed Blind Gudgeon, from potential leaks of injected CO_2 into subterranean habitat on the Island appears not to have been considered. This risk will have risen with increased injection rates.	Refer to the GJVs' response to Item 2.9 in Table 4.9 of this document.
8.3	Western Australian Museum	The proposed expanded proposal does not appear to pose any substantial additional threat to the unique and highly restricted subterranean fauna found on the Island.	Acknowledged.
9.10	DEC – Environmental Management Branch	There is a potentially increased risk of detrimental impact on fauna, including subterranean fauna, from possible failure of the expanded CO_2 injection system. Recommendation 24: More information is required regarding how the risks and impacts associated with a leak or release of CO_2 at the greater rate of production (vegetation/fauna/human) have altered, including clarification of the calculation of risks to subterranean fauna from a potential CO_2 escape. The accelerated rate at which reservoir CO_2 is proposed to be injected will require additional injection wells and drill centres, with a corresponding increase in pipelines, and as the pressure is expected to increase more rapidly in this Revised Proposal, a number of pressure release wells and associated ancillary infrastructure are required. Given the increase in the rate of CO_2 production and requirement for injection, failure of the injection system may lead to larger	Refer to the GJVs' response to Item 2.9 in Table 4.9 of this document in relation to potential impacts of a leak or release of CO_2 on subterranean fauna. Refer also to Section 4.17.1 of this document for "Further Information Regarding Risks and Impacts Relating to Leak or Release of CO_2 at Greater Volume of Production" and a discussion of facility integrity risk. As discussed in the EIS/ERMP for the Approved Development and the PER for the Revised Proposal, the proposal to dispose of reservoir carbon dioxide by underground injection is supported by extensive monitoring and uncertainty management. Critical to this strategy is the monitoring of reservoir uncertainty signposts in order that timely risk mitigation options can be implemented if required. These processes have been and will continue to undergo extensive independent review such as those previously undertaken by DoIR and the review undertaken as part of this PER process. These independent reviews have indicated that the Gorgon Gas Development is a world leader in the approach to management and risk mitigation associated with CO_2 injection.

Table 4.9		Subterranean Fauna	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
		volumes of CO_2 being leaked/vented/released to the atmosphere. Additional information is required regarding how the risks and impacts associated with a leak or release of CO_2 at the greater volume of production (impacts on vegetation/fauna/human) have altered. Greater rates of injection also may reduce any response time in the case pressure reaches peak levels within the formation. It is not clear that the mitigation and management of the CO_2 sequestration operations are adequate.	In light of this, the GJVs do not agree with the statement that it is not clear that the mitigation and management of the CO_2 operations are adequate.
9.23	DEC – Environmental Management Branch	Recommendation 23: The EPA to note that short-range endemic and subterranean fauna (troglofauna and stygofauna) survey and monitoring work remain incomplete. Information in relation to survey methodology, sample locations, distribution of individuals and the taxonomy of specimens found during ongoing surveys is required before an assessment of impacts can be made. There are still a number of subterranean fauna and short-range endemic taxa that are yet to be found outside the disturbance footprint (see Table 3.5 p 62). The PER commits to further monitoring work (as required under Ministerial Statement No. 748) for these species until they are located outside the disturbance footprint. Information provided in the PER suggests that some species previously thought to be restricted to the plant footprint are now found beyond the plant, however, there is no substantial discussion of this. There is no discussion on where the additional individuals were located, nor how many were located, and therefore there is no clarity on the range, distribution and potential impacts on these species. More information is required on the findings of sampling and taxonomic work and how future results are to be reported to DEC. Many statements on the locality and distribution of stygofauna species remain unproven. For example, the PER states that several species of Bathynellidae occur outside the impact area, however, these specimens are yet to be identified fully to species level. To further confuse the data and interpretation, the reference to table numbers throughout the discussion is incorrect. Stating that specimens of higher taxa (the same genus) are widespread is not a valid substitute for determining the status of a species. It is hoped that the proposed taxonomic work will provide clarification on this issue. Similar interpretations using high taxonomic groupings is evidenced in the PER Section 3.3.3.2, p. 61, where Amphipoda have been found in the Robe Valley.	A response to this comment in relation to terrestrial invertebrate SREs is provided in Table 4.5 (Item 9.23), of this document. Stygofauna were sampled using established techniques including groundwater bailing with haul nets. Troglofauna were sampled by means of custom-built litter traps containing leaf litter material left in the ground for a minimum of six weeks to allow sufficient time for collection. Surveys were conducted by subterranean fauna specialists, Biota Environmental Sciences. There are now 12 confirmed subterranean taxa occurring beneath the gas plant site (seven stygal and five troglobitic). Two of the troglobitic taxa previously known from under the plant site at the time of the EIS/ERMP assessment have now been removed from the list (*Archaeognatha* sp. 1 from B11 via more detailed determination, and *Symphyla* sp. 1 from B27 through project redesign). The stygal taxon nr. *Chilibathynella* sp. 1 has also since been demonstrated from taxonomic diagnosis to have a wider spatial distribution (at three reference bores) on Barrow Island. Thus four subterranean taxa are known only from the Gas Treatment Plant site. These consist of: ♦ *?Bogidomma* sp. 1 (stygal; site B3, n=1 specimen) ♦ *Amphipoda* sp. 1 (stygal; site B12, n=1 specimen) ♦ *Trinemura* sp. Nov. 1 (troglobitic; site B11, n=1 specimen) ♦ *Blattodea* sp. Nov. 1 (troglobitic; site B16, n=1 specimen). Based on hydrogeological evidence by Campbell and Wedepohl (2005), the aquifer is expected to be highly inter-linked. Further evidence supports the contention that the shallow surface geology of Barrow Island does not provide any barriers to gene flow and movement of stygofauna or troglofauna. It is therefore unlikely these species of subterranean fauna represent SREs that are spatially restricted to the Gorgon Gas Development footprint. Maps of locations for individual species formerly believed to be spatially

Table 4.9		Subterranean Fauna	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
		There is insufficient information in the PER to assess the short-range endemic and troglofauna surveys. The risk of impacts on short-range endemics and troglofauna therefore cannot be adequately assessed.	restricted to the Development footprint are presented in the Gorgon Gas Development Short-range Endemic and Subterranean Fauna Monitoring Plan. Locality information is spatially widespread and includes bores that were sampled from the centre of Barrow Island. Abundance of subterranean fauna should not be considered to indicate scarcity of individuals given the limitations to surveying this group of animals. As is common to many invertebrate surveys, abundance will vary with location and time for various reasons; few individuals at few locations do not represent rarity for subterranean fauna.
9.24	DEC – Environmental Management Branch	The expansion of the plant site will require more earthworks than the Approved Development, including additional drilling and blasting. To enable stability, the excavation of the plant site 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 comment is a correct statement. As acknowledged in the PER, it is not expected that the Revised Proposal will be sufficient to increase the consequence rating in the risk analysis so that the environmental risk remains the same as for the Approved Development. The excavation volume for the Gas Treatment Plant site is estimated to increase from a volume of up to approximately 3 million m^3 to a volume of up to approximately 6 million m^3. The additionally excavated material will be used as fill for the terraced parts of the plant site and also as fill for the causeway/MOF. The maximum depth below existing ground level will be approximately 16 m. The potential environmental impact footprint of the Approved Development as assessed in the EIS/ERMP is based on an area of 300 ha. The Revised Proposal as assessed in the PER is within this limit. The assumptions made during the risk assessment process for both the Approved Development and the Revised Proposal was that all subterranean fauna beneath the Gas Treatment Plant site would be impacted.
9.25	DEC – Environmental Management Branch	The increased area of land for long-term use may also lead to additional areas impacted by altered runoff, sedimentation, recharge, compaction and erosion, which may consequently affect terrestrial (including subterranean) habitat.	Refer to Table 4.4 (Item 9.2.5), which addresses comments regarding the general terrestrial environment. While there may be altered runoff, sedimentation, recharge, compaction and erosion related to the Revised Proposal, the GJVs do not anticipate these alternations will adversely alter the risks to subterranean habitats (including subterranean fauna) because: 1) these habitats are spatially widespread beneath the land surface of Barrow Island due to the geology of the Island 2) with the exception of four taxa, all other subterranean fauna are not restricted to the area of the Development footprint 3) an impact monitoring program (Condition 8 of Statement No. 748) will be in place to assess significant changes to drainage lines (erosion and vegetation), and groundwater (levels and analyses) within the Terrestrial Disturbance Footprint (TDF). The intent is that if a

Table 4.9		Subterranean Fauna	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
			significant change occurs to these metrics within the impact areas (TDF) relative to reference areas, then further investigations will be conducted to understand the measured changes. The design and procedural management measures aimed at preventing erosion and sediment carry from over-impacting the integrity and vegetation of existing drainage lines within and outside the terrestrial disturbance footprint, include the following: ♦ maximise infiltration of stormwater within the Gas Treatment Plant plot plan through minimising paved areas to the extent practicable, and allowing certain areas, where safe, to be flooded and then allowing collected stormwater to evaporate ♦ as part of the effort to minimise loading to the Class 3, clean stormwater drains, the onsite Class 3 stormwater drain piping could be constructed as perforated piping to allow infiltration to groundwater where practicable ♦ perimeter drains will be designed to overflow and redistribute stormwater flow as sheet flow, mimicking the natural stormwater sheet flow pattern, as opposed to discrete outlets to the terrestrial environment ♦ suitable material will be used to build and line the overflow ditches to prevent erosion of material and flow channelling ♦ the GJVs are investigating an alternative disposal of clean Class 3 and Class 4 stormwater to the marine environment in order to prevent overloading of the perimeter drains (and impact on footprint) and causing channelling of flow and erosion ♦ no stormwater will be discharged from the perimeter drains to the coastal dunes in order to protect the stability of the dune system and the health of its vegetation ♦ roads that cross drainage lines will be constructed so that they do not obstruct the natural flow patters of stormwater and impact downstream vegetation communities ♦ all drains will be maintained and cleaned of sediment and debris. 4) A Surface Water Management Common User Procedure has been produced. The objectives of the procedures are to minimise: ♦ erosion and the loss of topsoil ♦ siltation and sedimentation of natural drainage lines ♦ adverse turbidity of surface water

Table 4.9		Subterranean Fauna	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
			♦ alteration or interruption of the natural drainage patterns of surface water, runoff and groundwater recharge ♦ contamination of stormwater, surface water, ground water and soil from inappropriate storage of hazardous materials or leaks/spills.
9.35	DEC – Environmental Management Branch	Reference has been made to a subterranean fauna study undertaken by The University of Western Australia that is yet to be published (UWA 2007). Clarity is sought on the author and contributors of this study. This is to ensure that any independent reviewers linked to the review of management plans conditioned under the Approved Development are not involved in the study.	The study undertaken by UWA focused on the amphipod genus *Nedsia* that was found to occur inside and outside the Development footprint. It was unclear whether this genus presented unique assemblages (species) inside the Gas Treatment Plant footprint area relative to those found elsewhere on Barrow Island. Genetic haplotype information was used to compare distribution patterns by Dr Terrie Finston at UWA. Dr Finston has experience in using molecular approaches to clarify gene distribution for subterranean fauna in the Pilbara region and elsewhere in WA.

4.6.1 Additional Information Relating to Potential Restriction of Subterranean Fauna on Barrow Island

Subterranean fauna will move through karst (secondary dissolution) features which are developed in limestone formations. The karst features are developed in response to vertical movement of water from the surface (rainfall) to the watertable and cavities are also created and enlarged by lateral movement of groundwater. Solution tubes which are created by high water flow through fractures and karst features can extend for hundreds of metres and connect many cavities and karst features.

There is both geological evidence, showing a lack of geological barriers to subterranean fauna movement, and ecological evidence of a wide distribution of the more common species of subterranean fauna across Barrow Island, to indicate that subterranean fauna movement is unlikely to be restricted within or adjacent to the Gorgon Gas Development site.

The porous nature of the rocks on Barrow Island should allow for movement of genes across the Island, and the widespread distribution of species that have been collected in some number supports this assertion. However, this may not be the case for all species.

4.6.1.1 Geological Evidence

Significant karst features are observed in most drill holes in the Gas Treatment Plant site area, either directly, when there is no limestone and the drilling rod falls freely, or indirectly, where the permeability of the limestone is orders of magnitude higher than that which represents the limestone itself.

The karst features are expected to be variably interconnected with no limitation on lateral movement. Drilling trials on Barrow Island indicate interconnectivity on a local scale. Tidal responses measured in groundwater at existing monitoring wells by Groundwater Consulting Services (Burton 2007) at the Gas Treatment Plant site were all consistent with an interconnected aquifer. Groundwater quality beneath the Plant site varies in a manner consistent with groundwater movement through the site from the inland direction.

A zone of less-connected karst was noted at the WA Oil Terminal Tanks by Golder Associates (2008) where the permeability was high, but tidal response was significantly muted, and if such zones occur, they may limit movement of stygofauna within the immediate vicinity. No such areas have been observed within or adjacent to the Gas Treatment Plant site.

The geological system comprises subhorizontal layers of limestone, and there are no vertical geological features that are known that may affect karstic development or the connection between karst features.

The subhorizontal sand layer identified by Golder Associates (2008) at the Gas Treatment Plant site may limit vertical movement of stygofauna between limestone formation layers. There is no evidence of lateral impediments to subterranean fauna beneath the Plant site, or surrounding areas; however, the possibility of small isolated pockets cannot be entirely discounted.

4.6.1.2 Ecological Evidence

Data from subterranean species (troglobitic and stygal) that have been collected in higher numbers (e.g. *Draculoides bramstokeri*, *Speleostrophus nesiotes*, *Haptoloana pholeta*, *Halosbaena tulki* and *Stygoicaris stylifera*) indicate that these stygal and troglobitic species all have widespread distributions across Barrow island. Molecular (DNA) data and a review of morphology for *D. bramstokeri* suggest that there may be variation across the island (at a population level), but that this does not appear to support any of the species level divisions which would occur with substantial barriers to gene flow. More recent molecular analysis of stygal amphipods from Barrow Island also shows widespread distributions of the more common taxa on the island (Finston 2007).

These widespread species distributions and geological reviews suggest that habitat strata on the Island (e.g. interbedded sand/limestone) are relatively continuous (Biota Environmental Sciences 2007). If substantial geological barriers existed within the Island, we would expect to see many small-scale restrictions across a range of taxa, rather than the pattern of throughout-Island distributions that has been documented.

These species that have been collected in greater numbers may also provide an indicative assessment of the risks of species restrictions in the other, more poorly resolved and collected troglobitic and stygal groups. Most of the species listed above are the physically largest of the troglofauna and stygofauna and therefore perhaps at greatest risk of localised isolation due to geographical barriers (compared to smaller animals which could maintain population connections through finer interstices). The findings to date suggest that the remaining four subterranean taxa collected only from the Gas Treatment Plant footprint are expected to have wider distributions on Barrow Island.

4.7 Flora and Vegetation

Table 4.10: Flora and Vegetation

Table 4.10		Flora and Vegetation	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
3.2	Department of Industry and Resources	In the Revised Proposal, the Joint Venturers advise that they intend to seek access to the remaining 100 hectares. It should be noted that neither the Act nor the Agreement defines how this remaining 100 hectares may be used other than that it may, at the discretion of the responsible Minister, potentially be available for gas processing purposes. The Joint Venturers have advised the Department that they intend to submit a request under the Agreement to the Minister for State Development to seek access to the remaining 100 hectares.	As outlined on page 30 of the PER, the GJVs shall request under the State Agreement permission from the responsible Minister (as delegated under the *Barrow Island Act 2003)* to bring forward a proposal to allow for the use of land within the Gas Processing Area beyond that was reserved for the Development (e.g. allocation of the remaining 100 ha). The Revised Proposal will be accommodated within the previously set limits, in accordance with the enacted land use prescriptions for these limits.
9.10	DEC – Environmental Management Branch	There is a potentially increased risk of detrimental impact on fauna, including subterranean fauna, from possible failure of the expanded CO_2 injection system. Recommendation 24: More information is required regarding how the risks and impacts associated with a leak or release of CO_2 at the greater rate of production (vegetation/fauna/human) have altered, including clarification of the calculation of risks to subterranean fauna from a potential CO_2 escape. The accelerated rate at which reservoir CO_2 is proposed to be injected will require additional injection wells and drill centres, with a corresponding increase in pipelines, and as the pressure is expected to increase more rapidly in this Revised Proposal, a number of pressure release wells and associated ancillary infrastructure are required. Given the increase in the rate of CO_2 production and requirement for injection, failure of the injection system may lead to larger volumes of CO_2 being leaked/vented/released to the atmosphere. Additional information is required regarding how the risks and impacts associated with a leak or release of CO_2 at the greater volume of production (impacts on vegetation/fauna/human) have altered. Greater rates of injection also may reduce any response time in the case pressure reaches peak levels within the formation. It is not clear that the mitigation and management of the CO_2 sequestration operations are adequate.	Refer to Table 4.25 and Table 4.9, which provide a response regarding the risks associated with the expanded reservoir CO_2 injection system and potential impacts on subterranean fauna respectively. Risks to terrestrial fauna and humans are discussed in Table 4.5 and Table 4.28 respectively. The failure modes and effects studies that underpin the assessment of environmental risk considered the uncertainty of the proponent management plans including its ability to detect and respond to a deviation from anticipated reservoir behaviour. The independent technical specialists that participated in this study examined a wide range of possible failure modes associated with the revised proposal. As the failure modes and effects analysis was undertaken considering the total volumes and rates of reservoir CO_2 injected from the Revised Proposal it is possible to directly compare this assessment with the failure modes and effects assessment contained in the EIS/ERMP for the Approved Development. Refer to Section 12.5.3 of the PER for a comparison between failure modes and effects assessment, as well as Table 1.2 in Appendix I of the PER. Refer also to Section 4.17.1 of this document for further discussion. The potential impacts to vegetation from an unplanned CO_2 release would be due to a possible change in soil chemistry and potential metabolic effects. The residual risk to vegetation from an unplanned CO_2 release to the shallow surface environment is considered low. The injection of reservoir CO_2 is accompanied by an exhaustive monitoring and risk mitigation process, including implementing a wellhead maintenance program and strategy to ensure reservoir pressures remain acceptable with the increased rates of injection. Finally, the shallow surface (soil) CO_2 monitoring program will be put in place to verify any

Table 4.10		Flora and Vegetation	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
			surface leaks of reservoir CO_2.
9.22	DEC – Environmental Management Branch	Recommendation 22: The EPA to note that the long-term land take for the Gorgon development is now proposed to increase by 40 hectares to 240 hectares (of the 300 hectare limit of land tenure as conditioned under Gorgon State Agreement and *Barrow Island Act 2003*) for the Revised Proposal. This leaves limited area for any future expansion. The Revised Proposal will include an increase in the area of long-term land use within the 300 hectare limit by approximately 40 hectares. The 300 hectare limit has been imposed under the Gorgon State Agreement and Barrow Island Act. Granting of tenure over 'uncleared' land under this Agreement is limited to 150 hectares for leases, licences and ancillary services, 50 hectares for pipelines and easements, and 100 hectares to be reserved for future gas industry development. It is understood that Gorgon is applying for the additional 100 hectares for future gas development and therefore dependent on Gorgon's future development, there is the potential for the entire 300 hectares to be cleared and developed for the long-term.	As outlined in the PER, the *Barrow Island Act 2003* makes provision for up to 300 ha of land on Barrow Island to be used for gas processing purposes; it is the GJVs' intention to bring forward a proposal to request the Minister's permission to allow for the long-term use of the remaining 100 ha of land for use by the Gorgon Gas Development. The area available for future expansion was defined as 100 ha and the Revised Proposal constitutes an expansion comprising another 5 MTPA LNG train. The Revised Proposal will be accommodated within the previously set limits, in accordance with the enacted land use prescriptions for these limits.
9.27	DEC – Environmental Management Branch	There are also increases in clearing of several sensitive areas such as creek line vegetation (PER Section 6.3.2.1 p 140).	It is acknowledged that the change in Gas Treatment Plant footprint results in an increase in clearing of seven sensitive vegetation associations. As presented on page 137 of the PER, these seven vegetation associations consist of two coastal vegetation associations, one drainage line vegetation association, two limestone associations and two valley slope associations. However, the total areas of each of these vegetation associations that will be cleared are a small proportion of the total area mapped for each vegetation association. Generally 80% or more of these associations will remain on Barrow Island which is well above the 30% threshold that would categorise a significant impact to a vegetation association as outlined under the Environmental Protection of Native Vegetation in Western Australia Position Statement No. 2 (EPA 2000). As noted in the PER, the GJVs have undertaken detailed vegetation mapping of 10% of Barrow Island, so it is possible that these seven sensitive vegetation associations occur elsewhere on the Island, which would make the proportion being cleared smaller than that presented in the PER. There will be no change to the amount of clearing required for the other sensitive vegetation associations under the Revised Proposal. The Revised Proposal will be accommodated within the previously set limits, in accordance with the land use prescriptions for those limits.

4.8 Marine and Coastal Environment

Table 4.11: General Marine and Coastal Environment

Table 4.11		General Marine and Coastal Environment	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
2.14	Conservation Council of Western Australia	The CO_2 injection plan involves the use of seismic technology to track the location of the CO_2 plume, it is not clear if this will have a long-term impact on the marine environment, and in particular cetaceans.	An assessment of the potential impacts associated with seismic monitoring (once every 6 to 8 years during the operational phase of the development) was included in the assessment of the EIS/ERMP and the PER (Section 7.1.2.6). It is considered that noise and vibration emissions from the Revised Proposal work activities do not present additional risk, or different types of environmental risk, to marine fauna beyond those assessed for the Approved Development. The marine component of the 2009 CO_2 Seismic Baseline Survey will occur from May to August avoiding turtle breeding periods and southern migration of Humpbacks. The first two repeat surveys in ~2016/17 and ~2022/23 are likely to be vibroseis only and not have a marine component. Later repeat surveys that do include a marine component can be planned to avoid sensitive periods for critical fauna and cetaceans.
9.1	DEC – Environmental Management Branch	The proposed revised and expanded development on Barrow Island is larger than the original approved proposal. There will be additional biodiversity impacts from the proposal and it is considered that the PER has not adequately accounted for these. If the EPA is to recommend approval of the expanded development, additional offsets may be required, particularly in relation to impacts and potential impacts predicted for marine turtles.	The Revised Proposal will result in some additional impacts. However, the assessment of these impacts as presented in the PER and this document demonstrates that they are limited and manageable and are not considered by the GJVs to be greater than the risks identified for the Approved Development, for which the required environmental approvals under Part IV of the State EP Act (Statement No. 748) and the Commonwealth EPBC Act (EPBC Reference: 2003/1294) have been granted. Refer to Table 4.27 (Item 9.6) in this document, which addresses comments regarding key management actions and proposed environmental conditions, for a response in relation to additional offsets.
9.38	DEC – Environmental Management Branch	The biodiversity values of Barrow Island are unique and significant at State, national and international scales. Barrow Island contains a high diversity of flora and fauna that have not been exposed to the same intensity of threatening processes that impact on mainland flora, fauna and ecosystems. Thousands of years of isolation have resulted in the evolution of species and subspecies endemic to Barrow Island. Many reptile and invertebrate species on Barrow Island appear to be genetically distinct from mainland populations of the same species.	The comment is noted and understood. The comment is essentially background information on the environmental significance of Barrow Island, and is the justification for the comprehensive management approach to the relevant factors proposed by the GJVs with respect to both the Approved Development and the Revised Proposal. In order to protect the biodiversity values of Barrow Island, the GJVs have planned the implementation of a Quarantine Management System. The GJVs' commitment to the Quarantine Management System (QMS) was explained in Chapter 12, Section 12.6 of the EIS/ERMP. This

Table 4.11		General Marine and Coastal Environment	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
		Due to its isolation from threats present on the mainland, such as inappropriate fire regimes, introduced predators, grazing and many species of weeds, Barrow Island is an important refuge for significant biodiversity values. It hosts seven fauna species listed as threatened under both State and Commonwealth legislation and is considered significant for subterranean fauna at the regional, State and national scales. Barrow Island is an internationally important site for migratory shorebirds, hosting 14 seabird species and 25 wetland/littoral species listed under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*. Barrow Island is a significant nesting site for four species of sea turtles, and is considered a regionally important nesting area for Green and Flatback Turtles. Barrow Island was set aside as a nature reserve in 1910 in recognition of these outstanding flora and fauna values. It is currently reserved as a class A nature reserve for the purpose of 'Conservation of Flora and Fauna'. The Island is vested in the Conservation Commission of Western Australia and is managed by the Department of Environment and Conservation (DEC). In December 2004, the Government established the Barrow Island Marine Park on the western side of Barrow Island and the Barrow Island Marine Management Area surrounding the remainder of the Island (excluding the Barrow Island port area). Barrow Island Marine Park protects the significant Biggada fringing reef and Turtle Bay, an important breeding area for Green Turtles. Barrow Island Marine Management Area includes important and diverse coral, macroalgal and seagrass communities, with the latter two community types occurring on extensive limestone platforms and forming important refuges and feeding areas for a number of marine turtle species and dugong.	commitment has been formalised in Statement No. 748. Pursuant to Condition 10.1 for the Approved Development, *"…the Proponent shall submit the QMS to the Minister, taking into account the advice of the QEP that meets the aim and objectives set out in Condition 10.3 and the requirements of Condition 10.4, as determined by the Minister, unless otherwise allowed in Condition 10.2."* Condition 10.4 refers to Schedule 4 of Statement No. 748, which contains the specific details of the elements to be addressed in the QMS. Therefore, both the content of the QMS and the role of the QEP in providing advice to the Minister are already well established. The Revised Proposal requires exactly the same elements, since the stated expectations for the QMS are for it to be scalable to any size project on Barrow Island. The GJVs are committed to limiting land disturbance and rehabilitating land where facilities are no longer required. In order to reduce environmental disturbance and impacts on Barrow Island, the Gorgon Joint Venturers are committed to sharing facilities with the Barrow Island Joint Venture. Opportunities for sharing include the airport, accommodation, supply base, access roads and some production and maintenance facilities, training facilities and utilities such as water, power and waste disposal. The GJVs will ensure that no facilities are shared that could adversely impact safety or environmental performance, or impose a limitation on either party's production capability. A commercial agreement between the Gorgon Joint Venture and Barrow Island Joint Venture parties was executed in September 2008. It includes details regarding responsibilities and obligations of each party to the Barrow Island Coordination Council. The GJV has undertaken extensive modelling of dredging impacts for both the Approved and Revised Proposal. This modelling indicates that no impact is modelled to occur to areas supporting coral within the Marine Management Areas (external to the Barrow Island Port Limit). Limited impact is anticipated to areas in the Marine Management Areas near the spoil ground, but these predominantly support subtidal reef (low relief) and sand. The zone of influence will extend into the Marine Management Areas but this is only a low-level turbidity plume at concentrations not expected to impact at all and will be limited to the dredging period.
17.5	DPI	Terrestrial and Marine Environment In regard to significant natural features and significant flora and fauna it is acknowledged that the proposal must comply with the *Environmental Protection Act 1986* as per the Agreement Section 2 (3). However in regard to drainage, we would like to add, for	Refer to Table 4.4 (Item 17.5) in this document, which addresses comments regarding the terrestrial environment.

Table 4.11		General Marine and Coastal Environment	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
		your consideration, that any development located on or adjacent to the coast should not discharge waste and/or storm-water in a manner that may degrade the coastal environment including coastal and marine waters and ecosystems (SPP2.6 Section 5.1(xiii; xiv)).	

4.8.1 Further Information Regarding the Assessment of Drill/Blast-related Impacts

4.8.1.1 How the Revised Proposal Relates to the Approved Development

The Environmental Impact Statement/Environmental Review and Management Programme (EIS/ERMP) for the Approved Development (Chevron Australia 2005) included the potential requirement for marine drill and blast activities due to the variability in the geotechnical information available at that time. Reference to the potential requirement for marine drilling and blasting was included in the EIS/ERMP as follows:

> *"Should any isolated pockets of hard material be encountered, it may be necessary to undertake limited drilling and blasting"* (p. 142, 143).

Consequently, marine (drilling and) blasting was identified as a stressor and potential risks to marine fauna were discussed and assessed, with management strategies being proposed in Sections 6.3.8, 9.2.1, 11.5.4, Table 11-23 & Technical Appendix A1 (Section 3.10) in the EIS/ERMP for the Approved Development.

In the response to submission 18.104 associated with the Approved Development (Chevron Australia 2006), the GJVs also stated:

> *"Indications from geotechnical investigation, laboratory testing and discussions with dredge contractors suggest that drilling and blasting will not be required during construction of the dredge channels. However, there may be some isolated locations of extremely hard material in between the drilled boreholes. Although there is no indication that these exist, it is possible that some minor drilling and blasting will be required at isolated locations. As the number and size of these locations would be small the impacts have been assessed as minor."*

Additional marine geophysical and geotechnical information acquired after Statement No. 748 was published indicates that the rock substrate in the vicinity of the MOF location is significantly harder and more extensive than previous data indicated. This translates into a need to drill and blast approximately 500 000 m^3 of material in coastal waters for the construction of the MOF access channel and LNG vessel berthing pockets as proposed for the Approved Development.

Under Section 5 (viii) of Condition 17 (Statement No. 748), the Marine Facilities Construction Environmental Management Plan shall include measures that address:

> *"The avoidance of blasting as far as practicable and management measures to be applied if blasting is required."*

To avoid the need for extensive marine blasting in the near-shore area off Town Point, the MOF was extended into deeper water under the Revised Proposal. The proposed drill and blast program is now anticipated to assist in the removal of up to approximately 50 000 m^3 of hard rock at the western end of the revised MOF Access Channel, down from the 500 000 m^3 for the previous alignment.

The key characteristics of the proposed drill and blast program for the Revised Proposal are listed in Table 4.12.

Table 4.12: Characteristics of the Revised Proposal Drill and Blast Program

Location	Potential to encounter isolated hard rock anywhere within the dredge area but focus area likely to be in the deeper berth pockets of the MOF turning basin
Anticipated volume	From geophysical investigations anticipate between 0 to 50 000 m^3
Duration	Estimated program between 0 to 12 weeks
Timing	Program may potentially be required at any time of the year

4.8.1.2 Additional Information Provided to the EPA

To satisfy the requirement to provide additional information on drilling and blasting, a briefing on the drill and blast program, the blast design method, and the impacts and mitigation measures developed for the Revised Proposal was provided to the EPA and representatives from the Marine Ecosystems Branch of the DEC on 30 October 2008. The content of the briefing was based on best available information, including:

- information from the EIS/ERMP (Approved Development) and the PER (Revised Proposal)
- previous experience from recent drilling and blasting programs in the northwest of WA (including but not limited to Woodside Energy Limited Train V Expansion Project)
- specialist technical input.

The use of data and discussion of experiences from other Northwest WA drill and blast programs during the presentation to the EPA was considered appropriate to provide an understanding of the technical aspects of such a program. The GJVs aimed to use the best available information that was (and still is) available at the time of the presentation.

The information presented included management commitments additional to those made in the EIS/ERMP and the PER (expanded in Section 4.8.1.3 of this document).

4.8.1.3 Management of Potential Impacts

Condition 17 of Statement No. 748 requires the GJVs to prepare and submit a Marine Facilities Construction Environmental Management Plan to the Minister for the Environment for Approval. Environmental management for the marine drill and blast program will primarily be achieved through the implementation of the approved Plan.

This Plan is currently under development in consultation with the:

- Marine Turtle Expert Panel (Condition 15)
- Construction Dredging Environmental Expert Panel (Condition 19)
- DEC, Department of Fisheries, DPI and DEWHA
- Construction Contractor.

Environmental management strategies to reduce the impacts of marine drill and blast will be focused on three key areas, as outlined in Table 4.13.

Table 4.13: Key Areas of Management

Key Areas	Management Strategies
Contracting Plan	♦ Chevron Australia has full operational control of the program and will retain the start and stop authority for the work ♦ Contractor selection to be based on demonstrated experience with projects in similar marine environments

Key Areas	Management Strategies
	♦ Dredge contractor to be engaged early to work with Chevron Australia to develop appropriate environmental management approaches
Blast Design	Blasting specifications include the following criteria: ♦ A maximum allowable charge between 25 kg and 50 kg per delay ♦ Sequential charges requested to reduce the cumulative impacts of the explosions ♦ Drill method and detonation system selected to avoid sympathetic detonation between blast holes ♦ Stemming drill holes to concentrate the explosive force within the bedrock
Avoidance Management	♦ 500 m avoidance radius for key receptor species (to be confirmed in consultation with the Expert Panels) ♦ Marine fauna observers on vessels ♦ Blasting delayed if key receptor species are seen within the avoidance area ♦ Blasting undertaken during daylight hours ♦ Removal of surface fish kill following each blast

4.8.2 Further Information Regarding the Assessment of Dredging-related Impacts

4.8.2.1 Dredge Methods and Flow Paths

Only five or six cutter suction dredges (CSDs) in the global market are capable of dredging the hard rock material in the immediate vicinity of Barrow Island. Despite the recent global economic downturn, the availability of these specialised CSDs remains extremely limited. There are a number of alternative work methods that a CSD may adopt depending on the particular equipment planned to be used and site conditions.

The three alternative work methods that may be adopted on this Development are:

- The CSD cuts the material and loads a hopper barge (via suction pumps within the dredge) moored alongside the vessel. The hopper barge transports the removed material to the spoil ground and discharges the material through the split hull hopper. The flow path of the material in solution is from the cutter head rising up the ladder under suction (30 m), passing through the suction pump and then via a pressure pump piped along the vessel (100 m), through the manifold and into hopper barge.
- The CSD cuts the material and, using the suction pump, discharges the material onto the seabed. The material is then excavated by either a backhoe or a Trailer Suction Hopper Dredge (TSHD) depending on water depth. The flow path is from the cutter head under suction to side cast via a pipe to the seabed (approximately 15 m from cutter head), picked up by TSHD under suction and discharged into the hopper (50 m). The TSHD pumps are much lower in the vessel hull than the CSD pumps (deeper draft vessel) and consequently they pick up the material at a higher density (less water in solution).
- The cutter suction dredge cuts the material and the material remains in the vicinity of the cut head. The material is then excavated by either a backhoe or a TSHD depending on water depth. The flow path is limited to the pick up by TSHD under suction and discharge into the hopper (50 m).

The length of time the material cut by the CSD remains on the seabed (ranging from days to months) is an operational decision determined in the field taking into account the dredge spread and conditions. In general, the material in the MOF area is likely to be excavated

relatively soon after its placement as the progress of the CSD will be delayed by the presence of the material. In the deeper LNG channel area, the time that the cut material will remain on the seabed may be longer as the CSD and TSHD will not be working simultaneously in the same location.

4.8.2.2 Release of Fines

There are no published data available on the release of fines relevant to the various dredge methods likely to be employed. The information available from dredge contractors tends to support the particular method appropriate to their equipment. In view of this it is conservative to account for a 100% release of fines by all methods as adopted in the Gorgon model (GEMS 3D Coastal Model [GCOM3D] July 2008) (Global Environmental Modelling Systems [GEMS] 2008). The breakdown of the distribution of fines has been estimated by the GJVs' dredging consultant based on an understanding of the anticipated process. The assumptions adopted for the distribution of the release of fines material across the various dredging methods and dredges were as follows:

- CSD dredging the MOF and loading barges which overflow and then release the hopper contents at the spoil ground:
  - 30% of the fines released at the CSD cutter head
  - 35% of the fines released during overflow from the barge
  - 35% of the fines released during dumping at the spoil ground.
- CSD dredging the LNG channel and depositing the dredged material on the seabed for later pickup by the TSHD and dumping at the spoil ground:
  - 30% of the fines at the CSD cutter head
  - 20% of the fines released when material dredged by the CSD is crushed and deposited on the sea bed, including propeller wash on the deposited spoil
  - 30% of the fines released when the material is picked up and overflowed by the TSHD
  - 20% of the fines released during dumping at the spoil ground.
- TSHD dredging of the upper levels of the LNG channel and dumping of the dredged material at the spoil ground:
  - 30% of the fines at the TSHD drag head
  - 40% of the fines released when material is overflowed by the TSHD
  - 30% of the fines released during dumping at the spoil ground.

Note that the Dredge Simulation Studies Report was updated by GEMS (November 2008). This updated report is included as Appendix B in this Response to Submissions document.

4.8.2.3 Particle Size Distribution

The particle size distribution (PSD) and settling velocities used in the dredge plume modelling studies are presented in Table 4.14 in this document. It should be noted that there are differences between the distribution of fines between the natural sediments and those produced by the action of the CSD. As expected, the cut material has a greater proportion of fines less than 75 µm in diameter.

The dredge plume model includes the contribution of particles up to 250 µm in diameter to the plumes. Above 250 µm, the settling velocity is such that the material settles close to the dredge and does not contribute to the plume beyond the high impact zone.

The percentage of fines contributing to the dredge plume decreases as the particle size increases, because they are more likely to settle in close proximity to the source. Up to a

diameter of 75 µm, 100% of the fines are predicted to be released into the plume. For particle size diameters between 75 and 250 µm, there is a linear decrease in the contribution of fine particles to the plume, from 100% of particles < 75 µm in diameter to 0% of particles >250 µm in diameter.

Table 4.14: Particle Size Distributions and Associated Settling Rates used for Material Cut by the CSD

Particle Diameter (µm)	Settling rate (mm/s)	Natural Sediment Material (%)	Material Cut by CSD (%)
1000.0	796.0	13.0	14.0
502.4	200.2	6.0	8.0
399.1	126.3	7.0	23.0
251.8	50.29	25.0	23.0
158.9	20.03	21.0	8.0
126.2	12.63	17.0	6.0
89.3	6.330	1.0	3.0
79.6	5.028	1.0	2.0
63.3	3.173	1.0	1.0
50.2	2.002	1.0	1.0
39.9	1.263	1.0	1.0
31.7	0.7970	1.0	1.0
25.2	0.5029	1.0	1.0
15.9	0.2003	1.0	1.0
10.0	0.0796	0.0	1.0
8.0	0.0503	1.0	1.0
6.3	0.0317	0.0	1.0
4.0	0.0126	1.0	1.0
2.0	0.0032	0.0	1.0
1.0	0.0008	1.0	1.0
0.5	0.0002	0.0	1.0
	Total	**100.0**	**100.0**

The PSD for the natural sediments were obtained from sediment samples taken within the proposed dredge area. Without any previous dredging having occurred adjacent to Barrow Island there are no data available on the PSD of cut material for the proposed dredging area.

It has been suggested by the DEC that the GJVs grind up drill cores to approximate the action of the CSD and then analyse the resulting PSD. During dredging, only part of the material is cut while the remainder is broken down by the mechanical action of the rotating cutter head. The grinding of a 90 mm diameter core in a laboratory would provide a very poor representation of the action of the cutter head, which is in the order of 2 m in diameter and is comprised of numerous teeth. Therefore, the model incorporated results from the Geraldton Port dredging program, as these constitute the best available data.

4.8.2.4 Peer Review

The dredge plume modelling presented in the EIS/ERMP was used to determine the dredging-related Conditions in Statement No. 748. The proposed changes associated with the Revised Proposal noted in the PER maintain the same relative dredge volumes at the MOF and LNG area (i.e. 7.6 million m^3).

The relocation of the MOF turning basin has resulted in approximately 13% of this volume being relocated 800 m further offshore. As noted in Dredging Simulation Studies (Appendix B), the Development's dredging modelling consultant has updated the Gorgon Gas Development's dredging model to accommodate this relatively minor adjustment, updated the model inputs, and increased the level of detail. The revised model predicts similar impacts to those presented in the EIS/ERMP.

Dredge plume models use a combination of three numerical models. Two of the models are externally verified, including the Bureau of Meteorology (MESOLAPS), and the SWAN wave model, which is accepted as an industry standard for engineering and environmental marine design. The Development's dredging modelling consultant used an internally developed GEMS 3D Coastal Model (GCOM3D), which has been used for other recently approved dredging projects in Western Australia. These models use best available technology to predict dredge plume migration.

The Gorgon Gas Development conducted a peer review of the dredge logs used as input to the GEMS dredge plume modelling on 26 August 2008. The evaluation comprised a review of the reference documents used in the development of the dredge logs, a review of the interpretation of the geophysical site investigation and a calculation check of the dredging logs for GEMS turbidity modelling.

The evaluation included the following items:

- overall volume checks using alternative methods of calculation
- check on numerical accuracy of strength distribution volume calculations that are based on geophysical survey data
- check of dredging volume allocation to CSD and TSHD activities
- check on calculation of dredging logs including total haul distances, downtime and cyclone delays
- check of all spreadsheets used in calculations for numerical accuracy in formulas, method and totals.

Dredging volumes for individual strength categories were calculated from the geophysical survey cross-sections using hand calculation methods. Seismic refraction profiles were used to calculate volumes of each strength category using refraction velocity and Unconfined Compressive Strength (UCS) relationships. The hand-calculated volumes for each strength category were verified by checking the hand take-off quantities and compilation spreadsheets.

The evaluation confirmed the correct application of the assumed production rates to the various strength categories to derive the dredging durations and schedules. Validation of the actual production rates for individual equipment was excluded from the assessment as this was provided by the dredge contractors. The assessment indicated that good agreement exists with the quantities of dredged material that were hand calculated from the geophysical survey data cross sections, compared to 12-D digital contour modelling methods and the quantities of dredging materials in the execution plan were applied accurately to produce dredging logs that were prepared for the GEMS modelling.

The GJVs maintain that the proposed design change to the MOF turning basin does not result in a significant change in the predicted dredge impacts and that the commitments, including the Conditions (Statement No. 748) for the Approved Development, will be met for the Revised Proposal.

4.8.3 Further Information Regarding Marine Component of the Proposed CO_2 Seismic Monitoring Program

4.8.3.1 Timing

The marine component of the CO_2 Seismic Baseline Survey (approved to be undertaken subject to the conditions of Statement 748 and EPBC Reference: 2003/1294) is planned to be undertaken between late May and the end of August 2009. The 21 lines of shallow marine seismic data acquisition totalling 112.5 km will take less than one hour per line to acquire and will be undertaken during periods of high tide and low sea conditions. The marine part of the survey cannot be acquired in one period because the onshore recording equipment needs to be moved to the southern areas before the lines further to the east can be acquired. Carbon dioxide plume seismic monitoring surveys will be conducted approximately once every 6 to 8 years following the commencement of reservoir CO_2 injection.

4.8.3.2 Spatial Extent

The offshore seismic lines are located on the north-eastern part of Barrow Island (shown on Figure 4.3 in this document).

4.8.3.3 Pressure Levels

The air gun array used to acquire seismic data offshore is potentially injurious to marine mammals and fish depending on proximity and sensitivity of the species. However, the shallow marine seismic data acquisition is planned to be acquired using an 8.275 L airgun array operating at 13 790 kPa. The output of this array is only 3200 kPa at a 1.5 m water depth, whereas a typical deepwater seismic airgun array has a capacity of greater than 50 L and an output of 13 000 kPa. The specific activity includes running seismic lines off the north-east coast of Barrow Island in water up to 13 m deep between late May and end of August 2009.

The full suite of measures from the Standard Management Procedures specified in the EPBC Act Policy Statement 2.1 (DEWHA 2008) will be adopted during the survey. The Standard Management Procedures (30 minute pre-shooting watch, 30 minute soft start whenever the guns are fired, 500 m shutdown zone), would be applied to the small mammals and turtles as well as larger cetaceans to reduce the risk of impact from seismic activities.

4.8.3.4 Management of Potential Impacts

The baseline survey proposed for 2009 will be covered by a program specific Environmental Management Plan as well as meet the requirements of the State and Commonwealth approval conditions for the Approved Development.

A description and assessment of the potential impacts associated with marine component of CO_2 seismic monitoring was included in the EIS/ERMP p.119, 505, 511 and the PER (Section 7.1.2.6). It is considered that noise and vibration emissions from the Revised Proposal work activities do not present additional risk, or different types of environmental risk, to marine fauna beyond those assessed for the Approved Development.

Humpback whales as part of their northward migration will be in proximity to Barrow Island around July and August. Their northward migration occurs further offshore and west of Barrow Island. Humpback whales generally migrate southwards past Barrow Island in September and October, during which time they spread out more over the shelf. There are no critical habitats for Humpbacks or other whales around Barrow Island or between Barrow Island and the mainland and none of the recognised feeding, breeding or resting areas will be affected by the seismic monitoring. Resting Humpbacks are occasionally observed in the shallow waters to the east of Barrow Island and therefore the Part A Standard

Management Procedure specified in the EPBC Act Policy Statement 2.1 (DEWHA 2008) will be adopted during the baseline and repeat seismic surveys.

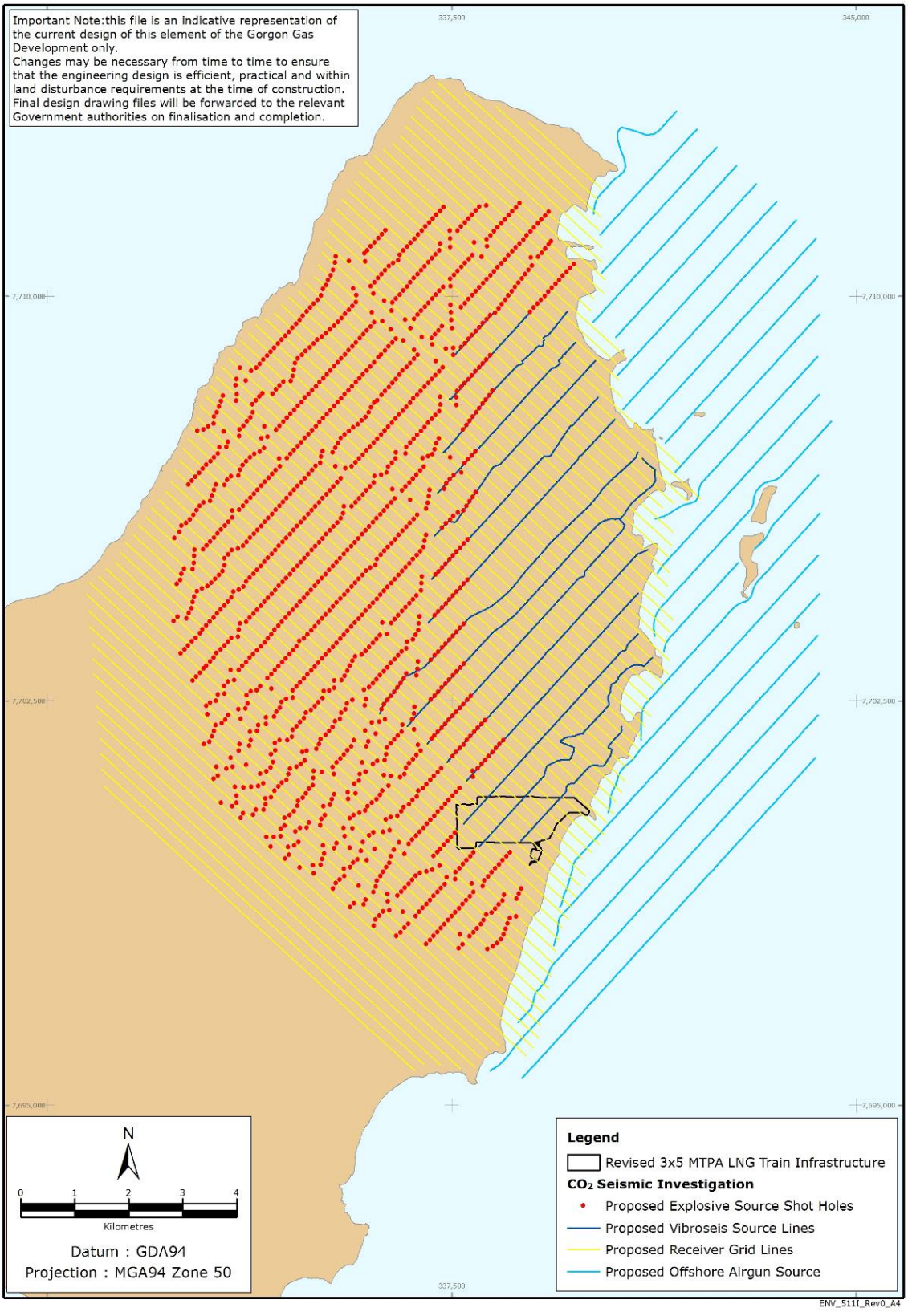

Figure 4.3: Extent of Seismic Surveys

4.9 Marine Fauna

Table 4.15: Marine Fauna

Table 4.15		Marine Fauna	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
2.7	Conservation Council of Western Australia	Increased light impacts and shipping movements on a major Flatback Turtle rookery. These impacts were considered unacceptable in Bulletin 1221 and thus must remain so with an increase in impacts due to additional industrial infrastructure.	In Bulletin 1221 the EPA expressed concern about the impact of the Gorgon Gas Development on Flatback Turtles; however, subsequent to the release of Bulletin 1221, additional information was obtained which was not available during the EPA assessment. This information was taken into account when the Minister approved the Proposal. As outlined in the PER, the environmental design measures and operating procedures are expected to mitigate the increase in light emissions and shipping activity from the Revised Proposal to an acceptable level consistent with that considered acceptable for the Approved Development. Refer to Section 4.9.1 in this document, which addresses comments regarding the potential impacts of artificial lighting on marine turtles as a result of the Revised Proposal. Vessel speeds will also be controlled to as low as reasonably practicable (commensurate with navigational safety and prevailing environmental conditions) to reduce vessel noise and vessel strike risk. These management measures are all included in the PER. It was acknowledged in the PER that LNG carriers and condensate carrier movements will increase from approximately 240 vessels per year to approximately 300 vessels per year and that this would result in an increase in the likelihood descriptor in the risk assessment for vessel strikes from 'likely' to 'almost certain'. However, this increase in likelihood did not change the overall risk level for vessel strikes, because the consequences are mitigated by risk management controls. Refer to Table 5.4 Risk Matrix on page 100 of the PER.
7.3	Cape Conservation Group	Increased light impacts and shipping movements on a major Flatback Turtle rookery. These impacts were considered unacceptable in Bulletin 1221 and thus must remain so with an increase in project size.	
2.11	Conservation Council of Western Australia	The impacts of dredging remain unacceptably high as per Bulletin 1221. This is relevant to the proposal due to the changed port facilities being a part of the proposal, the EPA must repeat their recommendation against this scale of dredging in the sensitive marine environment surrounding Barrow Island.	Refer to Table 4.16 (Item 2.11) in this document, which addresses comments regarding the marine physical environment and coastal processes.
2.14	Conservation Council of Western Australia	The CO_2 injection plan involves the use of seismic technology to track the location of the CO_2 plume, it is not clear if this will have a long-term impact on the marine environment, and in particular cetaceans.	Refer to Table 4.11: (Item 2.14) in this document, which addresses comments regarding the general marine and coastal environment.
4.2	Marine Parks and	We are concerned that the PER document does not address the	Refer to the response in Table 4.3 (Item 4.2) for information regarding

Table 4.15		Marine Fauna	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
	Reserves Authority	relevant cumulative impacts of expanding the existing development on and adjacent to Barrow Island. The Revised Proposal presents some new risks and increases the scale of others that were identified for, the Approved Development. In addressing each of the 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.	cumulative risk assessment, including that for marine turtles. Refer also to Table 4.20: (Item 4.2) in this document, which addresses comments received regarding marine benthic primary producers.
4.4	Marine Parks and Reserves Authority	The MPRA are also concerned that the extension of the causeway will have a significant impact on Flatback Turtle nesting, on the east coast of Barrow Island. Marine turtles move laterally in shallow waters along the coastline searching for a suitable nesting site.	The GJVs have considered the potential risk that the causeway/MOF structure may provide a diversion to nesting Flatback Turtles, potentially restricting access to the nesting beaches north and south of Town Point. Due to the highly mobile nature of marine turtles as described in (Section 7.1.2.4 of the PER), it was assessed that the additional 800 m of causeway and MOF are unlikely to limit the accessibility to either northern or southern beaches for Flatback Turtles. As with the Approved Development MOF, the Revised Proposal's MOF is expected to act like a natural headland, which turtles will need to navigate around. It is not expected to be a significant impediment to an animal designed to swim. Turtles do move in shallow waters but are also known to swim in offshore, deeper waters prior to coming to the shore to nest. Swimming is unlikely to be a problem for this marine species. In addition, of the 4,159 recorded nesting events on the east coast of Barrow Island, only 2.1% were recorded as visiting beaches either side of Town Point in the same evening (Pendoley Environmental 2008). Therefore, the potential for the causeway structure to adversely impact nesting turtles is considered to be limited.
4.5	Marine Parks and Reserves Authority	The existing gas processing facility at Town Point is adjacent to a significant rookery for Flatback Turtles. Light spill and light glow from this facility will increase if a third LNG train is commissioned (as indicated in the Revised and Expanded Proposal). The light study, as outlined in the PER, concluded that under normal operating conditions the processing facility would emit light similar to that of a full or quarter moon on a clear night. The MPRA are concerned that this level of light will impact significantly on nesting turtles and may lead to disorientation and/or misorientation of hatchlings. The potential impacts of increased light on turtle nesting were not considered in the PER.	Refer to Section 4.9.1 in this document, which addresses comments regarding the potential impacts of artificial lighting on marine turtles as a result of the Revised Proposal.
6.11	WWF	WWF-Australia assesses the risk categories to Flatback Turtles as critical (widespread long-term impact on population) and almost certain, for the populations nesting on the two beaches directly to	This comment was made by the submitter in regards to the EIS/ERMP for the now Approved Development; however, it has been responded to in regards to the Revised Proposal as the comments on the EIS/ERMP have

Table 4.15		Marine Fauna	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
		the north and south of the Town Point site. These two populations are a significant component of the regionally and globally important Flatback Turtle population, and potentially represent genetically distinct lineages from other regional nesting populations. WWF-Australia assesses the risk to the collective Barrow Island Flatback turtle nesting populations on Barrow Island as major (local, long-term or widespread, short-term impact leads to loss of local population/s and reduced viability of the race on Barrow) and likely. WWF-Australia assesses the major stressors as: ♦ Underwater noise associated with the construction, possible blasting and on-going operation of the proposed Development. This is likely to affect the Flatback Turtle nesting population (both internesting and foraging individuals) using the east coast of Barrow Island. The anticipated result is reduced nesting frequency. This stressor and its impact have not been adequately addressed in the documentation and studies. Noise will also affect the behaviour of Green, Hawksbill and Loggerhead Turtle (adult and juvenile) foraging populations along the east coast. The EIS/ERMP does not address this problem or investigate potential impacts. ♦ Light during construction and operation. This is likely to cause Flatback Turtle hatchling disorientation in the two nesting beaches in the vicinity of the proposed Development. This poses a risk through disorientation of hatchlings, potential disorientation with respect to their return to their natal nesting beach as adults, and potentially increased predation of hatchlings attracted to jetty and ship lights. The studies in Technical Appendices C 6 – C9, reaction of turtle hatchlings to different light sources, and the survey of existing lighting, underscores the likelihood of this risk, and does not adequately address the risk from the proposed development when fully operational. ♦ Altered coastal and nearshore currents in the internesting area as a consequence of the construction of the MOF and jetty, causing a potential disorientation of foraging and internesting Flatback Turtles and disruption of behaviour. The altered currents may cause alteration of beach characteristics that could alter nesting and/or hatching success. The modelling in	been repeated by WWF in their submission on the Revised Proposal. Flatback Turtles in Western Australia fall into two genetic groups: northern and southern. Barrow Island falls within the southern Western Australian breeding unit. Turtles nesting on Barrow Island east coast beaches are from the same breeding unit and do not display strict nesting beach fidelity (i.e. Flatbacks may nest on any of the east coast nesting beaches during a season and are not confined to a single beach). It is therefore unlikely that turtles using different beaches to nest will be genetically distinct and that turtles are limited to nesting on a particular beach. The PER sets out the turtle monitoring program and intervention actions (Section 7.1). The Montebello/Barrow Island region has very complex bathymetry, with many areas of strong currents (often much stronger than at the MOF) and turtles are abundant in the region and able to navigate. That is, the MOF is not an extreme situation and the expected conditions will lie within that naturally occurring in the region. Modelling indicates that the beach profiles will be stable after construction of the MOF due to a shallow protective reef. As part of the Gorgon Marine Baseline Monitoring Program, a 12-month baseline dataset for water and sediment quality has been collected for the Gorgon Gas Development. Sediment and water quality sampling sites include pre-specified locations around the proposed Gorgon Gas Development MOF and Jetty. Preliminary water quality data from the Marine Baseline Monitoring Program sampling sites around the proposed MOF location have been used in the design of the desalination plant and the water utilities systems for the Gas Treatment Plant. The data have also been used in defining water quality objectives and design criteria for disposal to sea of the desalination plant reverse osmosis process brine effluent stream in order to reduce the environmental impacts associated with this stream. The GJVs will also apply, as part of the design of the Gas Treatment Plant, a chemical selection and approval process designed to screen out chemicals associated with high environmental, health and safety (HES) risks in favour of chemicals that pose acceptable and ALARP risks to the health and safety of personnel and the environment. This process will apply to all chemicals to be used in the construction, commissioning and operations phases of the Gorgon Gas Development. The EIS/ERMP for the Approved Development addressed the impacts and risk resulting from major stressors identified by WWF (including noise, light spill, alteration to coastal processes, sedimentation and chemical pollution). Details of the technical information and results of field surveys

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		Technical Appendices B3-6 does not adequately address this stressor. ♦ Sedimentation and physical disturbance of internesting habitat from the construction of the causeway, the construction of the jetty and the dredging of nine million cubic metres of sediments for the boat channel and its frequent use by large vessels represents a significant impact on the internesting habitat, and is an almost certain major impact on internesting turtles. ♦ Chemical pollution. No chemical baseline data have been collected from the water and nesting beaches in the Town Point area. This is essential to ensure that the beaches remain pollutant free to enable normal development of the turtle embryos in the sand. A regular monitoring program and relevant management actions would need to be developed for this stressor. WWF-Australia maintains that these risks to a globally and regionally important listed marine species disqualify Barrow as a candidate site for the proposed development. On the basis of this level of risk, approval for the proposed development on Barrow Island should be denied. WWF-Australia calls for the proposed additional work described on p. 273: "Surveys in winter 2005 will determine whether the sandy seabed off Town Point is important to inter-nesting or hibernating Flatback Turtles", to be expanded to include an assessment of juvenile Flatback Turtle habitats.	and experiments on which the risk assessments were based were included in Technical Appendix C6 (Chevron Australia 2005). No new risks associated with the Revised Proposal were identified and the impacts were considered incrementally greater than the impacts associated with the Approved Development. The updated risk assessment also incorporated the results of investigations undertaken subsequent to the EIS/ERMP reporting (refer to Section 3.5.2.2 of the PER).
6.12	WWF	WWF-Australia notes that the nesting population of Green Turtles on the west coast of Barrow is regionally significant and that impacts on this population have not been fully evaluated. The proposed shore crossing and onshore feed gas pipeline option at Flacourt Bay should therefore be avoided. In addition, the foraging areas of resident Green, Loggerhead and Hawksbill Turtles in the waters off Barrow Island, have not been fully identified and the impacts examined. Further work needs to be conducted on species and size composition, habitat use, local movements and home ranges of these populations. The impacts of the proposed dredging and jetty construction including lighting and noise impacts on the resident foraging turtles should be conducted.	This comment was made by the submitter in regard to the EIS/ERMP for the now Approved Development. However, it has been responded to in regard to the Revised Proposal as the comments on the EIS/ERMP have been repeated by WWF in their submission on the Revised Proposal. The importance of Flacourt Bay for Green Turtles was recognised in the risk assessment for the Approved Development and was a major consideration in moving the shore crossing to North Whites Beach. No Gorgon Gas Development activities will be undertaken at Flacourt Bay. The impacts on foraging areas were considered as part of the risk assessment process based on research which indicated that: ♦ Green Turtles forage on macroalgae covered reefs along the west coast of Barrow Island

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			♦ Loggerheads have not been documented foraging in the Barrow/Lowendal/Montebello region. However, their bivalve and other molluscan food sources are likely to occur throughout the area ♦ Hawksbill Turtles feed on sponges and are likely to forage on coral and other reef habitat throughout the region. Ongoing studies by the GJVs (refer to Section 3.5.2.2 of the PER) have provided further data on the size and composition of the Green and Flatback Turtle populations. In view of the paucity of data and the difficulty in collecting meaningful data, the GJVs have conservatively assumed that noise will disturb internesting turtles on the east coast. This was taken into account in risk assessments leading to an assortment of mitigation measures designed to reduce the identified risks. Management measures proposed to mitigate effects of noise to internesting (adult) turtles are identified in the Long-Term Marine Turtle Management Plan (required by Condition 16 of Statement No. 748). Noise will be managed and where practicable minimised through: ♦ development of Noise Management Plans (as detailed in Noise and Vibration Impact Mitigation Strategies) that will include the prediction of noise and vibration sources and will identify measures to manage or reduce noise and vibration ♦ selection of helicopter flight paths to minimise impacts on nesting turtles ♦ sourcing of equipment and vessels with low operating noise and vibration levels which meet and operate within appropriate industry practice standards There is a paucity of published scientific data on the effects of noise and vibration on hatchlings on beaches. The GJVs commissioned Pendoley Environmental to conduct some pilot trials on the effects of a portable power generator to hatchling orientation and found no significant changes to the presence of a generator on the beach that was set at variable distances from where the hatchlings were located. Beach fan angles will be measured during construction to understand changes that may be observed relative to baseline (non-construction) time periods.

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			Where monitoring of hatchling fan angles on the beaches identifies that angles are significantly orientated away from the water relative to baseline levels, management actions will ensue, on advice from the Marine Turtle Expert Panel (MTEP). In-water effects of vibration/noise on hatchlings remain unknown. Refer to Section 4.9.1 in this document, which addresses comments regarding the potential impacts of artificial lighting on marine turtles as a result of the Revised Proposal.
7.7	Cape Conservation Group	The impacts of dredging remain unacceptably high as per Bulletin 1221. This is relevant to the proposal due to the changed port facilities being a part of the proposal. The EPA must repeat their recommendation against this scale of dredging.	Refer to Table 4.16 (Item 7.7) in this document, which addresses comments regarding the marine physical environment and coastal processes.
8.1	Western Australian Museum	Consideration of the developments Impact on Flatback Turtles should be more than adequately covered by the undertakings provided.	The GJVs acknowledge the Western Australian Museum's recognition that the additional undertakings specified in Statement No. 748 for the Approved Development adequately cover the management of potential impacts of the Revised Proposal on Flatback Turtles.
9.4	DEC – Environmental Management Branch	The Revised Proposal will further increase risks to the Barrow Island Flatback Turtle population through breeding impacts due to the enlarged causeway disturbance associated with the extended causeway (at 2.1 kilometres, 60 per cent longer than approved). There are a number of changes/additions to the Gorgon development that will potentially increase the risk to turtle populations nesting on Barrow Island. The most significant change is the proposed extension of the solid causeway/materials offloading facility structure from 1.3 to 2.1 kilometres out to sea. The most important Barrow Island Flatback Turtle nesting beaches are located on the east coast of the Island. Marine turtles would normally move laterally along the coastline in shallow waters searching for a suitable site to nest. The causeway obstruction will divide beach access for nesting turtles into northern and southern sections, effectively limiting the availability of nesting sites. Although satellite tracking studies may indicate that some turtles move up to 40 kilometres in range daily, it is considered that fully gravid females forced to swim an additional 4.2 kilometres round trip to navigate around the solid materials offloading facility	The GJVs have considered the potential risk that the causeway/MOF structure may provide a diversion for nesting Flatback Turtles, potentially restricting access to the nesting beaches north and south of Town Point. However, flipper tagging program results (Pendoley 2008) show that Flatback Turtles nesting on Barrow Island east coast beaches do not display strict beach fidelity, i.e. Flatback Turtles may nest on any of the east coast nesting beaches during a season and are not confined to a single beach. It is unlikely turtles using different beaches to nest will be genetically distinct since they appear to move freely between the beaches on Barrow Island. Due to the highly mobile nature of marine turtles (as described in Section 7.1.2.4 of the PER), it was assessed that the full length of causeway and MOF are unlikely to limit the accessibility to either northern or southern beaches for Flatback Turtles. As with the Approved Development MOF, the Revised Proposal's MOF is expected to act like a natural headland, which turtles will need to navigate around. The PER was structured to provide a summary of the Development's anticipated risks to the environment. The bulk of the quantitative data was placed in appendices rather than in the main document. References were

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		structure to find their preferred nesting location, will increase energy expenditure and it is highly likely nesting success will be impacted. Recommendation 14: Interpretation of the results in the text is inconsistent with the model outputs. It is recommended that a peer review of the model and interpretation of the model results be undertaken. The Revised Proposal includes increasing the length of the solid causeway/materials offloading facility structure by 800 metres to 2.1 kilometres. Modelling undertaken by the Proponent and presented in the PER suggests that there will be shadow zones either side of the causeway, and increased current speed around the end of the materials offloading facility. Quantitative measures as described within Appendix F should have been used in the PER main document when describing actual changes and likelihood of impacts. Further, the descriptions provided in the text of the Appendix are inconsistent with the model results. For example, Section 5 (p 31) states that modelling of Tropical Cyclone Bobby resulted in sedimentation in the magnitude of 0.02 metres, however, on review of the model output (Figure 3.8) it is evident that sedimentation on shore is up to 0.125 metres and even greater in offshore pockets with up to 0.275 metres (i.e. 10 times greater than the stated value). The manner in which the results are presented in the PER, including inconsistencies in the interpretation of the model output, lead to uncertainty as to the impacts on beach profile and fauna and do not allow proper assessment. The interpretation of the model results largely focuses on current speeds, shoreline accretion and erosion, and beach profiles. There is uncertainty about the potential impacts of sediment movement in the marine areas, including impacts on BPPH.	provided throughout the PER to direct readers to the further detail contained in the Appendices. The Coastal Modelling Barrow Island Report (RPS MetOcean 2008) has now been posted on the Gorgon Gas Development's web site (www.gorgon.com.au); additional details on the model set-up, coefficients, and assumptions are provided (refer to section 4 of the report). The report has been reviewed by an independent subject matter specialist (Damara WA Pty Ltd). This is the same consultant that DPI nominated to review the previous report authored by MetOcean Engineers (2005). Comments from the independent subject matter specialist on the Coastal Modelling Barrow Island Report (RPS MetOcean 2008) were addressed within the report to the satisfaction of the reviewer. This report concluded that: "Through inclusion of the MOF, wave protection of the shoreline is provided through a shadow zone in the lee of the MOF. The shadow zone may be of the order of approximately 45 degrees to the coastline. During the worst case (i.e. coupled spring tides, storm surge and wave setup), the inclusion of the MOF will actually prevent erosion of the shoreline rather than increase the erosion. Without the MOF in place, under these extreme conditions, a more severe local impact on the beach stability will be observed" (Page 47). The GJVs acknowledge that the interpretation of the model in Appendix F of the PER should have indicated a range of predicted erosion and accretion values. However, the conclusions drawn in the RPS MetOcean modelling report indicate that the likely impacts discussed in Appendix F (KJVG Report) are consistent with their findings. Changes to Benthic Primary Producer Habitat (BPPH) will be assessed through a monitoring program which will compare the baseline state of BPPH within the Marine Disturbance Footprint pre-dredging and post-dredging for a period of at least 3 years based on quantitative data on habitat changes to marine ecological elements, as required by Statement No. 748 (for the Approved Development). However, modelling indicates that sediment accumulation will be limited and the potential impact on BPPH will also be limited.
9.5	DEC – Environmental Management Branch	Lighting impacts of the expanded development, which result in no dark nights in the vicinity of Bivalve and Terminal beaches. The EPA notes that the proposal will have additional impact on the	Refer to Section 4.9.1 in this document, which addresses comments regarding the potential impacts of artificial lighting on marine turtles as a result of the Revised Proposal.

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		Barrow Island Flatback Turtle population. The long-term impacts of processing plant lighting considered to be equivalent to between a full and quarter moon every night on turtles breeding near Town Point. The processing plant is located directly inland of Town Point (location of causeway) and immediately inland of the east coast turtle nesting beaches. Light spill and light glow from this structure will increase due to the presence of the third LNG train, additional flaring and other associated infrastructure. It is expected that light spill and light glow will impact on nesting turtles and may lead to misorientation of hatchlings. The lighting study showed that under normal operating conditions, the plant would emit light of a similar lux to that of a clear night with between a full and quarter moon. Interpretation of the results with respect to impacts on turtles is absent from the PER, however, the results suggest that the plant would always be equally as bright as between a full and quarter moon under normal operations. The effect on turtle breeding of never having dark nights at Bivalve and Terminal beaches is uncertain given the general preference of turtles to nest on moonless/dark nights. Hatchling, juvenile and mature turtles may also be further impacted due to the increase in shipping and offshore lighting. Attempts to monitor hatchling dispersal in the past have proven to be problematic due to the nature of the study (night time dispersal, weather conditions etc.). The increase in shipping noise, potential for collisions and potential for misorientation and disorientation of hatchlings into vessel and shipping berth/jetty light fields is likely to increase the risk to the Barrow Island turtle population. The PER does not provide a means to quantify the increase in shipping and/or offshore lighting and therefore DEC remains uncertain as to the level of risk posed to turtle breeding success, and so to turtle conservation. The Revised Proposal includes the following additional light generating infrastructure and activities: ♦ addition of a third LNG train with associated infrastructure; ♦ additional marine/boil off gas flare; ♦ proportionate increase in flaring requirements; ♦ proportionate increase in potential for shut-downs, start-ups	

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		and emergencies with associated flaring and safety lighting requirements; ♦ changes to causeway/materials offloading facility length and configuration; and ♦ additional shipping and associated support vessels and infrastructure. As requested in advice to the EPA on the Revised Proposal Scoping Document (DEC 2008), the Proponent has undertaken a lighting study. This was completed and provided in Appendix D to the PER, however the study did not take into account all lighting (flaring and offshore lighting were not considered), nor were the outputs of the study used/translated to predict potential impacts on fauna. The text in the PER does not reference the results of the study to confirm the predictions of no significant change or additional risk to turtles and seabirds from the changes in the plant configuration, changes to the causeway/materials offloading facility and additional shipping with respect to lighting. 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.	
9.14	DEC – Environmental Management Branch	Navigating the deeper waters around the facility will also increase their chances of vessel strike in the shipping/vessel zone and be subject to interference from the facility's light fields.	The additional 1 m of water depth at the head of the MOF will have no impact on potential vessel strikes as the vessels entering and leaving the MOF are confined to the MOF channel. The increase in operations phase LNG vessel movements occurs a further 2 km offshore. If the comment relates to offshore shipping, it was acknowledged in the PER that LNG carriers and condensate carrier movements will increase from approximately 240 vessels per year to approximately 300 vessels per year and that this would result in an increase in the likelihood descriptor in the risk assessment for vessel strikes from 'likely' to 'almost certain'. However, this increase in likelihood did not change the overall risk category for vessel strikes because the consequences are mitigated by risk management controls. Refer to Table 5.4 Risk Matrix on page 100 of the PER. The lighting design of the MOF and LNG Jetty will conform to the requirements of the Project's Lighting Basis of Design (KJVG 2008b). The design will account for the requirements for low level, shielded lighting and will incorporate further light spill minimization strategies. The approach that the GJVs will undertake when designing these facilities will aim to contain light as much as possible on the structures and reduce

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			light spill to the sea. Whilst efforts will be made to reduce light spill on the jetty, the LNG carriers, which will be present 4 to 5 days per week, 24 hours per day at the jetty, will be the main source of light spill at that location. LNG carriers will be lit to conform to operational requirements and applicable maritime safety and security laws and regulations. Where possible, the GJVs will work with the LNG carrier crew to establish the minimum lighting levels for operational requirements whilst still conforming to applicable safety and security lighting level requirements. It must also be recognised that the LNG berths are located approximately 4 km offshore and 4 to 7.8 km away from any Flatback Turtle nesting beaches, reducing potential impacts on nearshore turtles and hatchlings. It should be noted that this likelihood increase from likely to almost certain was not accurately reflected in Table 7.2 of the PER where the likelihood for the Approved Development and the Revised Proposal are both recorded as a 2 (likely). This does not affect the overall risk associated with light spill however, which remains as Low for both scenarios (refer to Risk Matrix (Table 5.4) on p. 100 of the PER) . The management and mitigation measures described in the Long-term Marine Turtle Management Plan developed for the Approved Development (which will be reviewed by a Marine Turtle Expert Panel consistent with Statement No. 748) are considered to be able to effectively manage potential impacts.
9.15	DEC – Environmental Management Branch	The approach employed on behalf of the Proponent to study turtle movement is questioned. It is considered that platform transmitter terminals should have been used with complementary acoustic telemetry to locate and monitor submerged and resting gravid female turtles. The lack of the necessary behavioural information that would allow adequate prediction of the likely interaction between the proposed shipping facilities with the reproductively active Flatback Turtles is a concern. Without adequate data on the movement of juvenile and nesting and inter-nesting females, there is limited basis to properly assess the potential risk.	Satellite telemetry has provided invaluable data on the offshore behaviour of reproductively active Flatback Turtles during the internesting and non-nesting periods. Acoustic telemetry has been primarily used to detect animals that do not come to the surface often (e.g. fish). These devices therefore are more appropriate to identify the location of individuals underwater. For turtles that come to surface to breathe, the telemetry data from Platform Transmitter Terminals and GPS tags are appropriate and acceptable for spatial modelling studies of animals with large ranges. Satellite telemetry data provide location information equivalent to acoustic tags, although this type of data has the advantage that permanent submerged hydrophones do not need to be installed across the region or elsewhere. A complication to using acoustic telemetry is that permanent submerged hydrophones need to be installed across various locations in the marine environment and these may interfere with vessels that navigate the area. To date, the use of acoustic telemetry has been restricted to studying adult nesting (female) Flatback Turtles that can be caught and handled on beaches. There are occupational health and safety concerns about

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			capturing juvenile and sub-adult Flatback Turtles which do not have an on-shore life stage, and which require in-water capture. This limitation applies equally to satellite and acoustic telemetry. It should be noted that some restrictions also apply to other methodologies, including a similar limitation on radio transmitters (which will only work when an animal is on the surface), and the requirement to establish a series of receiver hydrophones on the seabed.
9.16	DEC – Environmental Management Branch	There are many situations that arise from the Revised Proposal that have the potential to increase the risk to Flatback Turtles, including those discussed above, and other more uncertain risks such as: ♦ The potential for the amplified lighting to lead to increased numbers of Silver Gulls as they feed on insects and other fauna attracted by the light. An increase in the gull population will consequently increase the predation of turtle hatchlings and lead to competition for nesting space with other shorebirds. ♦ Increased tidal current speed around the end of the causeway/materials offloading facility may cause turtles to avoid the area, or hatchlings to become trapped in eddy formations, and it has been suggested that funnelling fauna out past the end of the structure into deeper water could lead to increased predation from marine predators. As discussed in the previous section, in treating each of the individual risk categories in isolation, the PER does not present a cumulative impact assessment of the risk to turtles. It is DEC's view that the risk to turtles from the development will increase if the expansion is approved.	The marine fauna risk assessment (Table 7.2 of the PER) provides an overview of the key stressors and additional risks posed by the Revised Development on marine turtles. For a full list of the factors considered during the risk assessment, the detailed risk assessment tables in Appendix C of the PER should be consulted. During the risk assessment process, impacts associated with increased numbers of gulls due to additional lighting and alterations to currents were considered. The assessment found that: ♦ The Silver Gull population is predicted to increase in response to increased foraging time afforded by the light shining on the water during night time operations in the tanker loading area and the MOF. The Revised Proposal pushes the light spill associated with the MOF further offshore, but does not increase the quantum of light spill. The causeway will be longer, but the access lighting along the causeway will be managed to prevent light spill onto the water. Consequently, the affected area will move offshore, but there will be no greater increase in light spill (or gull population effect) associated with the Revised Proposal than that associated with the Approved Development. ♦ Silver Gull populations will be counted on Double Islands before, during, and after construction. If required, and depending on the perceived risks to the environment, seagulls can be controlled by reducing access to food, disturbing breeding sites and by culling breeding adults. Appropriate control measures will be selected in consultation with wildlife authorities on the basis of the monitoring program findings. ♦ The water depth at the end of the MOF for the Revised Proposal is only a couple of metres deeper at high tide than for the Approved Development and is not considered to change the risk of predation. Predators are as likely to target turtles cruising in the shallows along the shore, as they would be to target turtles moving along the length of the causeway or around its end.

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			The cumulative impact on turtles of all activities was considered and is not significantly greater for the Revised Proposal than for the Approved Development.
9.18	DEC – Environmental Management Branch	On a larger scale, there has been substantial and continuing development in the Pilbara and Kimberley regions, which raises the question of the cumulative risk posed to entire marine turtle populations in Western Australia. The contribution of additional and cumulative risk afforded by the revised Gorgon development to the Barrow Island breeding population and subsequently to the Flatback Turtle species as a whole, is considered by DEC to be of serious concern.	The GJVs understand that the Western Australian Minister for the Environment was able to assess the Approved Development with the benefit of knowledge of the existing extent of current and planned developments in the region. The changes proposed in the PER, in the opinion of the GJVs, do not significantly increase the risk to the Flatback Turtles beyond those assessed for the Approved Development and therefore do not increase the threat to the viability of the species regionally or globally. Regional level impacts were taken into account during the risk assessment. Flipper tagging program results over 3 years demonstrate that female (nesting) Flatback Turtles are faithful to nesting on Barrow Island (but do not display strict beach fidelity). Stressors to Flatback Turtles associated with the Revised Proposal would therefore be expected to occur at a localised (rather than regional) scale. If other developments in the region are well managed, then residual risks at a regional scale should be limited to localised areas of each development. Conditions 15 and 16 of Statement No. 748 for the Approved Development require the establishment of a Marine Turtle Expert Panel and Long-term Marine Turtle Management Plan respectively. It is recommended that these conditions also apply to the Revised Proposal, to manage any potential impacts attributable to the Revised Proposal. Additionally, as part of the Approved Development, the GJVs have committed to providing funds for a North West Shelf Flatback Turtle Conservation Program and Flatback Turtle Intervention Program.
9.20	DEC – Environmental Management Branch	Recommendation 17: The Proponent needs to address impacts on marine fauna as a result of noise generating activities.	Due to the importance of this issue, noise and vibration impacts were addressed in Section 7.1.2.6 of the PER based on the Approved Development assessment. Further detail on the Revised Proposal marine blasting program can be found in Section 4.8.1 of this document. Management of marine noise will be through adopting appropriate measures to limit impacts to the environment (p. 158 of the PER) and includes actions such as: ♦ vessel speeds will be controlled to as low as reasonably practicable ♦ exclusion zones will be established for marine blasting to reduce the likelihood of impacts to marine fauna. The residual risk section in Table 7.2 (p. 161 of the PER) assesses the

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			residual impacts on marine fauna after the application of planned mitigation measures.
9.21	DEC – Environmental Management Branch	Recommendation 18: Further analysis of the noise-generating infrastructure and activities specific to the Gorgon development is required before an assessment of risk to marine fauna can be made. The Revised Proposal includes the following additional noise-generating infrastructure/activities: ♦ addition of a third LNG train, associated gas turbines ♦ additional power generation turbines ♦ additional boil off gas flare – proportionate increase in flaring requirements ♦ additional shipping – LNG, condensate, support vessels etc. ♦ change to drilling and blasting and dredge requirements. Potential impacts on marine fauna from noise and vibration are discussed in a general context within the PER. Noise emissions related to additional shipping and changes to construction methodology for the causeway/materials offloading facility (drilling/blasting/ dredging) have not been quantified or addressed in detail. Further analysis of the noise generating infrastructure and activities specific to the Gorgon development is required before an assessment of additional or different risk to marine fauna can be made.	The PER for the Revised Proposal was prepared to assess the significance of the environmental impacts of the Revised Proposal that are in addition to, different from, or cumulative with the Approved Development. To do this, a risk assessment was undertaken on the whole scope of the Approved Development plus Revised Proposal where relevant. Noise from terrestrial facilities is not expected to impact on marine fauna because of the distance of the onshore facilities from the nesting beaches and water. The risk assessment details for the Revised Proposal provided in the PER provide an overview of the key stressors and additional risks posed by the Revised Proposal. For a full list of the factors considered during the risk assessment, the detailed risk assessment tables in Appendix C of the PER should be consulted. These indicate that during the risk assessment process, drilling, blasting and shipping noise was considered in the marine section and other forms of terrestrial noise were considered in the terrestrial section of the risk assessment. Only risk levels which were Medium and above or changed from the approved were discussed in detail in the body of the PER, i.e. a risk-based approach as agreed with the EPA. The PER for the Revised Proposal was prepared to assess the significance of the environmental impacts of the Revised Proposal that are in addition to, different from, or cumulative with those of the Approved Development. Further detail on the Revised Proposal marine blasting program can be found in Section 4.8.1 of this document. For information beyond this scope (e.g. detail on noise and vibration, which have not differed significantly from the Approved Development), consult the original EIS/ERMP.
15.4	Conservation Commission of Western Australia	The Conservation Commission is concerned about the manner in which various risks have been assessed and in particular with respect to the Island's turtle population. The Barrow Island population of the Flatback Turtle (*Natator depressus*) is of regional significance and the eastern beaches are acknowledged as being very important for this species. Risks to this population are often assessed in the document as single items whereas there needs to be an assessment of the cumulative impacts of a series of impacts on the population. For example, it is often the case that the construction of a causeway structure jutting out from a coastline	For both the EIS/ERMP and the PER, the environmental risk assessment was undertaken in accordance with the principles and guidelines contained in the following: ♦ AS/NZS 4360:2004 Risk Management (Standards Australia/Standards New Zealand 2004a) ♦ HB 203:2004 Environmental Risk Management – Principles and Process (Standards Australia/Standards New Zealand 2004b) ♦ AS/NZS 3931:1998 Risk analysis of Technological Systems –

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Item	**Submission from**	**Submitter comment**	**GJVs' Response**
		brings about changes to sand deposition and erosion for adjacent beaches. The scale of this needs to be modelled for possible impacts on the access and use of the eastern beaches by turtles over time rather than single specific events such as cyclones. The range of impacts, such as light impacts, movement of turtles along the coast etc. likewise need to be assessed in total. There are significant deficiencies that need to be responded to through the provision of supplementary information prior to the Environmental Protection Authority's consideration of the proposal.	Application Guide. (Standards Australia/Standards New Zealand 1998) Coastal process modelling presented in the PER (Appendix F) was undertaken by an experienced coastal modeller and reviewed by a subject matter specialist nominated by the DPI. This modelling looked at the scale of depositional and erosional changes across a broad temporal period (not just during large events) related to the alteration of coastal processes. The modelling indicated that there is no significant effect on the coastal processes with the marine facilities currently in place. Material eroded during extreme events will return to the beach zone during ambient conditions in the same fashion as such material would normally find its way to the beach, without the MOF in place. Overall, the expected impact of the marine facilities on sediment transport processes during tropical cyclones and ambient conditions was determined to be minor. The MOF is not expected to cause significant accretion or erosion of the shoreline and will not impact on the extent of the beach face and its profile in terms of turtle nesting suitability. Conditions 14 and 16 of Statement No. 748 for the Approved Development, require establishment of a Marine Turtle Expert Panel (MTEP) and Long-term Marine Turtle Management Plan. It is recommended that the same conditions are applied to the Revised Proposal, which will adequately manage any additional impacts on marine turtles attributable to the Revised Proposal. Refer to Table 4.3 (Item 9.3) in this document, which addresses comments regarding the risk-based assessment approach, specifically those dealing with cumulative impacts.
15.5	Conservation Commission of Western Australia	Clarification is required as to what is meant by 'significant' when discussing the actions to be undertaken if it is found that the proposal does have a significant impact on the turtle population. The point at which intervention would be considered should be outlined. The documentation provided shows that the risk assessment is poorly related to the quantification of the impact of the expanded proposal for several areas. A key requirement identified in the PER is to address the effects of the Revised Proposal on sea turtle population viability and this has not been clearly demonstrated. For the reasons mentioned, statements such as, *Overall, the impact on nesting activity is not predicted to be different from the Approved Development*, must be questioned.	Refer also to Table 4.3 (Item 15.5) in this document, which addresses comments regarding the risk-based assessment approach for the Revised Proposal. The assessment of potential impacts on sea turtles and their viability was undertaken as part of the PER. Section 7.2 of the PER provides a discussion of the potential impacts of the Revised Proposal on marine fauna, with a specific discussion of the potential impacts on sea turtles. This information formed the basis of the risk assessment summarised in Table 7.2; this analysis was undertaken in accordance with the principles and guidelines contained in the following: ♦ AS/NZS 4360:2004 Risk Management (Standards Australia/Standards New Zealand 2004a) ♦ HB 203:2004 Environmental Risk Management – Principles and

Table 4.15		Marine Fauna	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
			Process (Standards Australia/Standards New Zealand 2004b) ♦ AS/NZS 3931:1998 Risk analysis of Technological Systems – Application Guide. (Standards Australia/Standards New Zealand 1998) Details on how the risk assessment process for the Revised Proposal was conducted, including the methods used to incorporate available information and expert knowledge in the relevant fields, is provided in Section 5 of the PER. The Gorgon Gas Development's overall management approach to impacts will be adaptive particularly where the risk rating is Medium. This approach involves monitoring, which will provide the basis for a management response where performance targets are not met. This provides for contingency actions to be undertaken to ensure risks are kept to acceptable levels. Performance targets will be listed in the Long-term Marine Turtle Management Plan (as required by Condition 16 of Statement No. 748), and have been set for the following stressors to marine turtles: ♦ lighting ♦ vessels ♦ dredging ♦ spills and unplanned discharges ♦ beach stability: erosion and accretion ♦ noise and vibration ♦ dust ♦ beach access ♦ reverse osmosis seawater intake ♦ fishing by Gorgon Project personnel ♦ blasting ♦ human presence ♦ turbidity Where targets are not met, management actions will be discussed with the MTEP. Refer to Section 4.9.1 in this document, which addresses comments

Table 4.15		Marine Fauna	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
			regarding the potential impacts of artificial lighting on marine turtles as a result of the Revised Proposal.
18.2	Department of Fisheries	The document indicates that the dredge volumes are anticipated to remain the same as considered acceptable in the first assessment even though the main access channel will be changed (decrease in length and increase in width). DOF notes that any increased dredging and associated dredging plume is likely to have a negative impact on fish habitats in and around the Island.	As noted, the extension of the causeway and repositioning of the MOF turning basin will not require an increase in the amount of dredge material. This is clearly stated in the PER. The modelling shows the impact to be the same for the Approved development as for the Revised Proposal. The GJVs have committed to maximising the use of the dredge material by incorporating the excavated material in the MOF where practicable (key commitment no. 10.2, page 813 EIS/ERMP). The work method adopted for the dredge plume modelling for MOF dredging assumes a cutter suction dredge (CSD) cutting the material and loading hopper barges alongside the dredge. The hopper barges would then travel to the dredge disposal site and discharge the material. The distribution of fines modelled for this work method is: ♦ 30% released at the CSD cutter head ♦ 35% released during overflow from the barge ♦ 35% released during dumping at the spoil ground. The trailer suction hopper dredge (TSHD) will be used to excavate the unconsolidated material in the LNG area. The distribution of fines modelled for this work method is: ♦ 30% at the TSHD drag head ♦ 40% released when material is overflowed by the TSHD ♦ 30% released during dumping at the spoil ground. The GJVs intend to maximise the use of the dredged material by incorporating the excavated material in the MOF where practicable. The GJVs have an opportunity to schedule the reclamation works to minimise the turbidity of overflow water via a weir at the MOF reclamation site. The frequency of unloading the TSHD at the MOF area would be determined by the turbidity of the decant water and the extent of the dredge plume. This provides a flexible management tool to influence the dredge plume by limiting the turbidity resulting from the MOF reclamation and reducing the impact of plumes generated from the spoil ground.

Table 4.15		Marine Fauna	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
18.3	Department of Fisheries	The potential negative affects of the dredging and spoils disposal program is a concern for DOF as the project is on the fishing grounds of three commercial fisheries. The development, and more specifically the construction of the pipeline, is likely to have interaction with the Onslow Prawn Fishery, Pilbara Trap Fishery and Pilbara Trawl Fishery. These fisheries actively operate in between the coastline and Barrow Island thus the dredging and construction of the gas pipeline will impact on the fishing grounds. There is also a Pearl Lease Site at the Lowendal Islands, which, currently is not active but has the potential to become active. These islands are located within the Zone of Influence (as referred to in Figure 7.6 of the document).	Trends from the two most recent State of the Fisheries reports indicate that the Onslow Prawn Fishery typically operates within approximately 30 km of the mainland and did not trawl the waters near Barrow Island in 2005 or 2006 (Fletcher and Head 2006; Fletcher and Santoro 2007). The Gorgon Gas Development's dredging and dredge disposal activities are therefore unlikely to significantly impact this fishery, as the worksite is approximately 70 km from the mainland. While the fisheries are large in area, fishing tends to concentrate in a few smaller productive areas, and with the exception of the Gorgon Gas Development's Domestic Gas Pipeline, fishing activity will usually be remote from the infrastructure associated with both the Approved Development and the Revised Proposal. Pipeline installation may temporarily prevent trawling for prawns in small areas of this fishery. However, the area affected is insignificant in relation to the area available to this fishery and likewise, this area was not fished substantially in either 2005 or 2006. Dredging and dredge spoil disposal are not expected to significantly reduce the size of the Pilbara Trap Fishery grounds as the majority of dredging activities will be within the Barrow Island Port Area (apart from a portion of the dredge spoil ground which is just outside the port area), while the fishing ground for this trap fishery is very large and extends from south of Onslow to north of Port Hedland (Fletcher and Santoro 2007). The Domestic Gas Pipeline construction will result in a narrow exclusion zone (~500 m either side) for commercial fishing. However, in relation to the broad area available to this trap fishery and the small number of vessels active in the fishery (three vessels in 2006) (Fletcher and Santoro 2007), this restriction is not considered to be significant. Near the mainland, the Domestic Gas Pipeline route is within close proximity of an existing exclusion zone for the Apache pipeline and will result in very little further disruption to commercial fishing. The area expected to be impacted by dredging operations in Barrow Island waters and the area surrounding the proposed Domestic Gas Pipeline route are permanently closed to fish trawls (Fletcher and Santoro 2007), and as such no impacts are expected on the Pilbara Trawl Fishery due to dredging operations and pipeline construction. The Gorgon Gas Development dredging and spoil disposal Zone of Influence is the predicted extent of the visible turbid plume. The level of turbidity in the zone of influence is not expected to cause impacts to

Table 4.15		Marine Fauna	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
			benthic primary producers but does have the potential to affect feeding and growth of pearl oysters, given that they are filter feeders. However, the pearl lease near the Lowendal Islands is currently inactive and if it becomes active during dredging operations impacts are likely to be negligible given the distance from the dredge area. The pearl lease is at the northernmost extent of the Zone of Influence.
18.4	Department of Fisheries	The DOF would like to be kept abreast of any changes to the dredging and dredge spoil program as disturbance and turbidity caused by dredging is likely to affect the health of pearl oysters. It is noted that DOF will be represented on Chevron's Expert Panel for Dredging so this mechanism should ensure the above requirements.	Over and above mandatory consultation requirements, the GJVs will continue to proactively engage with DOF through their involvement on the Construction Dredging Environmental Expert Panel (CDEEP).

4.9.1 Additional Information Relating to the Potential Impacts of Artificial Lighting on Marine Turtles

In recognition of the significance of marine turtles on Barrow Island, the GJVs have agreed to fund a 30-year North West Shelf Flatback Turtle Conservation Program (Statement No. 748 –Additional Joint Venture Undertakings) which will include activities to:

- survey, monitor and research turtle population
- mitigate the loss by reducing interference to key feeding and breeding locations
- establish information programs to support protection.

Furthermore, the North West Shelf Flatback Turtle Intervention Program, also detailed in Statement 748, will require the GJVs to take further action to improve turtle recruitment should significant impact be detected.

The GJVs will consult with the Marine Turtle Expert Panel (MTEP) (required under Condition 15 of Statement 748) on matters relating to the management of marine turtles. The role of MTEP is "to provide advice to the Proponent and the Minister on marine turtle monitoring and management including:

i. Development and implementation of the Long-Term Marine Turtle Management Plan as required by Condition 16.1;
ii. Proposal-specific turtle studies as required by Condition 16.4;
iii. Monitoring program design and methodology as required by Condition 16.4;
iv. Additional management measures as required by Condition 16.45; and Any other marine turtle management matters requested by the Proponent or the Minister."

Details on light modelling studies and lighting design strategies has been presented in the PER; however, this section of the document aims to clarify issues raised during the public submissions process.

4.9.1.1 Lighting from the LNG Plant and Associated Flares

The light modelling study presented in the PER was based on conservative assumptions reflecting a very preliminary design stage and an early definition of the lighting philosophy and lighting design for the Gas Treatment Plant. The Plant lighting philosophy has subsequently been finalised and the design has progressed significantly since that time. There are a number of new technologies that can deliver significantly reduced light spill to the environment and energy efficiency whilst meeting safety objectives at the same time.

The recently finalised lighting philosophy specifies four major lighting regimes for the Gas Treatment Plant:

- Essential lighting: This will form the normal ingress and egress lighting system and will consist of full spectrum lighting which is normally 'on' at night when the plant is operational. Essential lighting intensity will be an average of 20 lux in process areas and 1 lux along walkways and general areas.
- Normal Task lighting: This will be supplied from the main distribution system and will consist of full spectrum lighting which is normally 'off'' and only switched on to provide the necessary task lighting when required. Task lighting levels vary in accordance with the area and equipment within. The LNG trains, for example, have been divided into approximately 12 different areas for task lighting.
- Emergency Escape Route Lighting: This will be supplied to facilitate a safe and orderly evacuation from an area in the event of total power failure along escape routes.
- Safety Lighting: Central Control Room and other critical operations areas (to be defined). These operational areas will have lighting at 20 lux minimum within 0.5 seconds on loss of main power.

During normal operations, only the essential lighting system will be on all the time. Its activation is photocell-dependent. Photocell-dependent activation of essential lighting means that the essential lighting on the Gas Treatment Plant will be activated by photocells that measure the average illumination levels in the area. If these levels fall under a predetermined level, the essential lighting will be turned on automatically.

The lighting philosophy, when applied to the Gas Treatment Plant areas, ensures that areas within 500 m of the beach, which includes the product tank storage areas, utilities area, workshops and quarantine area off the MOF, are lit only by localised shielded normal lighting. The majority of the lighting in these areas will be task lighting and emergency escape lighting which are normally switched off and will be on only on demand or in the event of an emergency. The lighting model indicates that lighting will be below the full to quarter moon collective illumination levels in the area within 500 m of both Terminal and Bivalve Beaches. This will occur for approximately 50% of each month, and therefore the ambient light of the moon is predicted to be brighter than the Gas Treatment Plant lighting during this period. Experimental work carried out since the EIS/ERMP was submitted has shown that Flatback Turtle hatchlings respond strongly to horizon elevation and that light glow over a tall dune (such as behind Bivalve Beach) is not expected to influence the hatchlings natural orientation away from the dune towards the sea while light glow at beach level is most attractive to hatchlings (Pendoley Environmental 2007).

The conservative assumptions that the light modelling study incorporated, but which are no longer valid, include:

- the removal of approximately 330 six (6) metre high poles along the Plant perimeter road. It is envisaged that these will now be replaced by LED lamps studded alongside road surface delineating roads and showing change in direction. These have been tested in many road applications across Great Britain and have been found to decrease significantly road accidents and eliminate light spill above a road.
- removal of the continuous lighting from the LNG tank access ladders to the top of the tanks as well as lighting the top of the condensate and LNG storage tanks. No personnel are expected to conduct inspections or maintenance work at night at the top of these tanks, and so they have been provided with normal and emergency lighting which will be switched off at all times, except in circumstances where personnel may need to access tank rooftops. Inspection and maintenance works on tanks will not be conducted in the turtle breeding season and will not be conducted at night unless exceptional circumstances arise.
- maintenance shutdown and maintenance works inside an LNG train have been assessed as requiring the whole of each LNG train to be flood lit to task lighting levels to allow clear and safe visibility levels be achieved. Lighting inside the LNG trains has now been split into 12 segments allowing only the affected segment where maintenance works are conducted to be turned on to task lighting levels above normal levels and not the whole train as modelled in the light spill modelling study.

In summary, the Gorgon Gas Development's lighting design will be such that the Gas Treatment Plant plot plan area covering the utilities areas, maintenance workshops, the Quarantine Approved Premise (QAP), the LNG and condensate tanks and the stormwater pond will be an almost dark area at night. The processing part of the Gas Treatment Plant will be lit only to essential lighting levels (average of 20 lux). These light sources within the plant will be positioned such that maximum shielding from beams and other plant and module structures and equipment will be afforded.

The wet and dry flares, supporting the process systems, will be built as ground flares, provided with radiation shielding and located in the furthest corner of the Plant from the beach. The distance from the ground flares to the beach is between 1 and 1.4 km, which in combination with the radiation shielding around the flares will prevent direct light spill from these flares reaching the beach.

The GJVs have estimated the duration of planned non-routine flaring events to be in the vicinity of two hours per event and an average of ten process upset events per train are expected in the initial years of operation, reducing to six process upset events per train per year during steady-state operations. Planned flaring for maintenance shutdowns can be conducted during day light hours where practicable. Major train shutdowns are planned to be conducted in the winter months of the year (June-August) to avoid schedule interruptions from the cyclone season and the occupational health effects of hot and humid weather during the summer months.

Gas Treatment Plant design updates have resulted in the requirement for only one BOG flare, rather than two as described in the PER. A BOG flare system will be provided as a safety system for the LNG storage and offloading facilities and operations. The BOG flare will be built as an elevated flare due to the low back pressure in the systems relieving to this flare. The BOG flare tower will be located approximately 400 m off the beach and could be as tall as 60 m based on preliminary flare system sizing and radiation calculations. A flare pilot flame will be permanently lit to ensure that the system is available when in demand. The BOG flare tip will be contained within a semi-enclosed structure, open to the sky, which will shield the naked flame and light emissions from the continuous burning of the pilot and purge gas.

BOG flare non-routine flaring scenarios include warm LNG carrier cool downs and accidental loss of a BOG compressor or BOG recycle compressor. The BOG Flare Light Spill Minimisation Options Review (Chevron Australia 2008c) assumes that the GJV-estimated 12 warm LNG carrier visits each year occur at a frequency of one visit per month. This effectively means that for the peak turtle nesting period from December to January, when adult marine turtles are approaching beaches, there could be two non-routine BOG flaring events, whilst during the period from December to April when hatchlings are emerging, there could be five non-routine BOG flaring events. Warm ship cool-down could take up to 24 hours, but the duration of actual flaring could be much shorter as during the initial stages of cool-down the content of the gas displaced to the flare is almost 100% nitrogen, which is gradually enriched with methane, but as soon as the mixture starts to burn and the content of inert gas declines, the LNG/inert gas mixture can be diverted to the Gorgon fuel gas system via the BOG recycle compressor.

A number of risk reduction measures have been implemented or are under design review to prevent light spill and flaring from the BOG flare. For example:

- shielding the continuous light spill from the flare pilots through the design of the flare tip structure.
- the BOG recycle compressor, which compresses the return LNG vapour from the LNG carriers during loading operations, provides back-up for the BOG compressor which services the LNG Storage tanks, in the event of a BOG compressor failure. (Note the reliability assessment studies for the 3 x 5 MTPA LNG Gas Treatment Plant [International Risk Consultants 2008] indicate that non-routing flaring from the BOG flare due to equipment failure will amount to less than 114 hours per year).
- engineering studies are underway to establish the earliest point at which the inert gas/hydrocarbon mixture coming from a warm LNG carrier could be diverted from the BOG flare to the fuel gas system; as well as whether fuel gas can be added from the start of the warm LNG carrier cool-down period to the inert gas returns from the carrier to adjust the composition such that the mixed gas can be compressed and sent to the fuel gas system from the outset of LNG carrier cooling operations, etc. When implemented, these measures will reduce the risk associated with the BOG flare operation to as low as reasonably practicable.

4.9.1.2 Lighting from the Causeway, MOF and LNG Jetty

The Causeway, MOF and LNG Jetty roads will conform to the specification for roads applied for the perimeter road of the Gas Treatment Plant. The road extent will be indicated by perimeter LED

studs embedded in the road surface. The lighting design of the Causeway, MOF and LNG Jetty will conform to the requirements of the Gorgon Gas Development's Lighting Basis of Design (KJVG 2008b). The requirements for low level, shielded lighting and further light spill minimisation strategies will apply.

The influence of vessel and LNG berthing facility lighting associated with the increased number of LNG tankers movements for the Revised Proposal, and the potential impact of this lighting on Flatback Turtle hatchlings, is not considered by the GJVs to be a significant risk. It should be noted that the LNG berthing facility will be approximately 4 km off the east coast of Barrow Island. Swimming hatchlings are known to be attracted to light, which can effectively trap them in the light field and may result in increased exposure to predation and decreased dispersion (Lorne and Salmon 2007). However, the GJVs contend that Flatback Turtle hatchlings may also be carried away from Gorgon Gas Development infrastructure by the strong ocean currents that affect the waters around Barrow Island.

Vessels will maintain a marine fauna observer (MFO) on watch during vessel movements close to shore and during times of high turtle activity. The MFO will maintain records of opportunistic observations of the aggregation of hatchlings around vessel light sources. The MFO must be a person who has been trained to an appropriate level to perform the task of marine fauna observation. These data will supplement the information collected as part of the Long-Term Marine Turtle Management Plan (LTMTMP), and add to the scientific community's knowledge of the Flatback Turtle hatchling behaviour.

LNG terminal tugs will be designed to minimise environmental impacts, including light emissions.

As outlined in the PER, the environmental design measures and operating procedures are expected to mitigate the increase in light emissions and shipping activity from the Revised Proposal to an acceptable level.

Additional mitigations measures applicable to east coast marine facility construction include the following:

- construction activities will be undertaken during dayshift where possible
- Lighting Management Plans will be developed for each contract (work package)
- lighting will be directed away from natural environment and reflective surfaces where possible
- acceptable lighting types and wattages will be prescribed to contractors
- light spill will be reduced through treatment measures and artificial lighting kept to a minimum

regular inspections of vessels for compliance with Lighting Management Plans, with targeted inspections during turtle hatching season to ensure that light management measures are in place and effective.

For information regarding Marine Facilities construction please refer to section 2.1 of this document.

4.10 Marine Physical Environment and Coastal Processes

Table 4.16: Marine Physical Environment and Coastal Processes

Table 4.16		Marine Physical Environment and Coastal Processes	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
2.11	Conservation Council of Western Australia	The impacts of dredging remain unacceptably high as per Bulletin 1221. This is relevant to the proposal due to the changed port facilities being a part of the proposal, the EPA must repeat their recommendation against this scale of dredging in the sensitive marine environment surrounding Barrow Island.	In Bulletin 1221, the EPA expressed concerns about the impact of dredging. However subsequent to the release of Bulletin 1221, additional information was obtained and taken into account in the Minister's determination of appeals. The Minister approved the proposal with conditions addressing dredging and other EPA concerns. The scale of dredging for the Revised Proposal is no more than that for the Approved Development dredging plan. The environmental risks posed by the changes attributable to the Revised Proposal are no greater than the risks identified for the Approved Development, for which the required environmental approvals under Part IV of the State EP Act (Statement No. 748) and the Commonwealth EPBC Act (EPBC Reference: 2003/1294) have been granted.
7.7	Cape Conservation Group	The impacts of dredging remain unacceptably high as per Bulletin 1221. This is relevant to the proposal due to the changed port facilities being a part of the proposal. The EPA must repeat their recommendation against this scale of dredging.	
4.3	Marine Parks and Reserves Authority	The Revised and Expanded Proposal includes an increase in the length of the solid causeway/MOF structure from 1.3 km out to sea to 2.1 km out to sea. As was made clear in the MPRA comments on the Gorgon Gas Development EIS/ERMP, the sediment disturbance associated with such an extension is likely to have a significant effect on the local marine 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. This is likely to cause very large scale changes in the surrounding coastal and oceanic processes with unpredictable and potentially very harmful effects to the marine communities in the adjoining Marine Park.	Refer to Table 4.17 (Item 4.3) in this document, which addresses comments regarding marine water and sediment quality. Coastal process modelling undertaken by an experienced coastal modeller and reviewed by a subject matter specialist nominated by the DPI has demonstrated that there is no "*marked effect that the causeway has on sediment patterns*" (PER Appendix F). The report concludes that there is very little sediment available for transport as the majority of the MOF site is a rock platform, hence the need for a cutter suction dredge.
4.6	Marine Parks and Reserves Authority	The expansion of the facilities including the extension of the causeway will require a substantially increased movement of material both dredged and transported. Although the immediate effects of this activity will be confined to the construction phase, there is the potential for long-term damage to occur. There is also the potential for long-term dredging maintenance to be required given the marked effects the causeway is likely to have on sedimentation patterns and coastal processes. These aspects are not addressed in any substantive way.	Refer to Table 4.3 (Item 4.6) in this document, which addresses comments regarding the risk-based assessment approach utilised for the Revised Proposal. As stated in the PER, the extension of the causeway and the repositioning of the MOF turning basin will not require an increase in the amount of dredge material. To accommodate the additional material required to construct the extension of the causeway, the GJVs have proposed to use dredge spoil material and reduce the amount of material transported to the disposal site. Therefore, there is no justification to expect that an increase in impacts in either in the short term or long-term

Table 4.16		Marine Physical Environment and Coastal Processes	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
			will occur. Coastal process modelling undertaken by an experienced coastal modeller, and reviewed by a subject matter specialist nominated by the DPI has demonstrated that there is no "*marked effect that the causeway has on sediment patterns*" (PER Appendix F). The report concludes that there is very little sediment available for transport as the majority of the MOF site is a rock platform, hence the need for a cutter suction dredge. There is no information that supports the proposition that "…there is the potential for long-term damage to occur." This position is unsubstantiated and unsupported by scientific evidence or argument.
6.11	WWF	WWF-Australia assesses the risk categories 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. These two populations are a significant component of the regionally and globally important Flatback Turtle population, and potentially represent genetically distinct lineages from other regional nesting populations. WWF-Australia assesses the risk to the collective Barrow Island Flatback Turtle nesting populations on Barrow Island as major (local, long-term or widespread, short-term impact leads to loss of local population/s and reduced viability of the race on Barrow) and likely. WWF-Australia assesses the major stressors as: ♦ Underwater noise associated with the construction, possible blasting and on-going operation of the proposed Development. This is likely to affect the Flatback Turtle nesting population (both internesting and foraging individuals) using the east coast of Barrow Island. The anticipated result is reduced nesting frequency. This stressor and its impact have not been adequately addressed in the documentation and studies. Noise will also affect the behaviour of Green, Hawksbill and Loggerhead Turtle (adult and juvenile) foraging populations along the east coast. The EIS/ERMP does not address this problem or investigate potential impacts. ♦ Light during construction and operation. This is likely to cause Flatback Turtle hatchling disorientation in the two nesting beaches in the vicinity of the proposed Development. This poses a risk through disorientation of hatchlings, potential	Refer to Table 4.15 (Item 6.11) in this document, which addresses comments regarding marine fauna.

Table 4.16		Marine Physical Environment and Coastal Processes	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
		disorientation with respect to their return to their natal nesting beach as adults, and potentially increased predation of hatchlings attracted to jetty and ship lights. The studies in Technical Appendices C 6 – C9, reaction of turtle hatchlings to different light sources, and the survey of existing lighting, underscores the likelihood of this risk, and does not adequately address the risk from the proposed development when fully operational. ♦ Altered coastal and nearshore currents in the internesting area as a consequence of the construction of the MOF and jetty, causing a potential disorientation of foraging and internesting Flatback Turtles and disruption of behaviour. The altered currents may cause alteration of beach characteristics that could alter nesting and/or hatching success. The modelling in Technical Appendices B 3-6 does not adequately address this stressor. ♦ Sedimentation and physical disturbance of internesting habitat from the construction of the causeway, the construction of the jetty and the dredging of nine million cubic meters of sediments for the boat channel and its frequent use by large vessels represents a significant impact on the internesting habitat, and is an almost certain major impact on internesting turtles. ♦ Chemical pollution. No chemical baseline data have been collected from the water and nesting beaches in the Town Point area. This is essential to ensure that the beaches remain pollutant free to enable normal development of the turtle embryos in the sand. A regular monitoring program and relevant management actions would need to be developed for this stressor. WWF-Australia maintains that these risks to a globally and regionally important listed marine species disqualify Barrow as a candidate site for the proposed development. On the basis of this level of risk, approval for the proposed development on Barrow Island should be denied. WWF-Australia calls for the proposed additional work described on p. 273: "Surveys in winter 2005 will determine whether the sandy seabed off Town Point is important to inter-nesting or hibernating Flatback Turtles", to be expanded to include an assessment of	

Table 4.16		Marine Physical Environment and Coastal Processes	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
		juvenile Flatback Turtle habitats	
6.14	WWF	WWF-Australia assesses the risk categories as critical and almost certain, for sedimentation impacts leading to coral mortality associated with dredging and dredge plumes, in the vicinity of the construction, and over a broader region, including marine conservation areas, in association with severe weather events such as cyclones. 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, and contamination and pollution of coral over large areas. The source of disturbance is prolonged exposure to sediments (suspended particulate and settled) from the construction of the causeway, the construction of the jetty, the dredging of nine million cubic meters of sediments for access channels, and maintenance dredging, in an area influenced by high tidal current flows and frequent cyclones and storm swells. Sedimentation will have an almost certain major impact on marine benthic primary producers, and shallow benthic and coastal communities.	Refer to Table 4.20: (Item 6.14) in this document, which addresses comments regarding marine benthic primary producers.
6.15	WWF	WWF-Australia assesses the major stressors as the physical disturbance of marine benthic primary producers and shallow benthic and coastal communities, resulting in impacts and loss of species and communities, and contamination and pollution of coral over large areas. The source of disturbance is the construction of the causeway, the construction of the jetty, the construction of access channels, and dumping grounds. Physical disturbance will have an almost certain major impact on marine benthic primary producers, and shallow benthic and coastal communities.	Refer to Table 4.20: (Item 6.15) in this document, which addresses comments regarding marine benthic primary producers.
6.16	WWF	WWF-Australia assesses the major stressors as altered coastal and nearshore currents along the eastern coast of Barrow Island, resulting in impacts and loss of species and communities, and contamination and pollution of coral over large areas. The source of disturbance is the construction of the MOF and jetty, causing altered current regimes, and altered patterns of sedimentation. The modelling in appendices B 1-6 does not adequately address this stressor. Altered coastal and nearshore currents will have an almost certain major impact on marine benthic primary producers, and shallow benthic and coastal communities.	Refer to Table 4.20: (Item 6.16) in this document, which addresses comments regarding marine benthic primary producers.
12.9	DEC – Marine Ecosystems	Coastal processes impact prediction – Appendix F	Coastal process modelling presented in PER Appendix F was undertaken

Table 4.16		Marine Physical Environment and Coastal Processes	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
	Branch	No evidence is presented in the PER demonstrating that the models used have been validated for their application at Barrow Island. In general, the results of predictive studies into potential effects of the MOF on coastal processes are discussed in Appendix F in qualitative terms. It appears that the domain within which bed level changes associated with tropical cyclones have been predicted only extends part way along the MOF structure. Not predicting bed level changes along the entire length of the MOF structure and throughout its zone of effect adds uncertainty to the predictions. The report in Appendix F states that water current speeds will accelerate around the MOF head, with maximum speeds around 0.7–0.8 m/s. The document does not place these currents into context. The current velocities predicted to result from the MOF represent an approximate doubling of ambient current speeds during some parts of the tidal cycle (particularly during ebbing tides). There is uncertainty around potential implications of this for issues such as the requirement for maintenance dredging of the MOF channel. Modelling predicts 'localised' areas of erosion and accretion will occur during tropical cyclones with the MOF in place. It is also stated that "sand may tend to accumulate in minor quantities from time to time". The overall conclusions are that the sediment erosion and accretion resulting placement of the MOF will be 'minimal' and original bathymetry patterns will be restored shortly after the passing of a cyclone. The report also indicates that there is very little in the way of nearshore sediment available for transport during extreme events. This raises the question that if erosion results from the placement of the MOF and eroded sediment is transported out of the local area, where will the supply of sediment come from to restore pre-erosion beach and sea bed characteristics?	by an experienced coastal modeller and reviewed by a subject matter specialist nominated by the DPI. The peer reviewer was satisfied with the model validation. Appendix F provides detailed quantitative information on the predicted impacts of the MOF. The conclusions of the modelling supported by the peer review found: ♦ the modelling program indicates that the MOF is not expected to have a significant impact on ambient sediment transport ♦ there is no significant effect on coastal processes with the MOF in place. Eroded material during extreme events will return to the beach zone during ambient conditions in the same fashion as such material would normally find its way to the beach, without the MOF in place ♦ the predicted impact of the MOF on sediment transport processes during tropical cyclones and ambient conditions is minor and changes in sedimentation will be manageable due to the low predicted rates of sediment transport in the area ♦ the MOF is not expected to cause significant accretion or erosion of the shoreline and will not impact the extent of the beach face and its profile in terms of turtle nesting suitability. The implications of changes in the water current at the head of the MOF are discussed in context in Appendix F of the PER (pages 151, 154, 155, 170 and 174). The water current speeds are a function of the tides and therefore will cycle diurnally varying in intensity from zero to a maximum determined by the change in tide over the lunar cycle. A review of the figures included in the Coastal Processes Modelling Report (Appendix F of the PER) demonstrates that the during spring tides the maximum current speeds in the localised area immediately adjacent to the end of the MOF are approximately 0.44 m/s prior to construction, increasing to approximately 0.69 m/s after the installation of the MOF. The increase in water current velocity at the MOF head is very localised. Considering the MOF head is situated on a rock platform it is unlikely that there will be any significant issue with sediment transportation or maintenance dredging.
17.8	DPI	Coastal Processes The work provided does not appear to address the concerns raised in review of the previous PER. The issues raised in the previous review of coastal processes modelling by Damara WA Pty Ltd (as attached) are still considered relevant to the latest	The Coastal Modelling Barrow Island Report (RPS MetOcean 2008) has now been posted on the Gorgon Gas Development's web site (www.gorgon.com.au); additional details on the model set-up, coefficients, and assumptions are provided (refer to section 4 of the report). The report has been reviewed by an independent subject matter specialist (Damara WA Pty Ltd). This is the same consultant that DPI nominated to

Table 4.16		Marine Physical Environment and Coastal Processes	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
		Coastal Processes Modelling Report For The Revised Marine Infrastructure (Appendix F). In particular we raise the following concerns: 1. Insufficient detail is provided of the model setup, coefficients, and assumptions to make an assessment of their suitability. 2. Insufficient information is provided on the model calibration. Reference is given to MetOcean (2008), assumed to be Report R1385, May 2008, Coastal Modelling Barrow Island, prepared for Chevron. However this report has not been included within the PER. 3. Insufficient supporting information is provided on the selection of the modelled cyclones. 4. The modelling does not appear to have taken to have included dredged channels or the LNG structure. 5. The impact of shadowing from the proposed structures has not been considered. This is fundamentally important as sediment trapped in the lee of the structure will not naturally be removed. The assessment of net sediment movement is not sufficient to identify this process. The consequence will be either shore realignment or the requirement for sediment management.	review the previous report authored by MetOcean Engineers (2005). Comments from the independent subject matter specialist on the Coastal Modelling Barrow Island Report (RPS MetOcean 2008) were addressed within the report to the satisfaction of the reviewer. The dredge channels have been included in the bathymetric models. The LNG jetty is an open pile structure and will have a limited impact on the outcome of the model. The Report (RPS MetOcean 2008) concludes that: "Through inclusion of the MOF, wave protection of the shoreline is provided through a shadow zone in the lee of the MOF. The shadow zone may be of the order of approximately 45 degrees to the coastline. During the worst case (i.e. coupled spring tides, storm surge and wave setup), the inclusion of the MOF will actually prevent erosion of the shoreline rather than increase the erosion. Without the MOF in place, under these extreme conditions, a more severe local impact on the beach stability will be observed" (p. 47). Historical photographs and inspection indicates that the rocky beaches either side of Town Point are devoid of sand, which confirms the assessment that there is no significant longshore sediment transport between these distinct littoral cells.

4.11 Marine Water and Sediment Quality

Table 4.17: Marine Water and Sediment Quality

Table 4.17		Marine Water and Sediment Quality	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
2.11	Conservation Council of Western Australia	The impacts of dredging remain unacceptably high as per Bulletin 1221. This is relevant to the proposal due to the changed port facilities being a part of the proposal, the EPA must repeat their recommendation against this scale of dredging in the sensitive marine environment surrounding Barrow Island.	Refer to Table 4.16 (Item 2.11) in this document, which addresses comments regarding the marine physical environment and coastal processes.
4.3	Marine Parks and Reserves Authority	The Revised and Expanded Proposal includes an increase in the length of the solid causeway/MOF structure from 1.3 km out to sea to 2.1 km out to sea. As was made clear in the MPRA comments on the Gorgon Gas Development EIS/ERMP, the sediment	The Revised Proposal's causeway and MOF are in essentially the same location as that for the Approved Development. For the Revised Proposal, the seaward end of the causeway and the MOF have shifted slightly to the north and their combined length has increased from

Table 4.17		Marine Water and Sediment Quality	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
		disturbance associated with such an extension is likely to have a significant effect on the local marine 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. This is likely to cause very large scale changes in the surrounding coastal and oceanic processes with unpredictable and potentially very harmful effects to the marine communities in the adjoining Marine Park.	approximately 1300 m to approximately 2100 m. Utilising this new design, coastal modelling was undertaken to assess the long-term impacts of the infrastructure on sedimentation and coastal processes. The results indicate limited change in shoreline and sedimentation levels even under the cyclonic conditions experienced during cyclones Monty, Bobby and Olivia, which is a reflection of the very small changes in local currents in response to the presence of the Gorgon Gas Development's infrastructure in near-shore marine waters. Historical photographs and inspection indicates that the rocky beaches either side of Town Point are devoid of sand, which confirms the assessment that there is no significant longshore sediment transport between these distinct littoral cells. The Revised Proposal's facilities do not provide a mechanism to induce long-shore drift and overall the risk of changes to the foreshore was shown to be low. Any risk of impact to the foreshore associated with the presence of the infrastructure and maintenance dredging can be appropriately managed and monitored.
4.6	Marine Parks and Reserves Authority	The expansion of the facilities including the extension of the causeway will require a substantially increased movement of material both dredged and transported. Although the immediate effects of this activity will be confined to the construction phase, there is the potential for long-term damage to occur. There is also the potential for long-term dredging maintenance to be required given the marked effects the causeway is likely to have on sedimentation patterns and coastal processes. These aspects are not addressed in any substantive way.	Refer to Table 4.3 and Table 4.16 (Item 4.6) in this document, which address comments regarding the risk-based assessment approach that was utilised for the Revised Proposal, and marine physical environment and coastal processes.
4.7	Marine Parks and Reserves Authority	The expansion of the facility will lead to substantially increased vessel traffic both during the construction phase and subsequently during the operations phase. This has the potential to expose the area to a greater risk of introduced marine pests, accidental spillages and ballast water effects.	The Gorgon Gas Development Quarantine Management System gives substantial attention to the risks posed to the marine environment as a result of vessel traffic. A risk-based quarantine assessment was applied to the vessel pathway and the outcome has been the subject of consultation with the Quarantine Expert Panel (QEP) and marine experts. Every vessel that enters the marine quarantine zones must meet the requirements of the respected zones. The requirements are entrenched in a mobilisation procedure and other specifications that include risk assessing each vessel, issuing of report which includes detailed instruction to vessel masters as to remediation required based on vessel condition, history of maintenance, slippage and dry-docking of long term charter vessels which cover all the vessels in the revised proposal. The quarantine compliance of vessel wetsides (underwater and wetted areas) are verified by an independent marine biologist. This status is audited on an unannounced schedule for the duration of the specific scope of work.

Table 4.17		Marine Water and Sediment Quality	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
			The changes in the revised proposal therefore add no new threats to the marine environment. Refer also to Table 4.21 (Item 4.7) in this document, which addresses comments regarding quarantine. The potential effect on marine fauna and marine benthic primary producers from accidental leaks and spills is discussed in Section 7.1.2.3 and 7.4.2.2 of the PER, respectively. The Revised Proposal was not considered to present a significant additional or different environmental risk to marine fauna or benthic primary producers. Potential impacts on marine water and sediment quality from leaks and spills were considered to be low, with existing mitigation measures being sufficient, and were not discussed further in the PER for the Revised Proposal.
6.14	WWF	WWF-Australia assesses the risk categories as critical and almost certain, for sedimentation impacts leading to coral mortality associated with dredging and dredge plumes, in the vicinity of the construction, and over a broader region, including marine conservation areas, in association with severe weather events such as cyclones. 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, and contamination and pollution of coral over large areas. The source of disturbance is prolonged exposure to sediments (suspended particulate and settled) from the construction of the causeway, the construction of the jetty, the dredging of nine million cubic meters of sediments for access channels, and maintenance dredging, in an areas influenced by high tidal current flows and frequent cyclones and storm swells. Sedimentation will have an almost certain major impact on marine benthic primary producers, and shallow benthic and coastal communities.	Refer to Table 4.20: (Item 6.14) in this document, which addresses comments regarding marine benthic primary producers.
7.7	Cape Conservation Group	The impacts of dredging remain unacceptably high as per Bulletin 1221. This is relevant to the proposal due to the changed port facilities being a part of the proposal. The EPA must repeat their recommendation against this scale of dredging.	Refer to Table 4.16 (Item 7.7) in this document, which addresses comments regarding the marine physical environment and coastal processes.
12.10	DEC – Marine Ecosystems Branch	***Other issues*** *Water and sediment quality data presented in the PER* The PER suggests that: ♦ cadmium levels were on average, double the ANZECC and ARMCANZ (2000) 99% level of protection trigger levels for	Refer to Section 4.11.1 of this document.

Table 4.17		Marine Water and Sediment Quality	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
		this metal (0.7 µg/L); and ♦ concentrations of all metals other than silver are below ANZECC and ARMCANZ (2000) Interim Sediment Quality Guideline (ISQG) Low trigger values. Neither the raw data nor the relevant reports are provided to appraise these findings. However, it should be noted that studies to estimate natural background levels of toxicants in water and sediment have been conducted throughout the Pilbara. The results of these studies indicate that natural background levels of: ♦ Cd in marine waters off the Pilbara coast is 0.005 µg/L and this is generally consistent with natural background concentrations measured at other locations in WA, NSW and in the Pacific Ocean and two orders of magnitude below the ANZECC/ARMCANZ 99% species protection guideline value; and ♦ Ag in marine sediments in the Pilbara (as median total sediment metal concentration) is <0.2 mg/kg. The ISQG Low value for Ag is 1 mg/kg. In view of the above, the Proponent should be implementing further investigations against the appropriate environmental quality standards. Alternatively, significantly more convincing arguments and quantitative data are required to support the following on page 70 of the PER: ♦ "…the concentrations of cadmium…may reflect normal background concentrations, rather than contamination (RPS 2007)" ♦ "The source of the elevated silver concentrations is unknown".	
12.8	DEC – Marine Ecosystems Branch	Environmental Quality Management Framework Environmental Values (Evs), Environmental Quality Objectives (EQOs) and associated levels of ecological protection have been established and spatially-defined for State marine waters off the Pilbara coast through a public consultation process (DoE 2005). The EPA has endorsed the 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. The Gorgon proposal has implications for the EQOs and spatial application of the levels of ecological protection off the east coast of Barrow Island. In view of	The GJVs commit to addressing the requirements under the State Water Quality Management Strategy Document No.6. The GJVs agree in principle that the delineation of a zone of modified Environmental Quality Objectives (EQOs) around the Gorgon Project Marine Infrastructure off the east coast of Barrow Island for the period of operation of these facilities is consistent with the Western Australian State Water Management Strategy. The definition of the zones of modified EQOs for operations activities around the relevant marine facilities shall be undertaken in consultation with the DEC Marine Ecosystems Branch. The GJVs suggest that this

Table 4.17		Marine Water and Sediment Quality	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
		the judgement reached by the EPA through its assessment of the original Gorgon proposal that the proposal should not be allowed to proceed, limited attention was given to addressing the environmental quality management framework (EQMF) for marine waters, which would only require modification if the proposal were to proceed. Now that a decision has been made by Government to allow original Gorgon proposal to proceed and that the proponent is currently pursuing environmental approval for its revised and expanded proposal, it is appropriate that the EQMF be addressed through this EIA process as set out in the State Water Quality Management Strategy Document No.6. Accordingly, in its responses to submissions on the PER, the Proponent should couch the environmental effects of the proposal in the context of the EQOs and associated levels of ecological protection shown in DoE (2006). Information supplied to the EPA will need to include maps that clearly show the extent to which the current EQOs and associated levels of ecological protection shown in DoE (2006) would be modified if the proposal is allowed to proceed. Summary: The Proponent should couch its proposal in the context of the EQMF – i.e. the Evs, EQOs and spatially defined levels of ecological protection described in DoE (2006) which have been endorsed by the EPA as interim to guide EIA and natural resource management in the Pilbara.	occurs during the preparation of the deliverables relating to marine environmental impacts. This could be addressed under Condition 14 of Statement 748, Coastal and Marine State and Environmental Impact Report.
18.3	Department of Fisheries	The potential negative affects of the dredging and spoils disposal program is a concern for DoF as the project is on the fishing grounds of three commercial fisheries. The development, and more specifically the construction of the pipeline, is likely to have interaction with the Onslow Prawn Fisher, Pilbara Trap Fishery and Pilbara Trawl Fishery. These fisheries actively operate in between the coastline and Barrow Island thus the dredging and construction of the gas pipeline will impact on the fishing grounds. There is also a Pearl Lease Site at the Lowendal Islands, which, currently is not active but has the potential to become active. These islands are located within the Zone of Influence (as referred to in Figure 7.6 of the document).	Refer to Table 4.15 (Item 18.3) in this document, which addresses comments regarding commercial fishing.
18.4	Department of Fisheries	The DoF would like to be kept abreast of any changes to the dredging and dredge spoil program as disturbance and turbidity caused by dredging is likely to affect the health of pearl oysters. It is noted that DoF will be represented on Chevron's Expert Panel	Refer to Table 4.15 (Item 18.3) in this document, which addresses comments regarding ongoing consultation with DoF related to the dredging and the dredge spoil program.

Table 4.17		Marine Water and Sediment Quality	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
		for Dredging so this mechanism should ensure the above requirements.	
Email dated 13 Feb 2009 (Pt 1)	DEC – Marine Ecosystems Branch	Please clarify where you have responded to our email of 29 October 2008 that identified significant data gaps in the time-series for TSS/Sediment deposition shown in figures 7.8 and 7.9 of the PER (you would recall that we requested and you sent the raw data files for these figures). We have requested an explanation of how these data were assessed against the thresholds which require at least 6 hourly values of TSS for daylight hours. In addition, we requested an explanation of how you have used the modeled sediment deposition rates (mg/cm2/d) to calculate daily loads which are required to evaluate against the sediment deposition load based thresholds (again given the apparent data gaps).	To accurately represent the fine detail in the dredge logs, the dredge plume model was run on 5 minute time-steps during plume generating activities. These time-steps started from an activity in the dredge log which did not generally coincide with an exact hour (refer to Appendix B of the Response to Submissions document for example dredge logs). For example, if dredging started at 08:17am the model would output data at subsequent 5 min intervals- 08:22am, 08:27am, 08:32am etc. Consequently, these time-steps did not always fall exactly on the hour. To calculate hourly data points (for turbidity or sedimentation), the model then interpolated between the time-steps closest to each hour, for example the 09:00am value was interpolated from 08:57am and 09:02am. These interpolated data were very close to the neighbouring values and together provided a regular hourly data set for assessment of possible exceedances of the threshold criteria. When GEMS selected the time-series data points to illustrate the Total Suspended Solids (TSS) and Sedimentation fluxes at key sites (Figures 7.8 & 7.9 presented in the PER), they chose only the exact hourly time steps for the sake of presentation. The data used to produce these graphs were subsequently requested by DEC. The supplied dataset had gaps where there was no exact hourly value, for example data at 08:57am would not be included in the time series file. This gave the impression that there were gaps in the dataset. However, to analyse potential exceedances of coral thresholds, the entire dataset (with interpolated hourly values) was used rather than just the plotted data that occurred on the hour. The coral health threshold criteria against which the model was interrogated, and which were used to predict impact zones, remained the same for the PER as they were in the EIS/ERMP. Turbidity levels were compared against the coral health threshold criteria as follows: • a turbidity value was output for each hour (interpolated data set) during daylight hours • an exceedance was triggered by six or more hourly values within the daylight hours exceeding the threshold value Daily sedimentation rates were compared against the coral health

Table 4.17		Marine Water and Sediment Quality	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
			threshold criteria as follows: • Each hour the dredge plume model output a new sedimentation value for each cell of the model domain (interpolated hourly value). • Each hour the new value for sedimentation was added to the preceding 23 hour dataset (incorporating resuspension) to produce a daily rate for that hour, in that cell. • The hourly values were a moving cumulative load for the preceding 24 hours (hence the mg/cm^2/day units are correct). • This increased the sensitivity of the model to exceedances of the 24 hour criteria, because every 24 hour period was assessed against the criteria. The sedimentation plots in the Final EIS/ Response to Submissions on the ERMP (Figure 9, Page 443) differed from those in the PER (Figure 7.9, Page 196) because resuspension of sediments was factored into the PER output. The EIS/ERMP plots show gross sedimentation (ignoring the predicted resuspension of fine particles due to wave action) whereas the PER plot shows a more realistic picture where the effect of resuspension affects the net sedimentation at any given point.
Email dated 9 Mar 2009	DEC – Marine Ecosystems Branch	However, further to our discussion around point 1 [pt 1 above in this table], our scan of the time series graphs (Figures 7.8 and 7.9, PER) for the southern Lowendal Shelf sites (sites A and B, Figure 7.6, PER), suggest there were significant TSS-related pressures at these sites, particularly during the first quarter. Given that we do not have the full time series data set to allow an independent verification, would you please confirm in your final response that the hourly time series of predicted TSS and Sediment Deposition for the southern Lowendal Shelf sites have been interrogated against the criteria as described in the PER and that the coral health criteria were not exceeded at those sites.	The criteria (and assumptions) for TSS and Sedimentation used in the model to predict the zones of impact are shown in Table 4 on page 20 of the GEMS Report (as presented in Appendix B of the Response to Submissions). Section 7.4 (pages 184 - 186 & pages 193 -194) of the PER provides a discussion and explanation of the modelled results for TSS and Sedimentation and how these results were used to predict the zone of high impact, zone of moderate impact and the zone of influence. The GJVs can confirm (on advice from GEMS) that the hourly time series of predicted TSS and Sediment Deposition for the southern Lowendal Shelf have been interrogated against the criteria as described in the PER and that the coral health criteria (for the zone of high impact and the zone of moderate impact) were not exceeded at those sites. It should be noted that the analysis for TSS was completed for daylight hours only (this is logical as there is no light to attenuate at night). A peak might therefore occur at night and would not be part of the analysis so some of the peaks in the TSS time series do not contribute to the impact

Table 4.17		Marine Water and Sediment Quality	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
			analysis.
Email dated 13 Feb 2009 (Pt 2)	DEC – Marine Ecosystems Branch	Is the particle size distribution for the CSD used in the modeling from crushed cores (as stated on p13 of the GEMS modeling report) or from Geraldton (p 84 in response to submissions)	Page 13 of the GEMS Report states: *During the Geraldton dredging project it was found that there were approximately twice as many fines below 40 microns as determined by analysis of crushed cores. This outcome was due to the grinding motion of the CSD cutter teeth on hard rock, producing "rock flour".* *This assumption has been included in Table 1 for the PSD adopted for dredging with the CSD.* This is consistent with the Response to Submissions on the PER (Rev 0, Page 84) which states: *Therefore, the model incorporated results from the Geraldton Port dredging program, as these constitute the best available data.* As a point of clarification, the Gorgon PER modelling utilised the particle size distribution (PSD) developed from the crushed cores from the Geraldton dredging project. The results of which were modified by doubling the amount of fines below 40 microns in order to define the PSD for the Gorgon modelling.
Email dated 13 Feb 2009 (Pt 3)	DEC – Marine Ecosystems Branch	With respect to assumptions related to the production of fines, recent documentation leaves us unclear about what has been modeled. Firstly, we note that Document C of the ERMP/EIS assumes that 5% of total cut material is converted to fines <75microns. We also note that modeling outlined in Appendix E of the PER was different in the sense that it was based on the assumption that 5% of total cut material is <100microns. Furthermore it is noted that reference to the 5%/100micron assumption stated in the modeling report appended to the PER has been removed from the revised modeling report in Appendix B to the response to submissions, and again refers to an assumption related to material release <75microns. Firstly, taking the percentage component of the fines production assumptions used by the modeller, the PSD data provided in the responses to submissions indicates that particles <75microns represent +13% of material cut by the CSD and particles <100 microns represent approximately 18%, again considerably more than the quoted 5%. These apparent inconsistencies leave us quite uncertain about exactly what has been input to the modeling.	The modelling assumptions have been updated as more knowledge and data have become available. The latest dredge plume modeling includes fines assumptions as presented in Appendix B of the Response to Submissions titled "Dredging Simulation Studies to Support the PER for the Revised Proposal" (dated November 2008) and included as Table 4.18 attached. Please note that the modelling assumption that 5% of total cut material is <100 microns was an incorrect inclusion in the PER Appendix E version of the Modelling Report (dated July 2008). This was rectified to indicate the correct assumptions that were used in the modelling as part of the Appendix B version of the Modelling Report (dated November 2008) that appeared in the Response to Submissions on the PER (Rev 0 and Rev 1). In geotechnical terms, only material below 75 microns is referred to as "fines". As can be seen from Table 4.18 attached, this equates to about 15% of material below 79.6 microns in the model for the Cutter Suction Dredge (CSD) (and would be slightly less for < 75 microns). However, the model also includes a portion of material between 75 microns and 251.8 microns which results in a total of approximately 26.5% of material liberated into suspension. This is a conservative assumption with the

Table 4.17		Marine Water and Sediment Quality	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
			intent of presenting the maximum extent of environmental impacts for consideration as part of the assessment documentation.
Email dated 13 Feb 2009 (Pt 4)	DEC – Marine Ecosystems Branch	With respect to assumptions related to the release of fines expressed as a 'percentage', we are still unclear about the net 'load' of fines that would be generated from the approach of utilizing a work method whereby the CSD cut and sidecast followed by TSHD removal versus the standard CSD approach of filling barges. As a means of developing an example the assumption that 5% of total cut material is converted to fines <75microns is used for a total dredge volume of 1 Mm3 where the specific gravity of limestone is 2.5 (could be any number for this example). The total load of fines produced would therefore be ~50,000m3 multiplied by 2.5 equaling 125,000 tonnes. Using this example, what would be the load of fines liberated from each key area (ie, the cutter head, during depositing on seabed, pickup during TSHD, dumping at the spoil ground) compared with the normal Cutter suction (ie release at the cutter head, released in overflow, at the dump ground)? We note the explanation in 12.5 j of the response to submissions but it does not clarify what the 'percentages' relate to. Is it correct to assume that for the case where 50% of total fines are generated at the cutter head of a CSD 62,500 tonnes of fines would be liberated (as in the MoF dredging scenario in Document C), whereas the cutter head release from the same CSD dredging at the same location could liberate 37,500 tonnes of fines (where 30% of total fines is assumed to be released at the cutter head as in the MoF dredging scenario described in Appendix B of the response to submissions on the PER) using a different work method?	The percentage fines attributed to each work method adopted in the current dredge plume model is described in the GEMS report Section 3.3.5 - The Release of Fines into the Water Column, Dredging Simulation Studies to Support the PER for the Revised Proposal, Appendix B of the Response to Submissions. Initially the GJVs had proposed using a cutter suction dredge (CSD) to load hopper barges in the LNG approach channel/turning basin area. However, only one contractor in the international market is known to have this capability (i.e. CSDs capable of loading large hopper barges). Due to this limitation on equipment availability, an alternative work method was adopted using the CSD to cut the material and side cast the material onto to seabed to be picked up later by the trailer suction hopper dredge (TSHD). Although this method appears to liberate more fines at the dredge source, based on the percentage fines liberated to each work method, there is a delay between the dredging operations of the CSD and the THSD. This delay provides a temporal shift (potentially several months) in the liberation of fines which will not result in increased impact in comparison with the original work method. As noted in the referred Section 3.3.5 of the Response to Submissions the modeling assumed that 30% fines are released at the cutter head irrespective of the follow up activity. Table 1 of the GEMS report (Appendix B) provides the Particle Size Distribution and Section 3.3.3 of the Response to Submissions describes how this distribution is applied in the model. Using the sidecast method, a further 20% are released as the material is deposited on the seabed near the cutter head. For example, if the cutter suction dredge is excavating a parcel of 1,000,000m^3 of material the total amount of fines liberated within the model is 26.5% which equates to 265,000m^3. An example is demonstrated in Table 4.18 attached.

Table 4.18: Worked Example of Dredge Fines

1	2	3	4	5	6	7	8	9
CSD FINES RELEASED				WORKED EXAMPLE FOR 1,000,000m3 OF CSD				
DIAMETER (MICRONS)	PSD	% CONTRIBUTION	% FINES RELEASED	TOTAL FINES RELEASED	30% RELEASED AT CUTTER HEAD	20% RELEASED WHEN DEPOSITED ON THE SEA BED	30% RELEASED AT OVERFLOW OF TSHD	20% RELEASED DUMPING AT SPOIL GROUND
Table 1 GEMS Report		p14 GEMS	2 X 3	3 x 1Mm3	5 x 30%	5 x 20%	5 x 30%	5 x 20%
1000	14%	0%	0.00%	-	-			
502.4	8%	0%	0.00%	-	-			
399.1	23%	0%	0.00%	-	-			
251.8	23%	0%	0.00%	-	-			
158.9	8%	54%	4.32%	43,159	12,948	8,632	12,948	8,632
126.2	6%	73%	4.38%	43,763	13,129	8,753	13,129	8,753
89.3	3%	94%	2.83%	28,310	8,493	5,662	8,493	5,662
79.6	2%	100%	2.00%	20,000	6,000	4,000	6,000	4,000
63.3	1%	100%	1.00%	10,000	3,000	2,000	3,000	2,000
50.2	1%	100%	1.00%	10,000	3,000	2,000	3,000	2,000
39.9	1%	100%	1.00%	10,000	3,000	2,000	3,000	2,000
31.7	1%	100%	1.00%	10,000	3,000	2,000	3,000	2,000
25.2	1%	100%	1.00%	10,000	3,000	2,000	3,000	2,000
15.9	1%	100%	1.00%	10,000	3,000	2,000	3,000	2,000
10	1%	100%	1.00%	10,000	3,000	2,000	3,000	2,000
8	1%	100%	1.00%	10,000	3,000	2,000	3,000	2,000
6.3	1%	100%	1.00%	10,000	3,000	2,000	3,000	2,000
4	1%	100%	1.00%	10,000	3,000	2,000	3,000	2,000
2	1%	100%	1.00%	10,000	3,000	2,000	3,000	2,000
1	1%	100%	1.00%	10,000	3,000	2,000	3,000	2,000
0.5	1%	100%	1.00%	10,000	3,000	2,000	3,000	2,000
TOTAL % FINES RELEASED			26.52%	265,232	79,570	53,046	79,570	53,046
				CHECK				265,232

4.11.1 Further Information Regarding Marine Water and Sediment Quality

Water samples collected from all ten sites in the July/August 2006 Marine Baseline Surveys (RPS BBG 2007) revealed cadmium concentrations of between 1.2 and 1.8 µg/L using methodology with a detection limit of 0.1 µg/L.

Since release of the PER for public comment, data have been received from three sampling events from three sites around Barrow Island that employed similar sampling techniques and an improved analytical procedure (Australian Commonwealth Scientific and Research Organisation [CSIRO]) as used by Wenziker *et al*. (2006). The maximum concentrations of cadmium measured in these samples ranged from 0.003 to 0.005 µg/L, with a detection limit of 0.002 µg/L. The increased precision of the ultra-trace data and the consistently low results support the conclusion that the measured cadmium concentrations in the waters surrounding Barrow Island are similar to concentrations measured in previous North West Shelf studies (Wenziker *et al*. 2006).

No further sediment metals analysis have been undertaken since the July/August 2006 Marine Baseline Surveys (Table 4.19 and Figure 4.4 in this document). Concentrations of silver in the sediment between <1.0 and 4.0 mg/kg were detected (detection limit of 1.0 mg/kg) during that study. In relation to the ANZECC/ARMCANZ (2000) ISQG-Low value of 1.0 mg/kg, results from three of the sites exceeded the target value, five sites were equal to the target value, and two sites were below the target value.

The source of the higher-than-expected concentration of silver is still unclear; however, given the higher than expected concentrations detected on both the west and east coasts at sample sites near and far from current infrastructure, it is unlikely to be reflective of anthropogenic contamination.

Table 4.19: Concentration of Silver

Site name	Silver (mg/kg)
HDD	1.0
HDD-S	3.0
HDD-N	1.0
HDD-S Ref	2.0
HDD-N Ref	1.0
Jetty	4.0
Jetty-S	<1.0
Jetty-N	<1.0
Jetty-S Ref	1.0
Jetty-N Ref	1.0

Note: Recorded at 10 sediment sample sites (Figure 4.4) located near Barrow Island, sampled in July-August 2006 (RPS BBG 2007) and analysed by ARL with a laboratory detection limit of 1.0 mg/kg

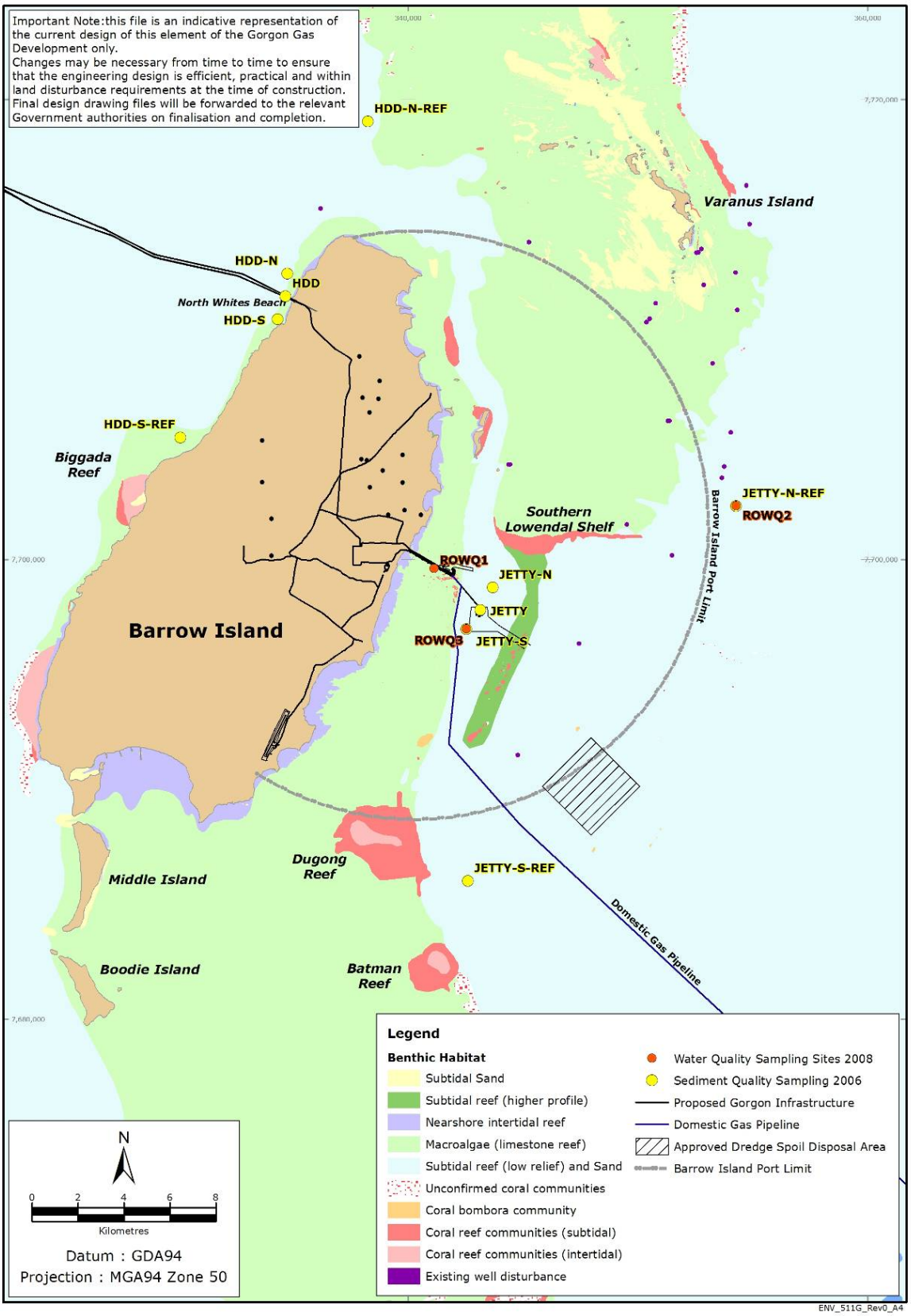

Figure 4.4: HDD and Jetty Water and Sediment Quality Sampling Sites

4.12 Marine Benthic Primary Producers

Table 4.20: Marine Benthic Primary Producers

Table 4.20		Marine Benthic Primary Producers	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
4.2	Marine Parks and Reserves Authority	We 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 Revised Proposal presents some new risks and increases the scale of others that were identified for, the Approved Development. In addressing each of the 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.	The information presented in the PER considers cumulative impacts to marine communities attributable to the Revised Proposal. Table 7.12 (p. 202) of the PER shows the areas of expected coral loss under the Approved Development and Revised Proposal scenarios – both loss estimates include impacts from dredging and the construction and preparation of infrastructure. The figures demonstrate that the predicted amount of coral loss due to the Revised Proposal has not increased from the Approved Development dredging-related loss of 22 ha. For details regarding habitat loss, refer to Section 2.2 of this document. For information regarding the assessment of cumulative risks to turtle populations refer to Table 4.3 (Item 4.2).
4.3	Marine Parks and Reserves Authority	The Revised and Expanded Proposal includes an increase in the length of the solid causeway/MOF structure from 1.3 km out to sea to 2.1 km out to sea. As was made clear in the MPRA comments on the Gorgon Gas Development EIS/ERMP, the sediment disturbance associated with such an extension is likely to have a significant effect on the local marine 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. This is likely to cause very large scale changes in the surrounding coastal and oceanic processes with unpredictable and potentially very harmful effects to the marine communities in the adjoining Marine Park.	Refer to Table 4.17 (Item 4.3) in this document, which addresses comments regarding marine water and sediment quality. In addition, it should also be noted that the coastal process modelling presented in Appendix F of the PER was undertaken by an experienced coastal modeller and reviewed by a subject matter specialist nominated by the DPI. The conclusions of the modelling supported by the peer review found: ♦ there is no significant effect on coastal processes with the MOF in place ♦ the predicted impact of the MOF on sediment transport during tropical cyclones and ambient conditions is minor and changes in sedimentation will be manageable due to the low predicted rates of sediment transport in the area ♦ the MOF is not expected to cause significant accretion or erosion of the shoreline and will not impact the extent of the beach face and its profile in terms of turtle nesting suitability.
6.14	WWF	WWF-Australia assesses the risk categories as critical and almost certain, for sedimentation impacts leading to coral mortality associated with dredging and dredge plumes, in the vicinity of the construction, and over a broader region, including marine conservation areas, in association with severe weather events such as cyclones. WWF-Australia assesses the major stressors as sedimentation of	This comment was made by the submitter in regard to the EIS/ERMP for the Approved Development; however, it has been responded to in regard to the Revised Proposal as the comments on the EIS/ERMP have been repeated by WWF in its submission on the Revised Proposal. The GJVs agree that the likelihood risk category for sedimentation impacts on corals is "almost certain" (Table 7.13 in PER). In calculating the consequence, it was assessed at the level of Minor (5)–Moderate (4)

Table 4.20		Marine Benthic Primary Producers	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
		marine benthic primary producers, and shallow benthic and coastal communities, particularly coral communities, resulting in impacts and loss of species and communities, and contamination and pollution of coral over large areas. The source of disturbance is prolonged exposure to sediments (suspended particulate and settled) from the construction of the causeway, the construction of the jetty, the dredging of nine million cubic meters of sediments for access channels, and maintenance dredging, in an areas characterised by high tidal current flows and frequent cyclones and storm swells. Sedimentation will have an almost certain major impact on marine benthic primary producers, and shallow benthic and coastal communities.	to reflect localised long-term changes that are unlikely to affect the viability of the rapidly growing taxa (5), but may affect viability in the local area of local communities based on slow growing taxa (4). The risk assessment of the impacts of dredging on benthic communities (Table 7.13 in PER) was based on the measures of likelihood and consequence listed in Tables 5.1 and 5.3 of the PER. The residual risk ranking has not changed versus the EIS/ERMP. The Revised Proposal's causeway and MOF are in essentially the same location as that of the Approved Development. For the Revised Proposal, the seaward end of the causeway and the MOF has shifted slightly to the north and their combined length has increased from approximately 1300 m to approximately 2100 m. Utilising this new design, coastal modelling was undertaken to assess the long-term impacts of the infrastructure on sedimentation and coastal processes. The environmental risks posed by the Revised Proposal are not considered by the GJVs to be greater than the risks identified for the Approved Development, for which the required environmental approvals under Part IV of the State EP Act (Statement No. 748) and the Commonwealth EPBC Act (EPBC Reference: 2003/1294) have been granted.
6.15	WWF	WWF-Australia assesses the major stressors as the physical disturbance of marine benthic primary producers and shallow benthic and coastal communities, resulting in impacts and loss of species and communities, and contamination and pollution of coral over large areas. The source of disturbance is the construction of the causeway, the construction of the jetty, the construction of access channels, and dumping grounds. Physical disturbance will have an almost certain major impact on marine benthic primary producers, and shallow benthic and coastal communities.	This comment was actually made in regard to the EIS/ERMP for the Approved Development; however, has been responded to in regard to the Revised Proposal. An additional 6.5 ha of seabed disturbance is associated with construction of the Revised Proposal's marine infrastructure in comparison to the Approved Development. The volume of dredging is anticipated to stay within the 7.6 million m^3 volume previously approved. The Revised Proposal's causeway and MOF are in essentially the same location as that for the Approved Development. For the Revised Proposal, the seaward end of the causeway and the MOF has shifted slightly to the north and their combined length has increased from approximately 1300 m to approximately 2100 m. The environmental risks posed by the Revised Proposal are not considered by the GJVs to be greater than the risks identified for the Approved Development, for which the required environmental approvals under Part IV of the State EP Act (Statement No. 748) and the Commonwealth EPBC Act (EPBC Reference: 2003/1294) have been granted.
6.16	WWF	WWF-Australia assesses the major stressors as altered coastal and nearshore currents along the eastern coast of Barrow Island, resulting in impacts and loss of species and communities, and	This comment was made by the submitter in regard to the EIS/ERMP for the Approved Development; however, it has been responded to in regard to the Revised Proposal as the comments on the EIS/ERMP have been

Table 4.20		Marine Benthic Primary Producers	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
		contamination and pollution of coral over large areas. The source of disturbance is the construction of the MOF and jetty, causing altered current regimes, and altered patterns of sedimentation. The modelling in appendices B1-6 does not adequately address this stressor. Altered coastal and nearshore currents will have an almost certain major impact on marine benthic primary producers, and shallow benthic and coastal communities.	repeated by WWF in its submission on the Revised Proposal. It should be noted that the coastal process modelling presented in PER Appendix F was undertaken by an experienced coastal modeller and reviewed by a subject matter specialist nominated by the DEC. The conclusions of the modelling supported by the peer review found: ♦ there is no significant effect on the coastal processes with the MOF in place ♦ the predicted impact of the MOF on sediment transport during tropical cyclones and ambient conditions is minor and changes in sedimentation will be manageable due to the low predicted rates of sediment transport in the area ♦ the MOF is not expected to cause significant accretion or erosion of the shoreline and will not significantly impact the extent of the beach face and its profile in terms.
9.7	DEC – Environmental Management Branch	The PER does not adequately address marine drilling, blasting and seismic requirements and their impact assessment and management. These aspects were not covered in the Approved Development and consequently not considered by the EPA at the time, and therefore constitute new risks requiring environmental impact assessment. Issue: Uncertainty of dredge modelling and impact prediction. Recommendation 6: Additional information is required on the scale, timing, location, duration and methodologies for proposed drilling and blasting activities in the marine environment for the Gorgon project, as well as predictions of risk, impact and management. Recommendation 7: Further investigation/information is required to demonstrate the relative impacts on fauna and Benthic Primary Producer Habitat (BPPH) and communities with regard to the relative environmental merits of drilling and blasting versus cutter suction dredging. Recommendation 8: Additional information is required on the changes to dredge methodology and model simulation process to allow an informed and transparent environmental assessment. Recommendation 9: A peer review of the dredge model and interpretation of the model results should be undertaken. As requested in advice to the EPA on the Revised Proposal Scoping Document (DEC 2008), the Proponent has undertaken a dredge plume modelling study. The study was completed and	Refer to Section 4.8.1 of this document, which provides a response to the key issues related to the marine drilling and blasting program. Additional information is also provided in Section 4.8.2 of this document in relation to dredging methods, the dredge model (including peer review details) and potential impacts. Information regarding the proposed CO_2 plume seismic monitoring program can be found in Section 4.8.3 of this document.

Table 4.20		Marine Benthic Primary Producers	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
		reported in Appendix E of the PER, but DEC has concerns about its methodology and accuracy. The study was requested to determine whether the changes to the development (in particular the dredging component of the marine infrastructure construction) would change the size and location of the effect zones (impact zones) from those of the Approved Development. The changes to impact zones will have important implications for the coral loss threshold calculation for the Gorgon development. The Proponent argues that one of the changes to the proposal is a reduction in the scale of marine drilling and blasting. As marine blasting and the residual environmental risk it presents were not determined for the Approved Development, a comparison cannot be made for the Revised Proposal. Drilling and blasting activities are therefore considered by DEC as an additional and new environmental impact that requires specific environmental impact assessment. The lack of information presented in the PER means DEC cannot evaluate the exposure of marine biota to risks of marine blasting or the likely effectiveness of indicative measures for the management and mitigation of such risk, In its consideration of the Approved Development, the EPA concluded that in view of the lack of information provided on the marine element of the proposed CO_2 seismic data acquisition program, further environmental impact assessment would be required before an informed assessment could be undertaken. No additional information has been submitted by the Proponent to enable the adequate assessment of risk from marine seismic activities and as such, DEC remains uncertain as to the types, scale, duration and timing of impacts and how risk associated with seismic activity adds to cumulative risk and impact predictions for key ecological receptors. There is also no investigation or discussion of the relative impacts of drilling and blasting compared to the grinding of hard rock to help determine the most effective way to minimise environmental impact, both short and long-term. Further investigation/information is required to demonstrate the relative impacts on fauna and BPPH and communities.	
9.8	DEC – Environmental Management Branch	Calculation of cumulative loss of coral and benthic primary producer habitat continues to be uncertain due to the level of detail provided in the PER, including lack of an appropriate marine habitat classification scheme and information on dredge model	A final map with a revised classification scheme (to reflect DEC comments on the EIS/ERMP) will be presented in the Coastal Marine Baseline State Environmental Impact Report (requirement of Statement No. 748). The mapping units in the PER have been maintained consistent with the

Table 4.20		Marine Benthic Primary Producers	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
		methodology. Recommendation 10: Clarity is required on the total predicted loss of coral and how the 22 hectare limit of coral loss will be ensured. Recommendation 11: The adequacy and accuracy of the calculation of BPPH and coral loss thresholds, and management and monitoring to ensure that loss of communities will remain within the Cumulative Loss Thresholds, requires validation. Further modification of the Approved Development includes the proposal to leave material dredged by the cutter suction dredge (CSD) on the seabed instead of pumping it immediately into overflowing barges to take the material to the spoil ground. The material cut and crushed by the CSD will later be picked up by the trailer suction hopper dredge (TSHD). Neither the PER nor the Dredging Simulation Study at Appendix E adequately describe the new methodology, raising questions such as: ♦ What has caused the big reduction in fines assumed to be released at the CSD cutter head (reduced from 50 per cent for the approved development, to only 30 per cent in the Revised Proposal)? And ♦ Will double handling of the material lead to additional risk of sediment deposition and turbidity? The study provides a limited understanding of the actual simulation process and there is no interpretation of results. The time series plots of sedimentation and total suspended solids (PER Figures 7.8 and 7.9, pp 195-196) are difficult to read and interpret due to their small size in the document. There are declared model deficiencies (PER Section 7.4.2.1 pp 184-185) for which subjective, nominal impact buffer areas have been included without detailed explanation as to the reasoning behind buffer size selection, particularly with respect to demonstrating impact avoidance and minimisation. Given these deficiencies, the dredge modelling study may be considered a significant flaw in the proposal. Predicting impacts According to the revised dredge plume modelling, the adjusted dredge footprint and plume are of a similar magnitude but have slightly changed location in association with the changes to the causeway, materials offloading facility, turning basin and construction methodology. The PER states that dredge volumes	categories defined in the EIS/ERMP to facilitate direct comparison of the scale of effects between the Approved Development and the Revised Proposal. Recommendation 11 was addressed in the EIS/ERMP. The methods used for calculating the loss of BPPH attributable to the Revised Proposal are the same as those used in the EIS/ERMP analysis. This approach was previously agreed to with regulatory agencies during the assessment of the EIS/ERMP. The assumptions relating to the percentage of fines released to the environment as a result of dredging operations are discussed in Section 4.8.2.2 of this document. There are no relevant published data available on the release of fines associated with the various dredge methods. The information available from dredge contractors tends to support the particular method appropriate to their equipment. In view of this, it is conservative to account for a 100% release of fines for all methods adopted in the Gorgon model, as some will be retained with the larger spoil particles. The breakdown of the distribution has been estimated by the GJVs' dredging consultant based on understanding of the process. Plots were presented to illustrate the transience of sedimentation and turbidity spikes. With regard to the monitoring of specific sites, this is unrelated to the establishment of Management Units. The 11 Management Units were established as part of the assessment of impacts on benthic primary producer habitats, as recommended under EPA Guidance Statement 29. The design of a monitoring program in consultation with the DEC and DEWHA is required under the conditions of approval for the Approved Development. A similar condition has not yet been set for the Revised Proposal, but it is assumed that the proposed monitoring program will need only minor revision to adapt it to the Revised Proposal. Baseline data collection has commenced and the monitoring program design is being finalised. This will be presented under separate cover as partial fulfilment of the existing conditions of approval. In response to Recommendation 12, the GJVs commenced coastal modelling and are committed to establishing a baseline and undertaking continuing modelling as required by Statement No. 748. The GJVs have also commenced the Coastal Stability Management and Monitoring Plan and the results will be provided to the Construction Dredging Environmental Expert Panel reporting to the Minister. In response to Recommendation 13 it should be noted that the model provides only indicative data on the extent of impacts due to dredging. To

Table 4.20		Marine Benthic Primary Producers	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
		and fines release are expected to remain the same, however, the plume shape and orientation are expected to change. Corresponding to a change in location of the plume is the potential for the communities predicted to be affected by the Approved Project to change. Discussion in the PER on the change in potential communities/habitat impacts is vague. There is no definition, description or detailed classification of marine habitat or communities in the PER. Without such information DEC cannot make an adequate assessment of the potential for impact on the marine environment. The Proponent also rates impact on BPPH and coral assemblages based on "regional significance" and size of colonies (PER Section 7.4.2.1. pp 198-199). It is considered that rating of impact in this way is subjective and underplays the actual disturbance to the marine environment. Instead, the Proponent should couch its assessment of the dredging/construction-related impacts in the context of the potential overall ecological consequences of impacts (loss through damage) predicted to arise from these activities. Calculation of cumulative loss thresholds and overall project impact prediction may be undervalued and without adequate information on the marine habitat classification used in the calculation process, DEC cannot make an assessment. Cumulative loss thresholds are reached/exceeded in several of the marine management units, however, the PER dismisses the exceedence within those particular management units because the exceedence is lower than that predicted for the Approved Development (PER Section 7.4.2.1. p 198). Impacts are also often downplayed in the PER by suggesting that the community affected/impacted is only of local significance as opposed to regional significance (PER Section 7.4.2.1. pp 198-199). While there are 11 management units, there remain other important areas that have been predicted to fall within the zone of influence, such as Dugong Reef (significant coral reef) and Bandicoot Bay (conservation area for benthic protection, mangroves and seabird habitat). Monitoring of these environmentally significant areas should be undertaken to ensure no impacts occur. The PER states a commitment to remain under the 22 hectare limit of coral loss for the entire project as required under Ministerial Statement No. 748 (for the Approved Development) and the	reduce the risk that the assessed impacts are not less than the actual impacts, conservatism is built into the model and its interpretation at multiple levels. Conservative buffers were also allowed around infrastructure such as the causeway to allow for rock roll, anchoring, shading, and edge effects – there are no data on which to base an accurate buffer. These data will be collected as part of the monitoring programs and will contribute to improving future environmental impact assessments. Recommendation 14 regarding coastal process modelling was presented in the PER Appendix F. The Coastal Modelling Barrow Island Report (RPS MetOcean 2008) has now been posted on the Gorgon Gas Development's web site (www.gorgon.com.au); additional details on the model set-up, coefficients, and assumptions are provided (refer to section 4 of the report). The report has been reviewed by an independent subject matter specialist (Damara WA Pty Ltd). This is the same consultant that DPI nominated to review the previous report authored by MetOcean Engineers (2005). Comments from the independent subject matter specialist on the Coastal Modelling Barrow Island Report (RPS MetOcean 2008) were addressed within the report to the satisfaction of the reviewer. This report concluded that: "Through inclusion of the MOF, wave protection of the shoreline is provided through a shadow zone in the lee of the MOF. The shadow zone may be of the order of approximately 45 degrees to the coastline. During the worst case (i.e. coupled spring tides, storm surge and wave setup), the inclusion of the MOF will actually prevent erosion of the shoreline rather than increase the erosion. Without the MOF in place, under these extreme conditions, a more severe local impact on the beach stability will be observed" (p. 47). The sediment model was aimed at assessing 'significant' changes that might occur to the stability of the Town Point beaches as a result of impacts from the MOF. Geotechnical investigations confirmed that there is no substantial sediment layer on the rock platform extending approximately 2 km from the shore. To model the potential for sediment transportation and to enable an assessment of change, a 300 mm layer of sand was arbitrarily imposed as an initial condition. The model does not allow sand ingress into the domain, though it does allow egress. As the rock platform is usually bare, the build-up observed on the boundary of the model is derived from the 300 mm layer arbitrarily added to the rock platform and therefore overstates reality.

Table 4.20		Marine Benthic Primary Producers	
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		Minister's determination (December 2006). However, in the calculations of coral loss based on the dredge modelling and other factors, the PER states that the predicted loss is slightly higher (22.43 hectares) (PER Section 7.4.2.1. p 202). It is not clear how this predicted loss is to be reduced to remain consistent with the 22 hectare coral loss limit. There are concerns that the calculations of BPPH and coral loss thresholds are accurate, and furthermore, that management and monitoring are adequate to ensure that loss of communities will remain within the limits prescribed by the Minister in the original approval. Issue: inadequacy of coastal process modelling – impacts on BPPH and beach profiles and associated risk and environmental impact assessment Recommendation 12: The PER itself does not adequately address impacts on beach profiles. The modelling study provided as an appendix provides more detailed and quantitative information, but is conflicting, which creates a high level of uncertainty. Further information/clarification on impacts on beach profiles is required. Recommendation 13: Model interpretation should include discussion on the risk of impacts on BPPH. Recommendation 14: Interpretation of the model in the text is inconsistent with the model outputs. It is recommended that a peer review of the model and interpretation of the model results be undertaken. The interpretation of the model results largely focuses on current speeds, shoreline accretion and erosion, and beach profiles. There is uncertainty about the potential impacts of sediment movement in the marine areas, including impacts on BPPH. The model is also limited within certain boundaries. Of particular concern, for example, is where the modelling shows up to 27.5 centimetre depth sediment accumulation for Cyclone Bobby (Appendix F Figure 3.8). The model domain extends from shore to less than half way along the solid structure, yet the highest sedimentation is shown at the seaward limit of the model. It is unclear whether this prediction is reliable or if it is an artefact of the model domain boundary ('edge effect'). The magnitude of sedimentation both inside and outside of the model domain (but still within the influence of the causeway/materials offloading facility) is uncertain, causing particular concern about areas to the north of the causeway that are further protected from prevailing	Appendix F provides quantitative information on the predicted impacts of the MOF. The conclusions of the model supported by the peer review found: ♦ the modelling program indicates that the MOF is not expected to have a significant impact on the ambient sediment transport ♦ there is no significant effect on coastal processes with the MOF in place. Eroded material during extreme events will return to the beach zone during ambient conditions in the same fashion as such material would normally find its way to the beach, without the MOF in place ♦ the predicted impact of the MOF on sediment transport during tropical cyclones and ambient conditions is minor and changes in sedimentation will be manageable due to the low predicted rates of sediment transport in the area ♦ the MOF is not expected to cause significant accretion or erosion of the shoreline and will not impact the extent of the beach face and its profile in terms of turtle nesting suitability. In regard to the submitters' concern about the boundary limitations of the model outputs, and with particular reference to Figure 3.8 in Appendix F, it should be noted that one of the aims of the GJVs in conducting this modelling was to assess the potential impacts of the coastal processes affecting the turtle nesting beaches of Barrow Island as a result of the Gorgon Gas Development marine infrastructure.

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<tr><th colspan="2">Table 4.20</th><th colspan="2">Marine Benthic Primary Producers</th></tr>
<tr><th>Item</th><th>Submission from</th><th>Submitter comment</th><th>GJVs' Response</th></tr>
<tr><td></td><td></td><td>weather by the facility.
The DEC remains uncertain of the appropriateness of model domain and results of modelling of sediment accretion and erosion predictions.</td><td></td></tr>
<tr><td>12.4</td><td>DEC – Marine Ecosystems Branch</td><td>BENTHIC HABITAT MAPPING
Benthic habitat maps in the PER show new areas of mapped coral communities and some improved resolution in terms of the types of coral communities present at some locations compared with similar maps produced for the ERMP/AIP. No report or other information has been provided with the PER that describes work done to modify the original benthic habitat maps. Accordingly, and as was the case for the ERMP/AIP, there remains a high degree of uncertainty with respect to benthic habitat surveys, the classification frameworks applied and mapping processes used for the revised and expanded proposal. Information is needed to clarify the benthic habitat mapping studies and how they were conducted.
The PER is clear that on the east coast of Barrow Is. There are coral assemblages/communities which are mapped as such and also there are corals and coral assemblages which are components of habitats that have been broadly classified as 'nearshore intertidal reef' and 'macroalgae'. The Conditions for the approved development recognise that high resolution benthic habitat mapping (particularly for corals and coral assemblages/communities) will be required in order to account for coral impacts. From the currently available information it appears unlikely that the most recent benthic habitat mapping work has been conducted to identify coral within the zones of high and moderate impact and areas in the zone of influence in sufficient detail to enable predictions of loss and impact to be thoroughly appraised in the context of limits set in the existing Conditions.
Uncertainty is compounded when data in the following table is considered. The Proponent has provided spatial data for benthic habitats, marine infrastructure and predicted zones of impact from dredging. EPA Spatial Services has analysed data supplied for the assessment of the original Gorgon proposal and the most recent data shown in the PER. All coral was grouped together and summarised to calculate areas (including areas attributed as 'unconfirmed coral').
<table>
<tr><td></td><td>High</td><td>Moderate</td><td>Total</td></tr>
</table></td><td>Changes in the boundaries of coral assemblages reflect improvements in the habitat data made possible by additional studies that have been undertaken since the release of the EIS/ERMP. The improvements in the benthic habitat map were facilitated by the acquisition of Laser Airborne Data Survey imagery, which shows the seabed features more clearly than the conventionally used aerial photography. The final baseline map with data on the extent of ground-truthing will be presented in the CMBSEIR as required under Condition 14 of Statement No. 748.
The PER used the current habitat map incorporating the latest ground-truthed data, while retaining the EIS/ERMP classification scheme for consistency. This allows for a direct comparison between the areas of loss predicted in the EIS/ERMP with those predicted in the PER.
The loss of BPPH was assessed in terms of dominant taxa (as per Guidance 29; EPA 2004) and the 'macroalgae' classification reflects the dominance of macroalgae and that coral is a minor component of that habitat type. The mapping was based on dominant community type and coral may be a minor component of the macroalgae dominated communities but not of bare sand or other invertebrate communities.

Statement No. 748 for the Approved Development prescribes the following conditions with the intent of limiting environmental impacts as a result of dredging and spoil disposal activities:
Condition 18, *The Limits of Environmental Impacts (Marine)* clearly specifies the Limits of Acceptable Change within the Zones of Impact (as defined in Schedule 5 of Statement No. 748). These limits have been set as indicators to ensure that coral mortality does not exceed 22 ha within the zones of high and moderate impact. Coral mortality is not acceptable in the zone of influence.
Condition 20, *Dredge and Spoil Disposal Management and Monitoring Plan,* has been set to ensure the Limits of Environmental Impacts, specified in Condition 18 (Table 1), are not exceeded due to the impacts of dredging or spoil disposal activities. This Condition requires GJVs to plan and implement a management and monitoring plan that prevents impacts which exceed the Limits of Acceptable Change set in Condition 18.</td></tr>
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<tr><th colspan="2">Table 4.20</th><th colspan="2">Marine Benthic Primary Producers</th></tr>
<tr><th>Item</th><th>Submission from</th><th>Submitter comment</th><th>GJVs' Response</th></tr>
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<table>
<tr><td>2006</td><td>15.8</td><td>14.2</td><td>30.0</td></tr>
<tr><td>2008</td><td>18.0</td><td>14.7</td><td>32.8</td></tr>
</table>
Why has the spatial coverage of coral habitat/communities changed between 2006 and 2008? Why has the geographic location of some mapped coral communities changed between 2006 and 2008?
Summary: there is a high degree of uncertainty with respect to benthic habitat surveys, the classification frameworks applied and mapping processes used for the revised and expanded proposal. In general terms, the sources of uncertainty are the same as those identified during the assessment of the original proposal.</td><td></td></tr>
<tr><td>12.5a</td><td>DEC – Marine Ecosystems Branch</td><td>Numerical modelling of pressure fields associated with construction
A range of significant concerns were raised during the assessment of the original proposal that the dredge log used to inform turbidity plume modelling was not consistent with how the Proponent actually proposed to carry out dredging as a base case. Specifically, the modelling incorporated a management scenario which was not intended as part of the base case dredging methodology (limiting barge overflow transferring more fines to the spoil ground). Examples below illustrate that similar concerns arise in relation to the revised and expanded proposal.
The 'base case' dredging methodology for the revised and expanded proposal is very different to what was simulated in the ERMP/AIP. The Proponent has re-modelled dredge plume dispersion and fate and a report is supplied in Appendix E (GEMS 2008).
Appendix E is skeletal at best, making it very difficult to understand the revised dredging process and how associated pressures have been modelled. Moreover, Appendix E is not a stand alone document and therefore needs to be considered in the context of a number of other documents prepared previously by and for the Proponent.
Despite the paucity of the information supplied in the PER and Appendix E, some fundamental sources of uncertainty have been identified.
For example, concern was expressed during the original assessment about fines source data that was used as input to the modelling. It was understood at the time that the fines data used for Barrow Is was sourced from dredging in different geotechnical</td><td>Limiting barge overflow is, and has always been, included in the Gorgon Gas Development's dredge plume model since this procedure is part of the proposed work method to minimise impacts.
Refer to Section 4.8.1 of this document which provides a response to the key issues related to the marine drilling and blasting program. Additional information is also provided in Section 4.8.2 of this document in relation to dredging methods, the dredge model and potential impacts.
The Particle Size Distribution (PSD) for the natural sediments was obtained from sediment samples taken within the proposed dredge area. Without any previous dredging adjacent to Barrow Island, there are no data available on the PSD of cut material for the proposed work site area.
It has been suggested by the DEC that the GJVs grind up drill cores to approximate the action of the cutter suction dredge and then analyse the resulting PSD. During dredging, only part of the material is cut while the remainder is broken out by the mechanical action of the rotating cutter head. The grinding of a 90 mm diameter core in a laboratory would provide a very poor representation of the action of the cutter head which is in the order of 2 m in diameter comprising numerous teeth. Therefore, the model used results from the Geraldton Port dredging program, as these constitute the best available data and a more accurate representation of what could occur than the ground drill cores.</td></tr>
</table>

Table 4.20		Marine Benthic Primary Producers	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
		conditions at Geraldton. During review of the PER, it has been noted that Section 2.3.4 of "Document C" (RPS BBG, March 2006, prepared as part of the AIP associated with the ERMP) describes a procedure for determining the settlement characteristics of particles likely to be produced by dredging at Barrow Island. This section goes on to describe a laboratory test to be employed using material from geotechnical cores obtained from Barrow Is. To better understand particle settlement behaviour. It is understood that geotechnical and geophysical studies have been completed for the areas to be dredged. If the particle settlement testing referred to above has not been undertaken, could the Proponent please explain why this is so, given the concerns raised during the EPA's assessment of the original proposal and that 30 months that have passed since release of Document C.	
12.5b	DEC – Marine Ecosystems Branch	Appendix E: Section 2. Approach to Modelling For the LNG channel, the dredging strategy has been revised from the original proposal such that the current proposal is to use a Cutter Suction Dredge (CSD) to cut/crush the harder material and leave it in-situ. A Trailer Suction Hopper Dredge (TSHD) would come along later to remove this material and transfer it to the spoil ground. The primary assumption about what percentage of the total dredged material mass is converted to fines (< 75 µm) is not stated in Appendix E. This percentage has been assumed at 5% in previous 'base case' modelling but there is no justification and no certainty about this. Sensitivity tests have shown that if the fines comprised 10% of the total dredged material then the impact zones would be much larger. There is also uncertainty about what percentage of the total dredged material is hard rock and what percentage are sands.	Refer to Section 4.8.2.3 of this document, which provides a response to the issues related to the particle fines expected to be released given the revised dredging methodologies. The GJVs have included a 100% release of the fines in the modelling approach so that the model is not sensitive to the relative distribution of fines. In reality, a significant portion of the fines will be locked into the reclamation site and the disposal site. The relative percentages of rock compared to sand that are anticipated in the dredge material are included in the GEMS (2008) report Appendix E of the PER (40% cut rock, 60% sediments).
12.5c	DEC – Marine Ecosystems Branch	It is also noted that in a briefing to the EPA on 30 October 2008, the Proponent advised that "if hard rock is encountered the cutting rate decreases and the production of finer material increases". This view is contrary to an earlier position the Proponent presented to the EPA to support its contention that fines production rates used in modelling were conservative (letter from Colin Beckett dated 5 May 2006). In the letter, Chevron presented a view that the stronger/harder material that is to be dredged would be more likely to shear and stay intact rather than being ground in to fines. The contemporary view (30 October 2008) on fines production	The information that is being compared has been taken out of context. The briefing to the EPA on 30 October 2008 described how a decision would be made to cease the cutter suction dredge and implement drilling and blasting. If the material is so hard that the cutter suction dredge cannot progress, it is reasonable to assume that constant grinding without being able to break-up the rock will result in increased fines generation. The letter from Chevron Australia dated 5 May 2006 was commenting on the relative differences between the rock at Geraldton and that found at Barrow Island. The conservatism that has been built into the model is that 100% of the

Table 4.20		Marine Benthic Primary Producers	
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		from dredging hard material raises questions about the claimed conservatism of fines production used in modelling.	fines material is released into suspension. In reality, a significant portion of the fines will be locked into the reclamation site and the disposal site.
12.5d	DEC – Marine Ecosystems Branch	The assumed allocation of fines released from various sources (e.g. at CSD cutter head, placing the cut/crushed material on the seabed, the follow-up TSHD operations and dumping at spoil ground) are given as percentages. The mass of fines released from a particular source is the product of the source allocation percentage and the total fines generated percentage of the total dredged material at a given time step in the dredging (e.g. 30% x (5% x mass of dredged material)). There is no justification provided or certainty for these source allocation percentages (other than that they have been estimated in consultation with Baggermans). During a telephone discussion with G. Prior, MEB has sought a response from Chevron in relation to this issue. A response had not been received at the time these comments were compiled. Once a response is received, further dialogue with the Proponent may be necessary. No model sensitivity analysis for the source allocation percentages has been given. Given the uncertainty about these assumptions it cannot be argued that they are conservative.	Refer to Section 4.8.2.2 of this document, which provides a response to the issues related to the setting of values for fines release. It should be noted that as there is some uncertainty associated with these values, conservatism was built into the model, with incorporation of an assumption that 100% of the fines material is released into suspension. In reality, a significant portion of the fines will be confined to the reclamation site and the disposal site. The GJVs have included a 100% release of the fines in the modelling approach so that the model is not sensitive to the relative distribution of fines.
12.5e	DEC – Marine Ecosystems Branch	It is also unclear if the pick-up and overflow by the TSHD has been represented as two (or possibly three) sources (i.e. seabed pick up, propeller wash and hopper overflow). It is noted that only one percentage (30%) is given. No characterisation of particle size distribution used for the modelling is given in this report. Furthermore, Appendix E does not set out the particle settling velocities used in the Gorgon simulation, neither does it state the basis on which these settling rates were derived these details are not found in the EIS/ERMP documentation (Also see earlier comments regarding the sediment particle settlement studies committed to by Chevron in Document C of the AIP but as yet no completed).	Section 4.8.2.2 of this document provides information on the breakdown of values for the Trailer Hopper Suction Dredge (TSHD) that were incorporated into the model. This information indicates that for different methodologies, the breakdown of the sources varies; however, it shows that different aspects of the TSHD, such as overflow and pick-up, warrant distinct values. Refer to Section 4.8.2.3 of this document, which provides a response to the issues related to fines distribution, including settling rates.
12.5f	DEC – Marine Ecosystems Branch	RPS BBG (Document C, March, 2006) states that "in the current modelling, LAPS data rather than Barrow Island observations were used to represent the meteorology, as the LAPS data represent the winds over the region far better than the single point Barrow Island". In principle it is agreed that forcing the hydrodynamic model with accurate wind data that incorporates spatial variability across the region is a superior approach to wind forcing the model with data derived from one point. However, the question still	The regional wind patterns are more useful for modelling the wind forcing of surface currents in a hydrodynamic model. The sensitivity analysis presented in the EIS/ERMP indicated that wind forcing did not contribute greatly to the predicted areas of impact. The shorter dredge schedule noted in Appendix E of the PER is correct and reflects the two years of project design development between 2006 and 2008.

Table 4.20		Marine Benthic Primary Producers	
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		remains as to whether the LAPS winds do provide an accurate representation of the surface winds. This question should be addressed by comparing directly measured winds with the LAPS winds derived for the points of measurement. This should be done over different seasons throughout the year to establish degree of correlation and statistical measures of error. There seems to be confusion about whether the anticipated dredging period is 13 months (Appendix E) or 16 months (RPS BBG, March 2006).	
12.5g	DEC – Marine Ecosystems Branch	Appendix E states that the wave model SWAN, driven by MESOLAPS winds, was used to provide orbital velocities for resuspension calculations. It is not clear whether this was done for previous simulations for the draft EIS/ERMP or the "final ERMP". Furthermore, there is no evidence that the SWAN model has been validated against local wave measurements off Barrow Island for different seasons of the year. There appears to be no documentation of the SWAN model implementation (domain, resolution, bathymetry, forcing, etc.) for the Gorgon, Barrow Island application.	The dredge plume simulations for the Approved Development did not include the SWAN wave model; waves and hence re-suspension velocities were derived from short-fetch algorithms based on winds. The SWAN wave model was used in the PER modelling to better account for the irregular waves that characterise coastal environments. The SWAN wave model is based on winds, bathymetry, deep water waters, currents and tides. SWAN was used partly for determining operability constraints on the Cutter Suction Dredge (CSD) and partly in response to a DEC request for better representation of the nearshore wave climate.
12.5h	DEC – Marine Ecosystems Branch	Appendix E: Section 3. Dredge Program Simulations Section 3.1 indicates that a Revised Dredge Plan used to develop modelling scenarios comprises (a) MOF further offshore; (b) MOF dredging prior to causeway construction – dredging of MOF with CSD loading hopper barges; (c) dredging of deeper parts of LNG channel with CSD and leaving on seabed till picked up by TSHD. The drilling and blasting program is anticipated to assist in the removal of up to approximately 50 000m^3 of hard rock at the western end of the revised MOF Access Channel. This volume can not be more accurately predicted for this PER and will ultimately be determined by the Dredge Contractor based on the in-situ findings during dredging (Revised Main, Section 2.4). The estimate of hard rock volume to be blasted/drilled/dredged in revised MOF channel is very rough – this leaves corresponding uncertainty in the amount of material to be dredged. No estimates have been given of the fines yield from the material that is to be drilled or blasted.	As was the case for the Approved Development, the Revised Proposal does not anticipate significant quantities of marine drilling and blasting. Consistent with the EIS/ERMP, the PER includes a nominal quantity (50 000 m^3) to account for limited drill and blast work should unforeseen geotechnical conditions arise. This is based on much more detailed studies than were available at the time of the EIS/ERMP. In positioning the MOF, the GJVs have used the most advanced 3D geophysical modelling available to avoid unnecessary drilling and blasting. Positioning the MOF is a trade off between increasing the MOF length even further or increasing the risk of drill and blast. Outputs from the 3D geophysical model was presented to the DEC during the briefing to the EPA Board on 30 October 2008. Blasting is expected to create less fine particles than the action of the cutter head to remove an equivalent volume of rock. The shock waves from blasting tend to fracture rock into larger pieces that can then be picked up with a backhoe. The larger pieces reduce the amount of handling and the amount of fines released. This adds to the conservatism of the estimates provided as the model assumes 100% of the fines released irrespective of the dredge method used. In reality, a significant portion of the fines will be locked into the reclamation site and the disposal site.

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12.5i	DEC – Marine Ecosystems Branch	MEB has sought responses from Chevron as to how long material cut and crushed by the CSD in the LNG access channel will be left on the seabed before a TSHD comes along to collect it and whether there is potential for loss of fines during this period?	The length of time the material cut by the CSD remains on the seabed (ranging from days to months) is an operational decision determined in the field (taking into account the dredge spread and conditions). In general, the material in the MOF area is likely to be excavated relatively soon after its placement as the progress of the CSD will be delayed by the presence of this material. In the deeper LNG access channel area, the time that the cut material will remain on the seabed may be longer as the CSD and TSHD will not be working simultaneously in the same location. The model incorporates a conservative approach and assumes 100% of the fines will be released into suspension within the dredge and disposal cycle in order to accommodate release scenarios.
12.5j	DEC – Marine Ecosystems Branch	Section 3.2 Development of Dredge Logs No sample dredge log included for LNG channel. Section 3.3 Modelling Assumptions There are numerous inconsistencies with respect to fines generation inputs to modelling which are sources of uncertainty with respect to impact prediction. The Table below illustrates examples where fines source allocation for the same activity varies between documents. Why do variables linked to the same process in the same location (e.g. CSD dredging of the MOF) change between different modelling studies and between different pieces of documentation prepared to inform EIA for the same proposal?	The PER (Appendix E) provides a sample dredge log for the MOF channel. The dredge log for the LNG channel has been completed to a similar level of detail, taking into account separate operations for the CSD and the TSHD. There is no inconsistency in the percentages documented in the table provided to DEC. The figures are only different when they refer to different work methods. Different work methods are used for different locations due to limitations on the draught of vessels, material strength, spoil location and reclamation requirements.

<table>
<tr><th colspan="2">Table 4.20</th><th colspan="2">Marine Benthic Primary Producers</th></tr>
<tr><th>Item</th><th>Submission from</th><th>Submitter comment</th><th>GJVs' Response</th></tr>
<tr><td></td><td></td><td>
<table>
<tr><th>Modelling for ERMP Document C (RPS BBG, March 2006)</th><th>Modelling for PER Appendix E (GEMS, July 2008)</th><th>PER Document Figure 7.4 (September 2008)</th></tr>
<tr><td>Release of fines allocated as follows:

LNG channel: 40% fines at CSD cutter head; 40% at hopper barge overflow; 20 % released at the spoil ground

MOF channel: 40% at the CSD cutter head; 40% from 'dewatering'; 20% to be retained inside the MOF</td><td>Release of fines allocated as follows:

LNG channel: 30% at CSD cutter head; 20% when deposited on seabed; 30% when picked up by TSHD; 20% released at spoil ground

MOF channel: 50% at CSD cutter head; 50% tailwater discharge.</td><td>Release of fines allocated as follows:

LNG channel: 30% at CSD cutter head; 20% when deposited on seabed; 30% when picked up by TSHD; 20% released at spoil ground

MOF channel: 40% at CSD cutter head; 40% at hopper barge overflow; 20 % released at the spoil ground</td></tr>
</table>
</td><td></td></tr>
<tr><td>12.5k</td><td>DEC – Marine Ecosystems Branch</td><td>Section 3.3.1 MOF
GEMS (July 2008) sets out fifteen assumptions (in dot points) used to construct the dredge log for model simulations of the MOF dredging. This set of assumptions is compared with a corresponding assumption set taken from Document C of the AIP (March 2006) and the differences between the assumptions used are shown in the following Table.

<table>
<tr><th>Document C (RPSBBG, March 2006)</th><th>Appendix E (GEMS, July 2008)</th></tr>
<tr><td>A bund wall in the MOF outline will be filled with dredge spoil pumped directly</td><td>Dredging of the MOF will be achieved by CSD loading directly to self-propelled</td></tr>
</table>
</td><td>Modelling is an indicative tool and has been used to set conservative boundaries of effect that the GJVs have committed to achieving in order to constrain impacts through the management of dredge operations. The similarity in the size of the dredging zones defined in the EIS/ERMP (Approved Development) and the PER (Revised Proposal) indicate that the small changes will have a negligible effect on the outcome of the modelling.
There has been some design development and changes in proposed work methods since the EIS/ERMP was issued. Some of the extracts of documents are presented out of context and inappropriately attempt to compare values from the range of different dredge methods proposed for the Gorgon Gas Development.
Based on the latest Development design and proposed methodologies, further detail on the issues associated with the marine drilling and blasting</td></tr>
</table>

<table>
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<tr><td></td><td></td><td colspan="2">
<table>
<tr><td>from the CSD</td><td>hopper barges for offshore spoil disposal</td></tr>
<tr><td>The rock is believed to be slightly harder on average than that encountered at Geraldton and may create more fines during CSD operations</td><td>The characteristics of the spoil are anticipated to be similar to that generated at Geraldton</td></tr>
<tr><td>It is assumed that 5% of total materials cut will be smaller than 75 microns diameter and that the distribution of these sizes will be similar to Geraldton</td><td>It is assumed that 5% of total materials cut will be smaller than 100 microns diameter and that the distribution of these sizes will be similar to Geraldton</td></tr>
<tr><td>40% of fines released at cutter head, 40% from dewatering discharge from the MOF, 20% retained inside MOF bund</td><td>50% of fines released from cutter suction head, 50 % from tailwater discharge</td></tr>
<tr><td></td><td>Dredging simulations commence September and last 13 months</td></tr>
</table>
Uncertainties arising that warrant the Proponent's response include:
♦ 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 of model predictions to these percentage allocations has not been tested
♦ No information is supplied in relation to fines liberation at the spoil disposal site for MOF dredging.
Further, Appendix E suggests that MOF dredging was simulated based on the use of a jumbo CSD. Based on advice from Chevron (G. Prior pers. comm.), MEB understands that a methodology for MOF dredging has not been selected but preference is leaning towards a method similar to that outlined for the LNG access channel in Appendix E (CSD cut with later pick up by TSHD). This</td><td>program and dredging-related impacts (including methods of dredging and details regarding the dredge model [including peer review of the model] have been included in Section 4.8.2.1 of this document).</td></tr>
</table>

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<tr><th>Item</th><th>Submission from</th><th>Submitter comment</th><th>GJVs' Response</th></tr>
<tr><td></td><td></td><td>MOF dredging to the contemporary/preferred methodology.
Section 3.3.2 LNG Access Channel
Appendix E sets out assumptions (in dot points) in relation to the dredge log for model simulations of the LNG Access Channel dredging. This set of assumptions is compared with a corresponding set of assumptions taken from Document C of the AIP (RPS BBG, March, 2006) and the differences between assumptions used are shown in the following Table.
<table>
<tr><td>Document C (RPS BBG, March 2006)</td><td>Appendix E (GEMS, July 2008)</td></tr>
<tr><td>Use of a TSHD and CSD</td><td></td></tr>
<tr><td>Harder material removed by large CSD pumping directly into hopper barge (2) that will transport material to spoil ground</td><td>Cut and crush rock with CSD and leave on channel bottom; remove crushed rock with a TSHD</td></tr>
<tr><td>Release of fines allocated as follows: 40% fines at CSD cutter head; 40% at hopper barge overflow; 20 % released at the spoil ground</td><td>Release of fines allocated as follows: 30% at CSD cutter head; 20% when deposited on seabed; 30% when picked up (and transported to spoil ground?); 20% released at spoil ground</td></tr>
<tr><td></td><td>"When loading the THSD progressively shaves thin layers off the surface of the seafloor generally penetrating 0.10 to 0.5 in situ density of the material" - what does this mean???</td></tr>
</table></td><td></td></tr>
<tr><td>12.5l</td><td>DEC – Marine Ecosystems Branch</td><td>Concerns arising that warrant a Proponent response include:
No information has been given for the laboratory analyses of field samples of "sands" to be dredged by the TSHD.</td><td>Table 4.14 in Section 4.8.2.3 of this document presents the results of laboratory testing of the natural sediments.</td></tr>
<tr><td>12.5m</td><td>DEC – Marine Ecosystems Branch</td><td>Why would the percentage of fines released at CSD cutter head vary between MOF (50%) and LNG access (30%) dredging and also between the different modelling studies (50% in the ERMP, 40% in Document C, 30-50% in Appendix E, 30/40% in the PER)? To clarify this point, there are two options for dredging. Both require the use of a CSD, however, fines allocation from the CSD</td><td>Refer to Section 4.8.2.3 of this document, which provides a response to the issues related to fines distribution.</td></tr>
</table>

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		cutter head differs between modelling studies and other EIA documents from 30% -50%.	
12.5n	DEC – Marine Ecosystems Branch	For the LNG access channel, it is not clear what percentage of the dredged material is hard and to be cut/crushed by the CSD (producing fines) and what percentages are sands.	The relative percentages of the geotechnical qualities of the dredge material are included in the GEMS report, which is Appendix E of the PER (40% cut rock, 60% sediments). Refer to Section 4.8.2.3 of this document, which provides a response to the issues related to fines distribution. The PSD table indicates that fines will be generated from both the CSD rock cutting (approximately 15%) and the TSHD removal of natural sediments (approximately 11%).
12.5o	DEC – Marine Ecosystems Branch	The 5 % fines assumption for material cut by the CSD appears to have no basis in local Barrow Island data.	Refer to Section 4.8.2.3 of this document, which provides a response to the issues related to fines distribution.
12.5p	DEC – Marine Ecosystems Branch	The percentage source allocations for fines has not been justified and no sensitivity analyses of this aspect appear to have been carried out.	Refer to Section 4.8.2.2 of this document, which provides a response to the issues related to the release of fines. A 100% release of fines has been included in the Gorgon Gas Development's model so that the modelling is not sensitive to the relative distribution of fines.
12.5q	DEC – Marine Ecosystems Branch	Section 3.4 Simulation of the Base Case Sample dredge logs for the simulated dredging of the access channel have not been included in the report.	The PER (Appendix E) provides a sample dredge log for the MOF channel. The dredge log for the LNG channel has been completed to a similar level of detail, taking into account separate operations for the CSD and the TSHD.
12.5r	DEC – Marine Ecosystems Branch	Section 4. Results Section 4.1 Turbidity and Sedimentation Impact Zone Analysis MEB has sought a written response from Chevron to queries relating to the interpretation of model output data. The email to Chevron is attached. A response had not been received when this advice was prepared. Once a response is received, further dialogue with the Proponent may be necessary. Many questions and uncertainties surround: ♦ the use of TSS and sedimentation as surrogates for stress leading to ecological impact; ♦ the inclusion only of dredge-induced levels of suspended sediment and sediment deposition rates and the failure to include background levels in the modelling, and estimation of cumulative stress for comparison with the threshold criteria; ♦ representation of the combined synergistic effects of light reduction and direct effects of exposure to sediment particles;	TSS and sedimentation are considered suitable surrogates for evaluating effects on ecological stressors because they represent the main mechanisms by which the dredging will affect the ecosystem. Recent examples of projects approved by the Minister for the Environment that had a requirement for water quality monitoring with the objective of establishing a link or relationship between water quality (turbidity and/or sediment deposition) and coral health (or benthic biota health) include: ♦ Dredging Program Cape Lambert Port Upgrade (Robe River Iron Associates) Statement No. 743 (12/07/2007), Condition 8-1 ♦ Pluto LNG Development, Burrup Peninsula (Woodside Energy Ltd) Statement No. 757 (24/12/2007), Schedule 4 (2) 5 ♦ Dredging Program Dampier Port Upgrade to a Throughput Capacity of 120 Million Tonnes Per Annum (Hamersley Iron Pty Ltd) Statement No. 731 (22/12/2006), Condition 8-1. GEMS, who completed the modelling for the Gorgon Gas Development, also conducted the modelling for the Cape Lambert Port Upgrade and

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		♦ why the Proponent has used 3 discrete pairs of intensity and duration rather than all combinations of these variables along a curve in impact prediction; ♦ how a TSS criterion that is intended as a surrogate for light reduction could be applied independently of the water depth of the biological receptor it is intended to apply to; ♦ why sedimentation alone (rather than the sum of all particle fluxes from all directions past the biological receptor) is taken as a measure of stress. Does this properly account for issues around energy expenditure of the biota to clear itself of sediment and to tolerate effects such as abrasion?	Dampier Port Upgrade using similar methodologies. The methods used in the PER for predicting the effects of dredge plumes on the receiving environment were the same as those agreed upon during discussions with the DEC, leading to the approval of the EIS/ERMP. To maintain consistency in approach, thereby allowing comparison between the Approved Development and the Revised Proposal, these parameters were not varied. Additional information can be found in Section 4.8.2 of this document.
12.5s	DEC – Marine Ecosystems Branch	The recovery of most BPP and BPPH within 2 to 5 years (e.g. sensitive corals) makes a large and untested assumption that patterns of recruitment and post-recruitment survival in corals and BPP will be maintained over that period.	The two to five year time frame for recovery of fast growing macrophytes is considered conservative. Observations from other sites (refer to Section 11.4 of the EIS/ERMP) indicate colonisation of denuded bare rock to occur within one to two years. Additional time allows dispersion to occur through re-suspension during storms or the settling of fines particles coatings on the substrate.
12.5t	DEC – Marine Ecosystems Branch	Figure 4.3 illustrates the geographical locations of the time-series. The zones of impact should have been included on this figure.	There is no Figure 4.3 in the PER. Figure 7.8 shows the time-series plot locations. Figure 7.6 provides a geographical representation of where these sample points are located. This figure includes the zones of impact.
12.5u	DEC – Marine Ecosystems Branch	In simple terms, dredge modelling presented in Document C and the PER are similar in that both modelling exercises assume the 20% of fines are liberated at the spoil ground (at least for the MOF in the PER). However, the two sets of predicted boundaries for zones of high and moderate impact and zone of influence differ significantly. Why is this so? Unfortunately, the documentation supplied is not sufficiently clear or detailed to understand why the two prediction scenarios differ and therefore an informed assessment can not be made at present.	The major changes to the dredge plume modelling presented in the EIS/ERMP are: ♦ location of the MOF further from the coast, resulting in a longer causeway and a shorter access channel to the MOF ♦ development of the MOF prior to the causeway joining it to the land thus allowing much better flushing during construction ♦ the dredging of the deeper parts of the LNG access channel with a CSD and leaving the material on the seabed instead of using overflowing barges to take the material to the spoil ground. The material cut and crushed by the CSD is picked up later from the seabed by the TSHD. A further significant change in the updated plume modelling is the greater detail included in the dredge logs. This has introduced a much more detailed representation of dredging behaviour to the simulation process that now reflects a cut-by-cut approach to the dredge logs along defined paths rather than the original approach where a particular volume was dredged from a sector of the channel in a given time.

Table 4.20		Marine Benthic Primary Producers	
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12.5v	DEC – Marine Ecosystems Branch	On Page 70 of the PER: "Reductions in light at the seabed are also caused by increases in suspended sediment in the water column, which result from seabed disturbance and the re-suspension of sediment by cyclones and terrestrial run-off. These events are infrequent, and in all but the shallowest areas, are associated with wave re-suspension of the sediments rather than by tidal flow (RPS BBG 2006h)". And then on Page 193 of the PER: "Declines in sediment concentrations over time indicate that a greater proportion of sediment is resuspended than is settling during each 24 hour period, reducing the overall prediction of bottom sediment load". It is somewhat difficult to reconcile these two passages as the first presumably refers to resuspension of the natural sediments in the area and the second relates to resuspension of dredging-related fines. To reduce uncertainty, the Proponent will need to produce empirical data supporting the first passage, demonstrate validation of the resuspension algorithms used in the modelling and then use these pieces of information to reconcile the passages.	The first statement refers to the main processes that result in the re-suspension of sediment and therefore increased turbidity. It states that these processes occur quite infrequently and are primarily driven by wave action. The increase referred to is in relation to turbidity. The second statement deals with the amount of sediment re-entering the system primarily in the context of the overall sediment load of the system. The decrease referred to is in relation to sedimentation. The two statements are not directly comparable.
12.5w	DEC – Marine Ecosystems Branch	Summary: there are significant uncertainties associated with numerical modelling applied to inform environmental impact prediction. Sources of uncertainty include difficulty reconciling modelling dredging scenarios with the actual proposed base case methodology, lack of clarity around interpretation of model outputs, lack of justification for selecting critical parameters that influence model outputs (e.g. fines source generation), and technical detail of the model itself and algorithms applied to represent key processes.	The main driver in maintaining consistency with the model parameters and internal algorithms was to enable comparison between the Approved Development and the Revised Proposal, given the changes that have occurred in location, volume and dredge logs. The models used in predicting the dredge plume behaviour were discussed and justified at length during the EIS/ERMP approval process. The GEMS dredging model has been used for other projects in Western Australia including the Cape Lambert Port Upgrade, Port Hedland RGP5, Geraldton Port Redevelopment and Dampier Port Authority and Hamersley Iron Port Expansion. The GJVs are committed to managing its dredging operations associated with the Revised Proposal to restrict the loss of coral communities to no more than the approved area of coral loss specified for the Approval Development (22 ha).
12.6	DEC – Marine Ecosystems Branch	Proponent's impact prediction framework – Benthic habitats MEB reiterates concerns it raised during the assessment of the original proposal about the scientific and ecological basis for 'coral health thresholds' applied in the Proponent's impact prediction framework. The same thresholds have been applied for impact prediction in the PER. In Table 7.9 of the PER, *Acropora* "thickets" are selected to represent a "sensitive but fast growing" key receptor. Considering	The coral health thresholds are considered to be conservative and in the absence of quantitative data to the contrary are therefore still applicable to the situation in the vicinity of Barrow Island. The 'assessment framework' (interpretation of coral impacts) has not changed since the EIS/ERMP approval. The concept of a 'key receptor' is that it is the main reason why an additional category (Table 7.9) was added; i.e. because it is expected to respond differently (to the other key receptors of the same habitat type – Table 7.9) to the stressors associated with dredging. *Acropora* thickets are expected to respond

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		the: ♦ context of the original assessment where *Acropora* was selected by the Proponent as the surrogate for the array of other coral and non-coral BPP receptors considered to be sensitive to pressures associated with dredging. It was predicted that there would be up to 100% mortality of sensitive corals and other BPP receptors within the predicted boundaries of the high and moderate impact zones; and ♦ overarching intent of the original conditions to limit the overall extent and severity of coral mortality in the high and moderate impact zones, it is inappropriate to now modify the assessment framework by selecting *Acropora* "thickets" as a sole sensitive receptor. *Acropora* thickets are probably not (well) represented within the moderate impact zone where it is critical the framework is properly applied. It is clear from numerous statements in the PER that *Acropora* colonies and assemblages and other sensitive corals and BPP receptors do occur, and in some cases are abundant, within these zones. It is unclear whether the Proponent's benthic habitat mapping has been conducted with sufficient resolution to enable the revised and expanded proposal to be appraised against existing Ministerial Conditions relating to coral loss.	similarly to small *Acropora* colonies and other sensitive coral taxa. The benthic habitat mapping is currently being completed and will be released in the Coastal and Marine Baseline State and Environmental Impact Report as required under Statement No.748.
12.13	DEC – Marine Ecosystems Branch	Page 150: "The realignment of the LNG berth and turning basin under the Revised Proposal will result in additional disturbance of subtidal reef (low relief) and sand benthic habitat. Some areas of this habitat support the growth of sea pens, part of the preferred diet of the Flatback Turtle. However, this habitat type is widespread across the east coast of Barrow Island and the region in general (DEC 2007)". There is no reference in DEC (2007) to sea pen communities within a subtidal reef (low relief) and sand benthic habitat. The PER tends to downplay the potential for local sea pen communities to be an important food resource for Flatback Turtles during the times they spend around Barrow Island.	Reference to the document (DEC 2007) relates to the distribution of these habitats (sand and low relief reef) in the region rather than the occurrence of sea pen communities within a certain type of habitat. This was correctly cited in the PER. As stated in Section 7.1.2 of the PER, the loss of the macroalgae dominant limestone reef area due to the construction of the Revised Proposal's causeway and MOF will not significantly reduce the feeding and pre-nesting areas for turtles as this habitat type is extensive in the region. In addition, while there is some evidence of resident Flatback Turtles in the area, the majority of which have been satellite-tracked to move away from Barrow Island waters during the non-breeding season to forage (Pendoley Environmental 2006a, 2006b, 2008).

4.13 Quarantine

Table 4.21: Quarantine

Table 4.21		Quarantine	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
2.10	Conservation Council of Western Australia	Quarantine risk, already judged by the EPA to be unacceptably high, is increased directly by the increased construction period and increased movement of materials. It is also increased indirectly by the increased pressure on the project due to the changing financial situation that has led to the additional LNG train being included in the initial construction phase.	In Bulletin 1221, the EPA expressed concern about quarantine management; however, subsequent to the release of Bulletin 1221, additional quarantine-related information was provided. This information was considered by the Minister for Environment in determination of the Appeals. The Minister subsequently approved the Approved Development in accordance with the EP Act with conditions addressing quarantine and other EPA concerns, including the establishment of a Quarantine Expert Panel (Condition 9 of Statement No. 748) which will provide advice on Development related terrestrial and marine quarantine matters. The Quarantine Management System has been designed to be scalable to accommodate changes; and therefore, the quarantine risks posed by the Revised Proposal are no greater than the risks identified for the Approved Development because the mitigation measures will be appropriately adapted.
7.6	Cape Conservation Group	Quarantine risk, already judged by the EPA to be unacceptably high, is increased directly by the longer construction period and indirectly by the increased pressure on the project due to the changing financial situation that has led to this proposal being included in the initial construction phase.	
4.7	Marine Parks and Reserves Authority	The expansion of the facility will lead to substantially increased vessel traffic both during the construction phase and subsequently during the operations phase. This has the potential to expose the area to a greater risk of introduced marine pests, accidental spillages and ballast water effects.	The Quarantine Management System gives substantial attention to the risks posed to the marine environment as a result of vessel traffic. The risk-based quarantine assessment method applies to the identified potential pathways of introduction and has been the subject of consultation with the Quarantine Expert Panel (QEP), marine experts and the public. Risk was assessed qualitatively and thus independently of the frequency of vessel movement. Every shipment is dealt with in the same manner, implementing the same safeguards, procedurally and through specification (e.g. inspection and anti-fouling precautions) to arrive at a residual risk per vessel movement. In qualitative risk assessment methodology, there is no accumulation of risk. The risk of an introduction remains the same for the first vessel movement as it does for the last vessel movement. No new pathways will be introduced as a result of the Revised Proposal, with marine pests being dealt with under the Quarantine Management System. The Quarantine Management System has been designed to be scalable to accommodate changes. The barriers in place at each step of the modules progression 'down the pathway' perform a predetermined function independent of how many modules are still to follow. The barriers in place for the Gorgon Gas Development are of such a nature that the pathway always incorporates the conservative case. This resulted in a system of barriers that are fit-for-purpose meaning the Development can

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			increase or decrease the intensity of each transaction depending on circumstances. This was needed due to variations in seasons, module construction locations, transit conditions, and number of modules depending on the final module construction philosophy, etc. For instance, the effect of mandatory residual insecticide on surfaces is the same for every module as it is the concentration of the chemical that is specified not whether it gets applied on not. The effect of sealing pipe-ends has the same outcome independent of the number of pipe ends. And so on for control panels, fin fan covers, etc. There are no less than five inspections that ensure modules are shipped compliant, every time for every module. This ensures that when a module is inspected and certified compliant the risk profile of all modules remain within the same risk category. Under this system, modules with differing risk profiles will not be grouped together into new categories. Such an approach would change the risk profile which is clearly not the Gorgon Gas Development's approach. However, when same profile modules are considered collectively, the profile has to be accepted as within the limits of the individual boundaries. Lastly, each module that is offloaded at Barrow Island is again contained in a Quarantine Approved Premises (QAP), scrutinised and remediated if necessary before release. This results in a low risk for the entire module scope of work. Therefore, the quarantine risks posed by the Revised Proposal are no greater than the risks identified for the Approved Development because the mitigation measures will be appropriately adapted.
5.8	Department of Health	The description of the quarantine management system in the PER is fairly general/generic. Nuisance and disease vector quarantine and impacts will need to be considered as part of' the quarantine strategy. Stormwater and wastewater infrastructure should be located, designed and maintained in a manner that does not create or exacerbate breeding of nuisance and disease vector arthropods. All earthworks, topography changes should be done in a manner that does not create breeding habitat for nuisance/disease vector insects. Employee accommodation both on Island and on the mainland should be located well away from known disease/nuisance insect breeding habitat. The Proponent should liaise with the Shire of Roebourne for advice on this.	The GJV's commitment to the Quarantine Management System (QMS) was explained in Chapter 12, Section 12.6 of the EIS/ERMP. This commitment has been formalised in Statement No. 748. Pursuant to Condition 10.1 for the Approved Development, *"…the Proponent shall submit the QMS to the Minister, taking into account the advice of the QEP that meets the aim and objectives set out in Condition 10.3 and the requirements of Condition 10.4, as determined by the Minister, unless otherwise allowed in Condition 10.2."* Condition 10.4 refers to Schedule 4 of Statement No. 748, which contains the specific details of the elements to be addressed in the QMS. Therefore, both the content of the QMS and the role of the QEP in providing advice to the Minister are already well established. The Revised Proposal requires exactly the same elements, since the stated expectations for the QMS are for it to be scalable to any size project on Barrow Island. Nuisance and disease vectors are addressed in the environmental management of human health for both the Approved Development and the Revised Proposal. These vectors are not the subject of a quarantine

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			strategy because all projects must address the human health hazards of nuisance and disease, irrespective of any requirements related to biosecurity. The design of Gorgon Gas Development facilities and operational practices at all locations (not only on Barrow Island) must take human health threats into account. Mosquitoes have not historically presented a health issue on Barrow Island. However, it is recognised that certain natural events could give rise to conditions suitable for mosquitoes to breed and that Development activity could also present breeding opportunities. Overall, it is considered that the associated health risk is low but they will nonetheless be managed through Chevron's risk management process and if required, use of appropriate occupational and environmental health resources. This is expected to include leveraging off the existing Chevron WA Oil relationship with the Shire of Ashburton's environmental health department. The HAZID process is being applied during the design phase and will be applied through the subsequent phases of the Gorgon Gas Development, including earthworks. Notwithstanding the separation of human health issues from biosecurity, the QMS is designed to prevent the introduction of non-indigenous species to Barrow Island. As such, the likelihood of introduction of potential vectors for nuisance and disease has been determined to be low. Advice from the original Quarantine Expert Panel (2003–2005) was that the threat of transmittable disease to Barrow Island flora and fauna was negligible, based on the low risk of introducing non-indigenous species to Barrow Island, the lack of suitable vectors for the transmission of animal pathogens, and the high standards of control on food vectors which is exemplified in the rigorous quarantine barriers associated with the food and perishables pathway described in the Additional Information Package of the EIS/ERMP (Chevron Australia 2005a). This view is supported by an expert study commissioned by the Gorgon Gas Development, which was published as Technical Appendix D8 in the Final EIS/ERMP Response to Submissions (Chevron Australia 2006) for the Approved Development. As such, the original QEP and Quarantine Advisory Committee (2006–2008) considered these threats, but did not recommend the development of additional quarantine barriers specifically addressing pathogens.
6.6	WWF	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 and the other Joint Venturers to manage these risks but are concerned that no amount of goodwill and effort	This comment was made in relation to the EIS/ERMP prepared for the Approved Development; however, it has been responded to in relation to the Revised Proposal where applicable. The GJVs appreciate the acknowledgement of the efforts being made to employ world class performance in the area of quarantine on Barrow

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		will reduce the risks to a reasonable level.	Island. The GJVs, through Chevron Australia as the operator of the existing Barrow Island oilfield operations, have 40 years of quarantine experience that has served to protect the conservation values of Barrow Island, an accomplishment of which Chevron Australia is proud. In this regard, Chevron Australia has developed a competent quarantine capacity in the organisation. This capacity has advanced from its initial grass-roots beginnings of quarantine management 40 years ago to a visible quarantine culture evident throughout the organisation today. This achievement is supported by the fact that no loss in biodiversity has been recorded to date on Barrow Island during the 40 years of oil operations. Consistent with this achievement, the GJVs have developed effective barriers for all of the potential pathways of introduction, with the goal of no introductions, in order to meet the standards for acceptable risk. In addition to effective barriers, the GJVs are committed to developing a monitoring program that will rapidly detect an introduction and mobilise an immediate Response and Eradication Strategy. This approach is informed by current practices on Barrow Island, which have successfully eradicated introduced species in the past. Given the experience and achievement of Chevron Australia as the oil operation operator on Barrow Island, and recognising the current initiatives of the GJV to maintain world class quarantine performance, the GJVs are confident that the emerging Quarantine Management System developed for the Revised Proposal (based on the Approved Development's Quarantine Management System), will safeguard the conservation values of Barrow Island in a manner that will not lead to species extinction. The Quarantine Advisory Committee which oversaw the QHAZ phase has recorded the view that "*The Committee is of the view that the outcomes of the workshops, as described in the draft Quarantine Supplement, are well founded and the barriers proposed are likely to result in a low risk of incursions to Barrow Island provided they are implemented in a timely, efficient and effective manner*" during a special sitting on 6 October 2005. This statement referred to the three priority pathways identified by the community for the GJVs to demonstrate an acceptably low risk is achievable using the Standards for acceptable risk developed at an earlier workshop. Thereafter, the GJVs completed the remaining pathways and presented the outcomes, all of which met the Standards for Acceptable Risk to the EPA. The Minister, on advice of the Appeals Convenor, was also convinced of the view that the barriers proposed by the GJVs would result in an acceptably low risk to the conservation values of Barrow

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			Island. A commercial agreement between the Gorgon Joint Venture and Barrow Island Joint Venture parties was executed in September 2008. It includes details regarding responsibilities and obligations of each party to the Barrow Island Coordination Council. While the Barrow Island Joint Venturers and the Gorgon Joint Venturers continue to have responsibility for the environmental management of their respective operations, the Barrow Island Coordination Council (BICC) is to be established to ensure there is a single point of contact and interaction for the Department of Environment and Conservation (DEC) (formerly Department of Conservation and Land Management [CALM]) as well as the development of consistent procedures on critical matters such as quarantine management and emergency response. The matters to be coordinated by the BICC include: ♦ providing a single point of contact and interaction for the DEC in relation to the management of issues related generally to the operations of the BICC participants on Barrow Island ♦ liaising with the DEC in relation to the terms and implementation of the management plan under Division 1 of Part 5 of the Conservation and Land Management Act so far as it relates to the operations of the BICC participants on Barrow Island ♦ establishing, monitoring and reviewing from time to time procedures to apply to quarantine of all people and materials brought to Barrow Island for the purposes of the operations of any of the BICC participants ♦ planning and coordinating the BICC's role in emergency response to and undertaking, where necessary, remediation of any suspected or actual breach of quarantine in the operations of any of the BICC participants ♦ planning and coordinating the BICC's role in emergency response to and undertaking, where necessary, remediation of escape of hydrocarbons or other pollutants from the operations on Barrow Island of any of the BICC participants.
6.13	WWF	It is WWF-Australia' s view that the draft EIS/ERMP fails to adequately assess the increased potential risk of the introduction of exotic animals, plants and micro-organisms to the integrity of the biodiversity within the Barrow Island Nature Reserve. WWF-Australia assesses the risk of quarantine breach and invasive plant	This comment was made in relation to the EIS/ERMP prepared for the Approved Development; however, it has been responded to in relation to the Revised Proposal where applicable. The GJVs have relied on independent expert advice to conclude that the

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		and animal species becoming established on Barrow Island as critical (widespread long-term impact on population/Extinction of race) and almost certain. WWF-Australia maintains that these risks disqualify Barrow Island as a candidate site for the proposed development. The determination of risk is based on the following analysis: ♦ It is well established that most extinctions worldwide over the past few hundred years have been on islands, and that the vast majority of these have been due to invasive plant or animal species. ♦ It is widely accepted among quarantine experts that there is no such thing as a perfect quarantine system. All quarantine systems fail from time to time, for reasons relating to human error and the impossibility of preventing some organisms travelling with people, equipment, shipping, etc., no matter how good the quarantine management system. Unfortunately, quarantine failures that lead to the establishment of introduced species are likely to be irreversible. ♦ While Chevron has a reasonably good history of quarantine on Barrow to date, it is attempting to develop a quarantine system of a standard higher than anything that currently exists anywhere in the world. However, the chance of doing this successfully in the short time available before construction is proposed to commence is very low. While Gorgon have made a commitment to quarantine, it is unlikely that quarantine will take precedence to construction timetables once the project gets underway. If early failures relate to organisms that survive and establish, those failures will be for all time. The probability of detecting most organisms before they become common is low. Eradication is not possible for most organisms without also destroying indigenous species, as most eradication attempts will involve the use of poisons. ♦ Gorgon has provided details of 'barrier' design for three 'priority' pathways. The information generated via the series of workshops held to consider these pathways is comprehensive but wholly paper-based. At the recent Community Consultation Meeting held in Perth on 10 November 2005 it was acknowledged that invited experts at	risks associated with the Gorgon Gas Development are low when managed using barriers that meet standards for acceptable risk for the identified pathways. This conclusion is supported by the successful quarantine performance of the current oil operations on the Island. The oilfield operation has existed on Barrow Island for more than 40 years. During this time, Chevron Australia (as the operator) has recognised the importance of quarantine, has implemented strict measures to prevent introductions, and developed a strong quarantine culture in the workforce. Notwithstanding these efforts, some quarantine breaches have occurred. In keeping with Chevron Australia's commitment to quarantine, which safeguards the conservation values of the Island, there have been instances when vigilant and competent personnel have denied barges from offloading on Barrow Island. These non-compliant vessels and their cargoes were instructed to return to the mainland for quarantine treatment without regard to cost or schedule. On the few occasions when non-indigenous species have been discovered in vessels, they have been dealt with swiftly and effectively with advice from DEC. Where weeds have been discovered, they have been the subject of a management containment and eradication program to prevent their spread. As a result of these pre-border, border and post-border efforts, Chevron Australia has prevented adverse impacts to the conservation values of Barrow Island and continues to improve its quarantine performance. The GJVs have recognised the need for a world-class QMS that will effectively manage the risks of introduction associated with the Revised Proposal and have made substantial progress to develop solutions that have been tested with independent experts. The community recognises that there cannot be a 'zero risk' solution for quarantine; however, the GJVs have addressed the community's expectations for acceptable risks to prevent the establishment of non-indigenous species on Barrow Island. In doing so, the GJVs have considered the recommendations of conservation and ecological specialists to prevent introductions on pathways associated with people, cargoes and vessels. The GJVs have compiled a comprehensive bibliography of the biological surveys of Barrow Island. A data gap is the limited knowledge of invertebrate species on the Island. The GJVs responded by commissioning CSIRO to provide advice designing an invertebrate baseline survey, and consulted with a number of independent invertebrate experts to gain an understanding of the required scope. The advice on the baseline surveys for invertebrate fauna provided by the independent

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		the workshops suggested risk scores with limited hard data and pointed out that they were working in an information vacuum. Also at the Community Consultation Meeting, Gorgon staff acknowledged that no attempt has been made to measure infection of existing pathways operated by Chevron to service the oilfield. Several plane loads of passengers and luggage fly to Barrow every week in addition to many barge trips that bring food and equipment each month, and this would have been an easy task. ♦ At present, despite the amount of work undertaken, Gorgon can not demonstrate that they will be able to meet the 'Community expectations for acceptable risk' developed under the guidance of the Quarantine Expert Panel (pp 555-556). (WWF-Australia notes that, as stated at the Community Consultation Meeting, the 'decision rules' relating to an end-score for a series of barriers described in Chapter 12 of the main document have been scrapped, following advice from the newly set up Quarantine Advisory Committee). The three 'priority' pathways detailed in the 'Additional Information Package' all yielded infection scores above '1' for food and perishables, invertebrates, vertebrates and plants. (See additional Information Package, pp. 8-9, 12, and 18.) Within the three acceptable risk scenarios, an infection score of '1' is clearly the only one that can be applied to the project. It is not possible to allocate a survival score of less than 4 (as there will always be a proportion of organisms that will survive on the Island once they arrive, as demonstrated by the weeds, rats and the tramp ant that have already survived there) and Gorgon is unable to demonstrate that detection and eradication scores will be less than 4, let alone 1. ♦ Chevron has made much of the existing oilfield's quarantine success, despite numerous documented quarantine breaches. While Gorgon states that there will be a better quarantine management system in place for the gas plant, the very large size of this industrial development, with a peak construction work force of more than 3000 people and involving the transport of many thousands of tonnes of sand, aggregate, equipment and food to the Island suggests that the chances of a breach-free quarantine system are extremely low.	experts has been carefully reviewed and considered. Building on the information provided in the CSIRO report, specialists participated in a workshop in Karratha on 6 July 2004, where the issues around baseline survey design were debated and discussed to determine the best approach. Professor Jonathan Majer of Curtin University, a respected invertebrate biologist, has designed a rigorous sampling methodology for the identification of indigenous species and introduced species on Barrow Island that incorporates the recommendations of a number of experts. The methodology is fit for purpose, and has been peer reviewed, and the GJVs have allocated appropriate resources to Curtin University to establish baseline data for invertebrate species. This baseline has been acknowledged by independent experts as the most comprehensive invertebrate baseline ever undertaken on Barrow Island. In the case of the Tramp Ant, this species was discovered as a direct result of the GJVs' baseline survey efforts. The Tramp Ant is prevalent in northern Australia and may have established itself on the Island under a natural colonisation pathway, as happens frequently on islands; or it is possible that it was introduced by oilfield activities. However, this cannot be determined with certainty. Micro-organisms were considered during the Approved Development's assessment. This topic is acknowledged to be a complex issue with many divergent views. The GJVs obtained advice on potential threats of disease to conservation values via desktop studies, as recommend by the QEP. Micro-organism threats to terrestrial vertebrate fauna were addressed by the School of Veterinary and Biomedical Science at Murdoch University. Plant pathogen threats were discussed by the Curator of the Plant Pathology Herbarium of the Department of Primary Industries and Fisheries, Queensland. Potential pathogens and their hosts were identified in these studies, such that quarantine management would consider these when developing appropriate barriers, particularly for the food and perishables and personnel pathways. The GJVs have committed to an iterative process of pathway and barrier development and as new information and knowledge becomes available on micro-organisms, such information and potential modifications to the existing barrier designs will be subject to the same scrutiny as was utilised in the original workshops. The barrier selection process and independent assessment are complete for the construction pathways to be associated with the commencement of construction, subject to Statement No. 748 Condition 10.2.

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		♦ Only three 'priority' terrestrial pathways have been completed to the 'barrier design' stage and details of these three pathways have been provided late in the comment period. Some additional progress has been made on marine pathways. However, there are more than 12 pathways in total, and it seems highly unlikely that sufficient evaluated detail on all pathways will be in place before construction commences. The construction of a jetty would increase the risk of establishment of introduced species, something that does not seem to be covered by the quarantine pathway approach. ♦ Micro-organisms seem to have effectively been ignored. However, each person visiting the Island brings along a suite of commensals and other micro-organisms which can only be contained through a conscious focus on disease. To date, there has been minimal effort to survey the Island's biota for natural or invasive diseases, and no quarantine barriers have been suggested to prevent disease infecting the Island's biota. ♦ Detection of any threat is not possible without quality baseline data. Baseline data on the invertebrate fauna of Barrow Island are extremely scanty and invertebrate studies commenced only very recently. Gorgon commissioned a report from CSIRO on baseline survey methodology but subsequently opted for a cheaper and less rigorous approach. Thus, terrestrial invertebrate fauna surveys have so far consisted only of a 'pilot' project. Invertebrate collections are necessarily large and identifications take a lot of time, and invertebrate studies are slow to produce results. Like all biological surveys, they need to cover several years and different seasons before reaching a level of comprehensiveness. However, this brief pilot study has already detected one introduced 'tramp' ant, showing repeated claims of 'no introduced animals' on Barrow Island to be based on incomplete data. It therefore seems no longer possible to collect adequate 'baseline' data on invertebrates prior to the commencement of construction should the project be approved. ♦ Gorgon has not developed protocols for eradication of	The GJVs have developed Standards for Acceptable risk in consultation with the public and subject matter experts. This was discussed in Chapter 12 of the Final EIS/ERMP Response to Submissions (Chevron Australia, 2006a) for the Approved Development. This describes three scenarios depicting a various combinations for the categories Introduction, Survival, Detection and Eradication. The GJVs have demonstrated that risk standards can be achieved that meet the expectations of the public. The possibility that introduction scores could not be reduced to a score of '1' was first discussed transparently in Community Consultation Meeting No.2, 20 April 2004, and subsequently in the Risk Standards Workshops No.2 and No.3. The GJVs also noted the view expressed by the community in these Risk Standards Workshops, that there should be a commitment 'to risk scaling of 3 as an upper limit' which the community and the technical experts viewed as acceptable levels of risk within the context of a 'zero tolerance' approach to introductions of non-indigenous species to Barrow Island. As such, the introduction scores for the food and perishables pathway, the sand and aggregate pathway and the people and luggage pathway are consistent with this upper limit and the GJVs' standards for acceptable risk. Following the lessons learned from the risk assessments conducted for the category Introduction, subject matter experts were divided on the matter of assessing survival. This was mainly as a result of limitations of science to support any such judgment, albeit qualitative. It was decided not to attempt to pursue the risk assessment for survival any further. This resulted in a component of the Standards for Acceptable Risk to drop away which effectively rendered it redundant. This could not have been foreseen by the community, or the subject matter experts that advised the GJVs on setting the Standards for Acceptable Risk. A further complication with regard to the Standards for Acceptable Risks emerged when subject matter experts were consulted with regard to setting up a surveillance program to demonstrate the effectiveness of the detection program. The Standards for Acceptable Risks required that in the event the GJVs could not record a risk score of '1' in Introduction, ignoring the belated advice on survival, had to record a risk score of '1' for Detection and Eradication. The GJVs set about this task by assembling a group of eminent subject matter experts, including leading government scientists, to develop such a detection program. On this group's advice, the GJVs advised a meeting of the EPA Board in May 2006 that this approach to assessing the effectiveness of a detection program cannot be completed with confidence. In its place, it was agreed at that meeting Gorgon will develop a 'Proof of Concept' developed by subject matter

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		introduced species once they establish. The risk based approach used by Gorgon scores infection, survival, detection and eradication. Almost all work has been on infection, with some attention on survival, less on detection and none on eradication.	experts that replace the qualitative assessment envisaged by the community at the time. The GJVs have consulted with a number of eradication specialists and are aware of the current eradication practices for undesirable species as recommended by a variety of government organisations, Australian Cooperative Research Centres, research institutions and conservation organisations. Chevron Australia (as the operator of the existing oilfield) has demonstrated its response capabilities to eradicate rodents on the few occasions that they were discovered, and has successfully managed weed eradication efforts, in consultation with appropriate experts. These examples of response and eradication, and the experience gained, are already informing the GJVs in the development of the Response and Eradication Strategy. This approach has in the past delivered the desired results. This is demonstrated by the successful eradication campaign of rats on Barrow Island where subject matter experts from DEC supported by Chevron, eradicated the rats on the Island with a program that was uniquely designed for that specific incursion taking into account the unique circumstances and environmental realities that prevailed at that time. Also the current weed management practice supports this notion. Although not completely free from weeds at present, sound weed management based on advice from DEC and a financial commitment from Chevron have resulted in a well-controlled weed management program on Barrow Island. Building on these successes, the GJVs will develop Species Action Plans in consultation with DEC and other subject matter experts, to establish an eradication capability that can indeed achieve an outcome as desired in the Standards for Acceptable Risk notwithstanding the inability to 'assess' such risk specifically.
8.2	Western Australian Museum	Likewise the process for mitigating the impact of Introduced Non-Indigenous Organisms appears to be covered by the protocols and guarantees given.	The GJVs appreciate the acknowledgement that the Revised Proposal is not considered to pose any significant new or additional risks as a result of introduced non-indigenous organisms in comparison to the Approved Development.
9.9a	DEC – Environmental Management Branch	Quarantine risks remain underestimated. For example, risk identification and management associated with additional causeway rock have been omitted.	Quarantine risks associated with the Gorgon Gas Development have never been underestimated. Identification of quarantine threats and the analysis of the risks of introduction have been systematically and comprehensively assessed by independent experts through the quarantine risk management process developed in consultation with experts and community stakeholders, as described in the EIS/ERMP for the Approved Development. More than 30 recognised independent experts, nominated by the original Quarantine Expert Panel (2003–2005), participated in 33

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			risk assessment workshops and were responsible for judging the quarantine risk to be low for all of the supply chain pathways. The example of armour rock is discussed below; Item 9.9b.
9.9b	DEC – Environmental Management Branch	Recommendation 19: Further information is required in regard to rock/fill materials to be imported from the mainland and the associated quarantine risks and management. The extension to the solid rock causeway and materials offloading facility will require very large amounts (tonnage not specified in the PER) of additional rock to be imported, but management of quarantine associated with this operation has not been discussed in the PER. DEC understands (from information gathered during consultation with Chevron) that the rock will be sourced from existing quarries in either Exmouth or Dampier. Although the causeway and materials offloading facility are to be built from the seaward extent toward the shore (to allow water flow and flushing of sediments during construction), there still remains the potential for invertebrates and rodents to emerge from the rock material and transfer ashore to Barrow Island. Further, there remains the risk that seed stored within the material may be blown or carried by birds or water to the Island. The closer to land the construction of the causeway develops, the greater the risk of invasion by foreign species becomes.	An analysis of the quarantine threats associated with rock armour, sand and aggregate was completed in two Infection Modes and Effects Analysis workshops (Chevron Australia 2004a, 2004b). There is less opportunity for non-indigenous species to be concealed in rock, but the quarantine threats are identical. Subsequently, the quarantine barriers for the sand and aggregate pathway were developed in Preliminary Barrier Analysis and Quarantine Hazard Analysis workshops (Chevron Australia 2004c, 2005c). The facilities and quarantine barriers developed for the quarrying of sand and aggregate, and the transport of these materials to Barrow Island are essentially the same as those for the armour rock to be used on the causeway. Quarried rock will be subject to quarry hygiene and management controls designed to isolate stockpiles from sources of mainland flora and fauna. Included in these management controls are the systematic quarantine barriers that apply to every supply chain pathway (e.g. pre-qualification of contractors, training, inspection requirements, evaluations). The prescriptive quarantine barriers to be applied to the rock pathway are a direct extension of those to be applied to the closely related sand and aggregate pathway: quarry selection and environmental management; quarrying of rock; sorting of rock to remove fines; loading and transport of rock; safe storage at the quarry; appropriate handling at the MOF. Due to the larger particle size of quarried rock, compared to aggregate, there is less opportunity for organisms to be concealed and therefore visual inspection of rock to determine compliance is much easier. Rock that will be used to construct the offshore portion of the MOF, poses a low terrestrial quarantine threat because the rock will be largely submerged, and it is never less than 500 m from the Barrow Island shoreline. Following placement of the offshore portion of the rock and ensuring the offshore portion is quarantine compliant, the 'land bridge' of the offshore portion of the MOF to the Barrow Island shoreline will be completed with rock sourced on Barrow Island. This construction sequence provides an effective quarantine barrier between the imported rock and the Island. A comprehensive surveillance program will commence at the start of rock placement focusing on the MOF as a potential point of entry for non-indigenous species. Once the placement of the offshore portion of the rock is complete, baiting for rodents will occur with a 48 hour standoff (as

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			for marine vessels) to ensure that no rodents occupy the offshore rock. Similarly, the exposed rock will be treated with residual insecticide to ensure that no invertebrates are present when the structure is connected to the shoreline.
9.9c	DEC – Environmental Management Branch	Recommendation 20: Additional pathways for the introduction and spread of weeds are apparent for the Revised Proposal and need to be addressed. Consideration of these pathways may also increase the risk level for weed introduction and spread.	No additional pathways exist for the Revised Proposal regarding the introduction or spread of weeds. As with the Approved Development, all of the pathways have been assessed to demonstrate that the risk of introduction is low.
9.9d	DEC – Environmental Management Branch	Recommendation 21: If the development is approved, a condition needs to be included for a Weed Management Plan to be developed and implemented with a whole-of-island integrated approach, to the satisfaction of DEC.	The GJVs' QMS has been designed to prevent the introduction of weeds, which are included in the definition of non-indigenous species. Condition 10.3 of Statement No. 748 requires the QMS to be designed to detect and control/eradicate weeds in the event of an introduction to Barrow Island. The GJVs recognise that weed management must be integrated into a whole-of-island approach, and is committed to doing so. The GJVs' management approach will be recorded and implemented via a Barrow Island Weed Management Plan.
9.9e	DEC – Environmental Management Branch	The introduction or spread of non-indigenous plant species (weeds) have been determined in the PER to be of low risk due to no additional or new pathways being identified for the Revised Proposal. It is considered by DEC that the additional rock importing required constitutes a significant expanded pathway for the introduction or spread of weeds. The addition of several wells and associated tracks and equipment related to the additional requirements of the CO_2 sequestration operation is also considered to present an expanded pathway for the introduction and spread of weeds. Although the disturbance will be in accordance with the approved 300 hectare limit, the location of tracks and wells within various pockets of vegetation will create several fronts from which weeds may be introduced into areas previously undisturbed, and which may then spread.	The proliferation of weeds will be managed as part of the Weed Management Plan, which will include a section on weed hygiene measures that are aimed at reducing the risk of intra-island spread.
9.9f	DEC – Environmental Management Branch	There is uncertainty about the commitment and mechanism by which the Proponent will manage new and existing weed infestations on Barrow Island in a whole-of-island approach. Commitments are also made to adopt a whole-of-island approach to quarantine management. There is, however, no commitment to control existing weed populations outside of the immediate Gorgon footprint, which would be consistent with a whole-of-island approach and would also minimise the potential for weeds to spread to Gorgon areas.	There is no uncertainty about the commitment of the GJVs or the mechanisms for managing new and existing weed infestations on Barrow Island. The existing WA Oil operation has developed a Weed Management Plan in consultation with the DEC and is responding to existing occurrences of weed species accordingly. A commercial agreement between the Gorgon Joint Venture and Barrow Island Joint Venture parties was executed in September 2008. It includes details regarding responsibilities and obligations of each party to the Barrow Island Coordination Council (BICC).

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		A survey of Barrow Island is required to determine baseline data for current weed status. This would provide the Proponent with an understanding of the scale of the problem with respect to both the management of existing weed infestations as well as surveillance to ensure early detection and eradication of new weed occurrences. Such a survey should include high resolution mapping of the extent of current weed infestations. The survey report and baseline weed map should be provided to DEC and used in development planning and conservation management on the Island, and maintained in a GIS format for everyday use by both the Proponent and DEC. A Weed Management Plan is required for Barrow Island. This would provide direction on the scale of the weed problem on the Island, the vectors for spread both past and present, and what to do about these (for instance road maintenance policy, airport management, and vehicle and machinery cleandown). The plan should outline control operations, surveillance methodology and reporting processes. Reports should provide information on outcomes of control operations and management of both new and existing infestations, as well as provide trends over time. This plan should be developed in consultation with, and to the satisfaction of DEC, and be subject to annual reporting and review.	While the Barrow Island Joint Venturers and the Gorgon Joint Venturers continue to have responsibility for the environmental management of their respective operations, the BICC is to be established to ensure there is a single point of contact and interaction for the Department of Environment and Conservation (DEC) (formerly Department of Conservation and Land Management [CALM]) as well as the development of consistent procedures on critical matters such as quarantine management and emergency response. The matters to be coordinated by the BICC include: ♦ providing a single point of contact and interaction for the DEC in relation to the management of issues related generally to the operations of the BICC participants on Barrow Island ♦ liaising with the DEC in relation to the terms and implementation of the management plan under Division 1 of Part 5 of the Conservation and Land Management Act so far as it relates to the operations of the BICC participants on Barrow Island ♦ establishing, monitoring and reviewing from time to time procedures to apply to quarantine of all people and materials brought to Barrow Island for the purposes of the operations of any of the BICC participants ♦ planning and coordinating the BICC's role in emergency response to and undertaking, where necessary, remediation of any suspected or actual breach of quarantine in the operations of any of the BICC participants ♦ planning and coordinating the BICC's role in emergency response to and undertaking, where necessary, remediation of escape of hydrocarbons or other pollutants from the operations on Barrow Island of any of the BICC participants. Statement No. 748, in Condition 10.3 (for the Approved Development), clearly reflects the GJVs' stated commitment to detect, control, eradicate and mitigate adverse impacts of non-indigenous species introductions as a result of Gorgon Gas Development activities. The QEP will provide advice to the GJVs and the Minister in this regard, as stipulated in Statement No. 748 Condition 9.2. Statement No. 748 Schedule 4 details the elements of the QMS that relate to detection, control, eradication and mitigation. The GJVs have sought and received advice from the original QEP and the Quarantine Advisory Committee regarding the sensible execution of

Table 4.21		Quarantine	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
			detection, control, eradication and mitigation. This advice is 'on the record' of these meetings and is being implemented. The implementation of detection, control, eradication and mitigation will be subject to advice of the newly formed QEP under Statement No. 748 Condition 9. In addition, the GJVs have previously agreed to a $10 million guarantee to reflect its commitment in the event that additional eradication is considered to be warranted by the Minister (see Statement No. 748).
9.9g	DEC – Environmental Management Branch	Weed invasion and spread have been considered by the Proponent as a low level risk for the Revised Proposal. The quarantine risk (including weed spread) was considered unacceptably high by the EPA for the Approved Development, and given the additional clearing and long-term infrastructure, it is considered that the risk cannot have been reduced as a consequence of the Revised Proposal.	The quarantine risk for the Approved Development was judged to be acceptably low by more than 30 independent experts, a view upheld by the Appeals Convenor and the Minister. Subsequent to the quarantine commitments that resulted in this low risk, the GJVs have committed to the establishment of a Quarantine Approved Premises, licensed by the Australian Quarantine Inspection Service (AQIS) at the point of arrival for vessel cargoes at the MOF. The requirements of the QMS for preventing introductions are therefore more stringent than those that led to the risk of introduction being acknowledged as low. Furthermore, the requirements of the QMS are scalable, and the threats of introduction were judged by independent experts to be attributable to rare stochastic environmental events over a long construction period, which are not related to the frequency or number of shipments of materials to Barrow Island. This means that the risk scores were not derived from the constant presence of Non-Indigenous Species (NIS) concealed on goods, people or vessels but rather a very unlikely situation were an individual succeeded in evading a complex web of barriers at varies time intervals and often exposed to such barriers for prolonged periods of time such a inside a fumigated containers of shrink-wrapped envelope, heat treated enclosure or a pressure washed or steam cleaned interspaces. The likelihood of this happening is considered extremely remote and therefore driven by some stochastic event such that it cannot be predicted but it might happen. Thereafter, this individual organism must then survive the Barrow Island competitive environment, find a mate, produce offspring. This again is a function of the first dilemma of evading the barriers. Even more unlikely, is that the surviving individual either be gravid or capable of parthenogenesis. That is indeed a stochastic event. This has been explained in both the responses to comments on the Approved Development and in the Appeals process for the Approved Development.
9.9h	DEC – Environmental Management Branch	Commitments are made within the PER to control/eradicate weeds that have been introduced or spread after commencement of the Gorgon project, however, as there are no adequate baseline data	The statement that *"there is no adequate baseline data available concerning the weed status of Barrow Island"* is incorrect. See Section 3.3 of the PER for an outline of the investigations undertaken for vegetation

Table 4.21		Quarantine	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
		available concerning the weed status of Barrow Island, it is unclear as to how they will meet this commitment. The Proponent also commits to managing new and existing weeds as a core component of the Quarantine Management System. The system makes broad reference to sites being maintained weed free and the requirement for reporting new weed occurrences, however, it does not provide adequate information regarding the management of new and existing weed species on the Island or the processes to be undertaken to ensure no new species are introduced.	and flora, and fauna. Barrow Island is proven to be relatively free from weeds. This is largely due to a sustained commitment by the past and present operators of the oil operation. The GJVs are committed to continue in this tradition. See also the response provided for Item 9.9f above.
9.9i	DEC – Environmental Management Branch	The PER states that plans are advanced to license a Quarantine Approved Premises on Barrow Island to facilitate direct shipments of materials and avoid the potential for cross contamination at other Australian ports of entry. This is a new quarantine initiative compared to the Approved Development and as such requires a more detailed discussion within the text. Until additional information is provided on the initiative, its suitability on Barrow Island cannot be assessed.	The GJVs' commitment to licence a Quarantine Approved Premises (QAP) on Barrow Island goes beyond previous quarantine commitments for the Approved Development, which were judged to result in a low risk of introduction. The QAP adds an additional layer of protection at the point of entry on the MOF, without compromising or interfering with other quarantine or environmental management commitments already committed to for the Approved Development. The requirements for a QAP are well-described by the statutory authority of AQIS. The GJVs will progress the QAP through AQIS, subject to its stated requirements. The GJVs have made commitments beyond those already described for the Approved Development, and reflects a commitment for continuous improvement as per the Barrow Island Quarantine Policy. The GJVs will review and revise their processes as is reasonably required to avoid the introduction of NIS.
15.3	Conservation Commission of Western Australia	The very high standard of work intended with respect to quarantine measures is acknowledged and associated with this is the need to ensure that any subsequent breaches are quickly acted upon. As an example is the threat to the Island's environment posed by the weed buffel (*Cenchrus ciliaris*) where a disturbance event might lead to its rapid spread. There is a need to provide information on the status and distribution of weed species, with this then contributing to the risk assessment associated with the expanded proposal.	Section 3.3.1.4 of the PER provides a description of the introduced flora that have been recorded on Barrow Island, and describes the weed monitoring and weed control programs that have occurred in the last two years. The GJVs have committed to preparing a QMS designed to detect and control/eradicate weeds in the event of an introduction to Barrow Island (this system is being prepared for the Approved Development and would be extended to account for the Revised Proposal). The quarantine risk for the Approved Development was judged to be acceptably low by more than 30 independent experts, a view upheld by the Appeals Convenor and the Minister. Subsequent to the quarantine commitments that resulted in this low risk, the GJVs' have committed to the establishment of a QAP, licensed by the AQIS at the point of arrival for vessel cargoes at the MOF. The requirements of the QMS for preventing introductions are therefore more stringent than those that led to the risk of introduction being acknowledged as low. In addition, the GJVs have agreed to a $10 million guarantee to reflect its

Table 4.21		Quarantine	
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			commitment in the event that additional eradication is considered to be warranted by the Minister.
18.5	Department of Fisheries	The document claims that there is not likely to be any additional risks (and/or changes to the risks identified in the first submission) of marine pests, and therefore Section 8.0 Quarantine Management and Risks focuses primarily on terrestrial pest introductions. The DOF believes that there is a potential increase in risk profile and/or changes to the previous risks identified for marine pests as a result of the change in some design aspects. Specifically, modularisation and the increased construction phase (extended by 3 to 6 months) may affect the risk. The DOF would like the following points addressed as these may change/increase the risks of marine pests for the Revised Proposal: ♦ Changes to the frequency of vessels travelling into the waters around Barrow Island; ♦ Time of year that the vessels will be travelling; ♦ Nature of the vessels being used; and ♦ Origination of vessels. The DOF notes that the Revised Proposal relies more heavily on modularisation thus resulting in decreased volumes of construction supplies and raw material being shipped to Barrow Island. While the use of modules will decrease the amount of shipping, the construction phase has been extended. The shipping of the modules is still a concern to the DOF. A system will need to be developed between the Proponent and DOF whereby notification will be required of vessel movements. The vessels, which are of particular interest to the DOF, would be those doing trans-shipment of supplies, dredging, and maintenance. As a result, there will be a need for DOF resources to be provided throughout the life to provide timely advice and input to adequately address these risks.	Direct shipments to Barrow Island have been assessed as representing a low introduction risk through the Quarantine Hazard Analysis (QHAZ) workshops (Chevron Australia 2006a, 2006b, 2006c). The findings and recommendations of these QHAZ workshops contemplated multiple shipments of modules to Barrow Island from foreign fabrication yards. The risks were assessed qualitatively for all potential pathways of introduction. The results of the QHAZ workshop for direct shipments resulted in a residual risk of introduction score of '1' (i.e. extremely remote, highly unlikely on a qualitative scale of 1 to 10) for both hull fouling and ballast water threats, adopting the recommendations of independent experts. The number of additional direct shipments required for the Revised Proposal would not be expected to affect the low risk judgements made by the independent experts. The adopted quarantine barriers are scalable for any number of vessels, and are independent of the ports previously visited or the time of year. Scalability in the context of the QMS refers to the ability the GJVs have to apply the QMS requirements to any volume without increasing the risk level. The QMS requirements relate to procedures, specification and guidelines that can accommodate any volume as the critical barriers are all measurable and readily auditable. In the case of vessels it is a complete wetsides maintenance regime which includes risk assessments, remediation reports and the applications of antifouling paints. This procedure determines the risk level that then remains constant irrespective of the number of shipments Qualitative risk assessment is not a summation of individual risk; it is an understanding of residual risk that underlies the implementation of a scalable management system. As long as the different vessels do not exhibit different categories of risk, the risk profile does not increase. The nature of the vessels calling into Barrow Island was well described in two IMEA workshops (Chevron Australia 2004a, 2004b), two PBA workshops (Chevron Australia 2004c, 2005b) and the QHAZ workshops for marine vessels (Chevron Australia 2005b). These documents are publicly available on the Gorgon website (http://www.gorgon.com.au/03moe_quarantine.html#frames(content=03moe_quarantine_body.html). Vessels entering the Controlled Access Zone of Barrow Island must disclose their previous ten ports of call, as only one of the elements of the Risk Assessment Report requirements identified in the Gorgon Project

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			Marine Quarantine Zonation document (Chevron Australia 2007). This requirement recognises that the origination of vessels used for Development activities is an important aspect of threat identification; however, these locations cannot be confidently predicted years in advance. The QMS requires that vessels entering Commonwealth waters and Western Australian State waters comply with applicable laws and regulations in force at the time of entry. The GJVs will comply fully with any State regulations administered by the Department of Fisheries requiring notification of Development-related vessel movements in Western Australia.

4.14 Air Emissions

Table 4.22: Air Emissions

Table 4.22		Air Emissions	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
14.1	DEC – Air Quality Management Branch	The assessment of PM_{10} concentrations ignores background concentrations, which are significant in the Pilbara region and would possibly not meet NEPM limits even without addition of the Gorgon project emissions. The overall increment of PM_{10} concentrations from the proposed development is minimal, but it is not acceptable to overlook this issue.	As noted by the DEC, the background PM_{10} concentrations in the Pilbara region can be significant; however, the proposed Gorgon Gas Development is located on Barrow Island, which is situated approximately 55 km from the Pilbara coast in a marine environment where it could be expected that the PM_{10} concentrations would be significantly lower. There is no information currently available on PM_{10} concentrations at Barrow Island; however, the GJVs will implement a baseline monitoring program for the construction and operations phases that will include monitoring of PM_{10} concentrations.
14.2	DEC – Air Quality Management Branch	The concentration of ozone during CO_2 venting periods can be high. It appears that venting will occur for 20% of the period of AGRU operation, and that ARGU operation is continuous. Although the modelling was based on continuous venting, 20% is a significant fraction of the year, so it can not be said that attaining the modelled peak is "highly improbable". On the other hand, the NEPM limit is based on the second highest day, which could have been lower. Also, for emissions which occupy 20% of the year, consideration of the fifth or sixth highest ozone concentration might have been worthwhile.	Refer to the response provided in Section 4.17.2 of this document. The phrase "highly improbable" was used as the CO_2 venting is not expected to occur on a continuous basis as modelled, but may occur over time periods varying from hours to days, which would reduce the amount of pollutants being vented into the atmosphere, thereby reducing the possibility of high concentrations occurring in adverse conditions. Adverse conditions contributing to ozone formation are understood to be high ultraviolet (UV) radiation in the atmosphere typically experienced during the summer months of the year. It is not practicable to time planned acid gas venting events in accordance with the daily level of UV

Table 4.22		Air Emissions	
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			radiation. However planned major train maintenance shutdowns will be scheduled around the winter months of the year, which will result in these adverse conditions being effectively avoided.
14.3	DEC – Air Quality Management Branch	Three "1V-1102" in Table 7-8 are the main source of R_{smog} during upset conditions, but nowhere are they identified. However, in Section 8.1.5.2, it is stated "These high ozone concentrations result from the increased emissions of VOC from the Amine Regenerator Reflux Drum vent (Table 7-8)". It would have been useful for the major contributors to emissions to have been more clearly identified.	With reference to Tables 7-5, 7-6, 7-7 and 7-8 and Figure 3-2 of SKM's Air Quality Assessment Report (Appendix G of the PER), the major sources of emissions of atmospheric pollutants include: ♦ 1KT-1510, 2KT-1510, 3KT-1510, 1KT-1530, 2KT-1530, 3KT-1530 are the LNG Train GE Frame 7 Refrigeration Compressor Gas Turbines (noted as MR LP Compressor Gas Turbine Stack and PR Compressor Gas Turbine Stacks on Figure 3-2) ♦ GT-4001, GT-4002, GT-4003, GT-4004 and GT-4005 are the Power Generation Plant GE Frame 9 Gas Turbine Generators (shown as Power Generation Gas Turbine Generator Stacks on Figure 3-2) ♦ F-4001 and F-4002 are the two heating medium heaters shown on Figure 3-2 ♦ A-6201 and B-6210 are the wet and dry gas flares respectively (all located in the Ground Flares area shown on Figure 3-2) ♦ A-6203A/B are the BOG Flare main and spare flare headers (shown as BOG flares on Figure 3-2; now both located onto one derrick tower) ♦ 1V-1101 (3 off) are the main acid gas vents within the acid gas trains, off the Amine Regenerator Reflux Drums (noted as Acid Gas Vents in AGRU Trains). LNG and condensate tanks are shown only for information on Figure 3-2. They were not identified as major emission sources for the purposes of the Air Quality Assessment study.
14.4	DEC – Air Quality Management Branch	Predicted H_2S concentrations, particularly during CO_2 venting periods, are significant. They are compared only to occupational health limits, which they meet, but not to ambient odour criteria. A commonly-quoted odour threshold for H_2S is 200 $\mu g/m^3$, which corresponds to a considerable fraction of the Island surface in Figure 8-36 of Appendix G.	The potential for personnel exposure to hazardous concentrations of H_2S during acid gas venting was recognised early. A number of risk reduction options to mitigate the effects of H_2S and BTEX released with the acid gas stream were considered early in the Development's design; e.g. incinerating the acid gas stream after dilution with hydrocarbon gas, BTEX adsorption using activated charcoal or a liquid solvent (TEG), AGRU process modifications, etc. Due to the vented acid gas stream being extremely dilute, low in pressure and high volume, none of these options are able to deliver a significant risk reduction across HES objectives in a cost effective manner. The Development's design has therefore focused on increasing the reliability of the CO_2 injection system and the vent

Table 4.22		Air Emissions	
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			system design that facilitates the quick dispersion of the acid gas stream. The air quality modelling work conducted by SKM for the purposes of the PER considered a continuous 24 hours a day, 365 days a year acid gas venting scenario; in reality such events will be of much shorter duration and will add up cumulatively to less than 20% of the operational plant time, or less than 76 days per year on average. Reliability modelling conducted for the 3 x 5 MTPA Gas Treatment Plant (International Risk Consultants 2008) indicates that each of the CO_2 compression trains could be out of service for up to 87 hours a year, or approximately 260 hours (approx. 11 days) in total for the three trains, during which time the acid gas produced by the Acid Gas Removal Units (AGRUs) would be vented. This equates to approximately 3% of the time over a calendar year. Reliability modelling did not include the reliability of the CO_2 injection wells or the target Dupuy formation; however, acid gas venting periods shall not exceeds 20% of the operational uptime of the Plant (calculated as a five year rolling average). The modelling results presented in the PER are based on a design H_2S concentration in the inlet Gorgon feed gas stream of 25 ppmv, whilst in reality it is expected that this concentration will be a factor of two to ten times lower. This effectively means that the H_2S modelling results presented in the PER are conservative and may be considered to represent a worst-case concentration during acid gas venting. The risk of H_2S to the health of personnel is dependent on its concentration and the exposure period. The following information on low concentrations of H_2S is available from the World Health Organisation (WHO) Concise International Chemical Assessment Document 53: Hydrogen Sulfide: Human Health Aspects (available from http://www.inchem.org/documents/cicads/cicads/cicad53.htm): ♦ the Lowest Observed Adverse Effect Level (LOAEL) is 2.8 mg/m^3. An uncertainty factor of 10 for LOAEL and of 3 for human variability (particularly in relation to asthmatics) is applied to give a short-term tolerable concentration of 2.8/(10 x 3) = ~100 µg/m^3. No time adjustment to exposure is used as H_2S toxicity is concentration rather than duration-dependent ♦ the WHO air quality guideline for hydrogen sulfide is 150 µg/m^3 for an average concentration over 24 hours. The health end-point was eye irritation. To avoid odour annoyance, a 30 minute average ambient air concentration not exceeding 7 µg/m^3 is recommended.

Table 4.22		Air Emissions	
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			The above information will be considered in setting performance criteria for the design of the acid gas vent stack. Personnel exposure to H_2S will be reduced by the fact that the Gas Treatment Plant is designed to be operated with minimal operator presence in the field and only a few operators are expected to be at the Plant site at any one time. Additional design and procedural controls will be included in the Plant's design, e.g. warning personnel of acid gas venting events and allowing for their safe egress from potentially affected work areas: ♦ use of H_2S gas monitors/sensors strategically located around the plant to detect the presence of low level hazardous concentrations of H_2S and alert operators via a sound alarm ♦ switch over from acid gas injection to acid gas venting will cause an alarm within the Central Control Room, which will be amplified in the field. This will alert personnel to commence safe egress from the area ♦ a permit to work system will be put in place for any work carried out in the vicinity of the Acid Gas Removal Units (AGRUs) and the CO_2 compression trains. As a last barrier to reduce personnel exposure, adequate PPE will be provided in strategically located areas around the Plant to allow for safe and controlled egress from affected work areas.
14.5	DEC – Air Quality Management Branch	Please note the following important information relevant to the review of this proposal: ♦ Pollutants of concern considered by the consultant are SO_2, NO_2, O_3, particles and H_2S. There may be other pollutants emitted at trace levels that may contribute to cumulative concentrations; ♦ We do not assess the proposed technology in terms of emission control, and how this relates to requirements for implementation of "Best Practice" as per EPA Guidance Statement No. 55; ♦ Greenhouse gas emissions have not been assessed as part of the air quality review; ♦ We do not attempt to verify measured emission concentrations, stack flow rates or other parameters/calculations used in the estimation of reported	Noted that these are the limitations/caveats that the DEC – Air Quality Management Branch place on their review.

Table 4.22		Air Emissions	
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		emission rates.	
Verbal query 19 Feb 2009	EPA Board meeting	Did the modelling include the existing operations on Barrow Island (oil field) and Varanus Island? Did the model include the other contributors to the Pilbara airshed?	The modelling included predicted impacts from the following existing or approved industrial activities: ♦ Existing WA Oil Facilities on Barrow Island (including the gas power generation station); ♦ NWSV Karratha Gas Plant including the new Train 4 and Train 5; ♦ The Pluto Gas Plant; ♦ Hamersley Iron power station at Parker Point near Dampier (2 stacks); and ♦ Burrup Fertiliser's ammonia plant (2 stacks). The Varanus Island Facility was not considered to emit significant quantities of air pollutants to be included in the model.

4.15 Light Emissions

Table 4.23: Light Emissions

Table 4.23		Light Emissions	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
6.11	WWF	WWF-Australia assesses the risk categories 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. These two populations are a significant component of the regionally and globally important Flatback Turtle population, and potentially represent genetically distinct lineages from other regional nesting populations. WWF-Australia assesses the risk to the collective Barrow Island Flatback Turtle nesting populations on Barrow Island as major (local, long-term or widespread, short-term impact leads to loss of local population/s and reduced viability of the race on Barrow) and likely. WWF-Australia assesses the major stressors as: ♦ Underwater noise associated with the construction, possible blasting and ongoing operation of the proposed Development. This is likely to affect the Flatback Turtle nesting population (both internesting and foraging individuals) using the east coast of Barrow Island. The anticipated result is reduced nesting frequency. This stressor and its impact have not been adequately addressed in the documentation and studies. Noise will also affect the behaviour of Green, Hawksbill and Loggerhead Turtle (adult and juvenile) foraging populations along the east coast. The EIS/ERMP does not address this problem or investigate potential impacts. ♦ Light during construction and operation. This is likely to cause Flatback Turtle hatchling disorientation in the two nesting beaches in the vicinity of the proposed Development. This poses a risk through disorientation of hatchlings, potential disorientation with respect to their return to their natal nesting beach as adults, and potentially increased predation of hatchlings attracted to jetty and ship lights. The studies in Technical Appendices C6–C9, reaction of turtle hatchlings to different light sources, and the survey of existing lighting,	Refer to Table 4.15 (Item 6.11) in this document, which addresses comments regarding marine fauna.

Table 4.23		Light Emissions	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
		underscores the likelihood of this risk, and does not adequately address the risk from the proposed development when fully operational. ♦ Altered coastal and nearshore currents in the internesting area as a consequence of the construction of the MOF and jetty, causing a potential disorientation of foraging and internesting Flatback Turtles and disruption of behaviour. The altered currents may cause alteration of beach characteristics that could alter nesting and/or hatching success. The modelling in Technical Appendices B3-6 does not adequately address this stressor. ♦ Sedimentation and physical disturbance of internesting habitat from the construction of the causeway, the construction of the jetty and the dredging of nine million cubic meters of sediments for the boat channel and its frequent use by large vessels represents a significant impact on the internesting habitat, and is an almost certain major impact on internesting turtles. ♦ Chemical pollution. No chemical baseline data have been collected from the water and nesting beaches in the Town Point area. This is essential to ensure that the beaches remain pollutant free to enable normal development of the turtle embryos in the sand. A regular monitoring program and relevant management actions would need to be developed for this stressor. WWF-Australia maintains that these risks to a globally and regionally important listed marine species disqualify Barrow as a candidate site for the proposed development. On the basis of this level of risk, approval for the proposed development on Barrow Island should be denied. WWF-Australia calls for the proposed additional work described on p. 273: "Surveys in winter 2005 will determine whether the sandy seabed off Town Point is important to inter-nesting or hibernating Flatback Turtles", to be expanded to include an assessment of juvenile Flatback Turtle habitats.	
6.12	WWF	WWF-Australia notes that the nesting population of Green Turtles on the west coast of Barrow is regionally significant and that impacts on this population have not been fully evaluated. The Proposed shore crossing and onshore feed gas pipeline option at	Refer to Table 4.15 (Item 6.12) in this document, which addresses comments regarding marine fauna.

Table 4.23		Light Emissions	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
		Flacourt Bay should therefore be avoided. In addition, the foraging areas of resident Green, Loggerhead and Hawksbill Turtles in the waters off Barrow Island, have not been fully identified and the impacts examined. Further work needs to be conducted on species and size composition, habitat use, local movements and home ranges of these populations. The impacts of the proposed dredging and jetty construction including lighting and noise impacts on the resident foraging turtles should be conducted.	
9.5	DEC – Environmental Management Branch	Lighting impacts of the expanded development, which result in no dark nights in the vicinity of Bivalve and Terminal beaches. The EPA notes that the proposal will have additional impact on the Barrow Island Flatback Turtle population. The long-term impacts of processing plant lighting considered to be equivalent to between a full and quarter moon every night on turtles breeding near Town Point The processing plant is located directly inland of Town Point (location of causeway) and immediately inland of the east coast turtle nesting beaches. Light spill and light glow from this structure will increase due to the presence of the third LNG train, additional flaring and other associated infrastructure. It is expected that light spill and light glow will impact on nesting turtles and may lead to misorientation of hatchlings. The lighting study showed that under normal operating conditions, the plant would emit light of a similar lux to that of a clear night with between a full and quarter moon. Interpretation of the results with respect to impacts on turtles is absent from the PER, however, the results suggest that the plant would always be equally as bright as between a full and quarter moon under normal operations. The effect on turtle breeding of never having dark nights at Bivalve and Terminal beaches is uncertain given the general preference of turtles to nest on moonless/dark nights. Hatchling, juvenile and mature turtles may also be further impacted due to the increase in shipping and offshore lighting. Attempts to monitor hatchling dispersal in the past have proven to be problematic due to the nature of the study (night time dispersal, weather conditions etc.). The increase in shipping noise, potential for collisions and potential for misorientation and disorientation of hatchlings into vessel and shipping berth/jetty light fields is likely to increase the risk to the Barrow Island turtle population. The PER	Refer to Section 4.9.1 in this document, which addresses comments regarding the potential impacts of artificial lighting on marine turtles as a result of the Revised Proposal. The additional 1m of water depth at the head of the MOF will have no impact on potential vessel strikes as the vessels entering and leaving the MOF are confined to the MOF channel. The increase in operations phase LNG vessel movements occurs a further 2 km offshore. If the comment relates to offshore shipping, it was acknowledged in the PER that LNG carriers and condensate carrier movements will increase from approximately 240 vessels per year to approximately 300 vessels per year and that this would result in an increase in the likelihood descriptor in the risk assessment for vessel strikes from 'likely' to 'almost certain'. However, this increase in likelihood did not change the overall risk category for vessel strikes.

Table 4.23		Light Emissions	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
		does not provide a means to quantify the increase in shipping and/or offshore lighting and therefore DEC remains uncertain as to the level of risk posed to turtle breeding success, and so to turtle conservation. The Revised Proposal includes the following additional light generating infrastructure and activities: ♦ addition of a third LNG train with associated infrastructure; ♦ additional marine/boil off gas flare; ♦ proportionate increase in flaring requirements; ♦ proportionate increase in potential for shut-downs, start-ups and emergencies with associated flaring and safety lighting requirements; ♦ changes to causeway/materials offloading facility length and configuration; and ♦ additional shipping and associated support vessels and infrastructure. As requested in advice to the EPA on the Revised Proposal Scoping Document (DEC 2008), the Proponent has undertaken a lighting study. This was completed and provided in Appendix D to the PER, however the study did not take into account all lighting (flaring and offshore lighting were not considered), nor were the outputs of the study used/translated to predict potential impacts on fauna. The text in the PER does not reference the results of the study to confirm the predictions of no significant change or additional risk to turtles and seabirds from the changes in the plant configuration, changes to the causeway/materials offloading facility and additional shipping with respect to lighting. 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.	

4.16 Noise Emissions

Table 4.24: Noise Emissions

Table 4.24		Noise Emissions	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
6.11	WWF	WWF-Australia assesses the risk categories 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. These two populations are a significant component of the regionally and globally important Flatback Turtle population, and potentially represent genetically distinct lineages from other regional nesting populations. WWF-Australia assesses the risk to the collective Barrow Island Flatback Turtle nesting populations on Barrow Island as major (local, long-term or widespread, short-term impact leads to loss of local population/s and reduced viability of the race on Barrow) and likely. WWF-Australia assesses the major stressors as: ♦ Underwater noise associated with the construction, possible blasting and on-going operation of the proposed Development. This is likely to affect the Flatback Turtle nesting population (both internesting and foraging individuals) using the east coast of Barrow Island. The anticipated result is reduced nesting frequency. This stressor and its impact have not been adequately addressed in the documentation and studies. Noise will also affect the behaviour of Green, Hawksbill and Loggerhead Turtle (adult and juvenile) foraging populations along the east coast. The EIS/ERMP does not address this problem or investigate potential impacts. ♦ Light during construction and operation. This is likely to cause Flatback Turtle hatchling disorientation in the two nesting beaches in the vicinity of the proposed Development. This poses a risk through disorientation of hatchlings, potential disorientation with respect to their return to their natal nesting beach as adults, and potentially increased predation of hatchlings attracted to jetty and ship lights. The studies in Technical Appendices C6–C9, reaction of turtle hatchlings to different light sources, and the survey of existing lighting, underscores the likelihood of this risk, and does not adequately address the risk from the proposed development	Refer to Table 4.15 (Item 6.11) in this document, which addresses comments regarding marine fauna.

Table 4.24		Noise Emissions	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
		when fully operational. ♦ Altered coastal and nearshore currents in the internesting area as a consequence of the construction of the MOF and jetty, causing a potential disorientation of foraging and internesting Flatback Turtles and disruption of behaviour. The altered currents may cause alteration of beach characteristics that could alter nesting and/or hatching success. The modelling in Technical Appendices B3-6 does not adequately address this stressor. ♦ Sedimentation and physical disturbance of internesting habitat from the construction of the causeway, the construction of the jetty and the dredging of nine million cubic meters of sediments for the boat channel and its frequent use by large vessels represents a significant impact on the internesting habitat, and is an almost certain major impact on internesting turtles. ♦ Chemical pollution. No chemical baseline data have been collected from the water and nesting beaches in the Town Point area. This is essential to ensure that the beaches remain pollutant free to enable normal development of the turtle embryos in the sand. A regular monitoring program and relevant management actions would need to be developed for this stressor. WWF-Australia maintains that these risks to a globally and regionally important listed marine species disqualify Barrow as a candidate site for the proposed development. On the basis of this level of risk, approval for the proposed development on Barrow Island should be denied. WWF-Australia calls for the proposed additional work described on p. 273: "Surveys in winter 2005 will determine whether the sandy seabed off Town Point is important to inter-nesting or hibernating Flatback Turtles", to be expanded to include an assessment of juvenile Flatback Turtle habitats.	
6.12	WWF	WWF-Australia notes that the nesting population of Green Turtles on the west coast of Barrow is regionally significant and that impacts on this population have not been fully evaluated. The proposed shore crossing and onshore feed gas pipeline option at Flacourt Bay should therefore be avoided. In addition, the foraging areas of resident Green, Loggerhead and	Refer to Table 4.15 (Item 6.12) in this document, which addresses comments regarding marine fauna.

Table 4.24		Noise Emissions	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
		Hawksbill Turtles in the waters off Barrow Island, have not been fully identified and the impacts examined. Further work needs to be conducted on species and size composition, habitat use, local movements and home ranges of these populations. The impacts of the proposed dredging and jetty construction including lighting and noise impacts on the resident foraging turtles should be conducted.	
9.20	DEC – Environmental Management Branch	Recommendation 17: The Proponent needs to address impacts on marine fauna as a result of noise generating activities.	Refer to Table 4.15 (Item 9.20) in this document, which addresses comments regarding marine fauna.
9.21	DEC – Environmental Management Branch	Recommendation 18: Further analysis of the noise generating infrastructure and activities specific to the Gorgon development is required before an assessment of risk to marine fauna can be made. The Revised Proposal includes the following additional noise generating infrastructure/activities: ♦ addition of a third LNG train, associated gas turbines; ♦ additional power generation turbines; ♦ additional boil off gas flare – proportionate increase in flaring requirements; ♦ additional shipping – LNG, condensate, support vessels etc.; and ♦ change to drilling and blasting and dredge requirements. Potential impacts on marine fauna from noise and vibration are discussed in a general context within the PER. Noise emissions related to additional shipping and changes to construction methodology for the causeway/materials offloading facility (drilling/blasting/ dredging) have not been quantified or addressed in detail. Further analysis of the noise generating infrastructure and activities specific to the Gorgon development is required before an assessment of additional or different risk to marine fauna can be made.	Refer to Table 4.15 (Item 9.21) in this document, which addresses comments regarding marine fauna.

4.17 Greenhouse Gas Emissions

Table 4.25: Greenhouse Gas Emissions

Table 4.25		Greenhouse Gas Emissions	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
1.7	Chamber of Commerce and Industry Western Australia	CCI notes that liquefied natural gas is a relatively clean fuel that imposes a smaller carbon footprint than alternative fossil fuels. We understand that global demand for liquefied natural gas as an environmentally beneficial fuel source is growing and this trend is likely to continue. The Gorgon Gas Development represents an opportunity for Western Australia to utilise its natural resources to forge better environmental outcomes on an international scale.	Comment acknowledged.
2.12	Conservation Council of Western Australia	The scientific understanding of the risks associated with greenhouse gas emissions have only increased in the time since the original proposal was assessed. The risk of failure of the geosequestration project has not diminished through any demonstrated successful projects (i.e. demonstrated over time). 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 the offshore oil and gas reservoirs, this would also decouple the project from Barrow Island, thus allowing an economically, socially and environmentally more acceptable location for the Gorgon projects LNG facilities. Woodside is proposing a dedicated CO_2 pipeline from the LNG plant to Browse or another depleted offshore field near the NWS joint venture for the Browse Basin project.	There have been significant demonstrations of successful sequestration projects between the publication of the EIS/ERMP and that of the PER. The Sleipner Project, which has been in operation for several years, has been joined by the In Salah and Snohvit Projects. These projects inject carbon dioxide at between 700 000 and 1 000 000 tonnes per year. There is also the Otway Basin Pilot Project, which is a significant demonstration of this technology in Australia. The performance of these projects continues to be actively reviewed in the peer-reviewed literature. The Gorgon Gas Development risk assessment relating to CO_2 injection was updated for the Revised Proposal as part of the PER. As part of this process, a Failure Modes and Effects workshop was held to consider the Uncertainty Management Plan developed for the Revised Proposal and assess potential failure modes that might result in an adverse environmental impact. The assessment of failure modes was undertaken by an independent technical panel of experts in the field of CO_2 injection and involved observers from Western Australian and Commonwealth Government Agencies (for a list of attendees please refer to page 272 of the PER). The overall outcome of the risk assessment update relating to CO_2 injection was that there are no additional cumulative risks as a result of the Revised Proposal. The Gorgon Gas Development has also been subjected to several rounds of independent technical assessment by the DoIR. It is true that the Western Australian community will bear the greenhouse 'footprint', which will increase with the emissions associated with the gas processing on Barrow Island. However, given greenhouse gas emissions are a global concern, consideration should also be given to the lifecycle emissions resulting from the use of LNG from this development versus

Table 4.25		Greenhouse Gas Emissions	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
			other forms of energy (e.g. coal). The GJVs are not in a position to comment on other projects. Each project has its own characteristics, requirements and priorities in terms of location, design, gas composition and access to sites. In the case of the Gorgon Gas Development, there are many drivers in addition to the opportunity to dispose of reservoir CO_2 that make Barrow Island the preferred location. Locating the Development on Barrow Island provides the additional environmental benefit to significantly reduce the Development's greenhouse gas emissions by enabling the injection of reservoir CO_2. It would not be possible to achieve this reduction in greenhouse gas emissions if the Gorgon Gas Development was located elsewhere.
2.13	Conservation Council of Western Australia	The injection of CO_2 into the Dupuy Formation is already an experimental project using experimental technology, the risk of failure is significant. As such, increasing the volume and rate of CO_2 injection increases an already high level of risk. No expansions should be considered until the initial project has demonstrated an ability to reliably sequester the CO_2 over a period of time.	Geosequestration is not new with commercial scale CO_2 injection operations commencing at Sleipner in the Norwegian North Sea since 1996 and more recently at In Salah since 2004. Both these large-scale CO_2 injection projects have associated research and development programs. The GJVs have been active participants in the research and development of geosequestration technologies since the inception of this line of research and as such are well placed to apply these technologies. The technologies to undertake geosequestration including gas compressors, pipelines, wells, monitoring technologies and approaches to uncertainty management are all technologies that are well-established and readily applied in the oil and gas industry. The Development's risk assessment relating to CO_2 injection was updated as part of the Revised Proposal's PER. As part of this process, a Failure Modes and Effects workshop was held to consider the Uncertainty Management Plan developed for the Revised Proposal and assess potential failure modes that might result in an adverse environmental impact. The assessment of failure modes was undertaken by an independent technical panel of experts in the field of CO_2 injection and observers from Western Australian and Commonwealth Government Agencies (for a list of attendees please refer to page 272 of the PER). Although the independent technical panel that undertook the failure modes and effects assessment assessed that CO_2 leakage via the Plato and Godwit Faults as 'Possible', the likelihood can be reduced by changing the bottom hole location of a number of the injection wells proposed in the northernmost portion of Barrow Island. The bottom hole location of Inj-08 shown on Figure 12.3 of the PER has been moved south and east and is now in line with DC-N3. The bottom hole locations have not been finalised and are subject to approval under

Table 4.25		Greenhouse Gas Emissions	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
			the *Barrow Island Act 2003* in consultation with the Department of Mining and Petroleum (DMP) who plan to conduct additional due diligence of the Gorgon Gas Development changes prior to their approval of the development plan. The likelihood of leakage via the Godwit and Plato faults may change from 'Possible' to 'Remote' with relocation of Inj-08 further south and east as well as other management measures. The overall outcome of the risk assessment update relating to CO_2 injection was that there are no additional cumulative risks as a result of the Revised Proposal. The GJVs have committed to comprehensive monitoring of the CO_2 injection system to ensure that the CO_2 plume behaves as predicted. An adaptive management program will be implemented to manage any risks associated with the CO_2 injection processes. The work has been, and will continue to be, scrutinised by government through the agreed Carbon Dioxide Disposal Management Plan as well as ongoing supervision of CO_2 injection activities.
2.14	Conservation Council of Western Australia	The CO_2 injection plan involves the use of seismic technology to track the location of the CO_2 plume, it is not clear if this will have a long-term impact on the marine environment, and in particular cetaceans.	Seismic monitoring of the subterranean CO_2 plume will periodically emit noise and vibration (once every six to eight years) during the operational phase of the Gorgon Gas Development. The impacts to marine fauna from seismic-related noise and vibration emissions are predicted to be limited to short-term behavioural disturbances. The EBPC Act Policy Statement 2.1 outlines procedures for managing interactions between seismic surveys and cetaceans and these will be followed in seismic monitoring of the CO_2 plume. Seismic monitoring was assessed as part of the Approved Development. It is considered that noise and vibration emissions from the Revised Proposal work activities do not present additional risk, or different types of environmental risk, to marine fauna beyond those assessed for the Approved Development. Refer to Table 4.11: (Item 2.14) in this document, which addresses comments regarding the general marine and coastal environment. Further information is provided in Section 4.8.3 of this document.
2.15	Conservation Council of Western Australia	It is not understood why the plume modelling is for 1000 years, what happens in the next 500 years if/when the plume meets the Plato or Godwit faults? What happens if the modelling is incorrect (given especially that modelling of the movement of CO_2 through underground aquifers must be a relatively new and not well calibrated exercise)? This is especially concerning given comments on page 273 that the independent risk assessment panel found that leakage via faults is "possible". Given the	While images from a single model run were provided in the PER, the GJVs have completed a large number of simulations. This has allowed the GJVs to develop a complete picture of possible outcomes across the full range of reservoir parameters. This follows the standard approach widely used in the oil and gas industry for the management of subsurface uncertainty. This approach to simulation was a key part of the independent technical reviews of reservoir CO_2 injection undertaken by DoIR, the results of

Table 4.25		Greenhouse Gas Emissions	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
		consequence for WA's greenhouse gas emissions, the marine, subterranean and terrestrial environment at Barrow Island Nature Reserve, this is an unacceptable level of risk. The proposal to use an adaptive uncertainty management approach to CO_2 management also adds to concerns as this also demonstrates a high level of uncertainty around the behaviour of injected CO_2 at this volume and pressure. Injection of CO_2 must be shown to be permanent and certain.	which have been previously discussed. Simulation modelling shows that following the cessation of injection operations the rate of plume migration through the reservoir drops significantly. The selection of the modelling window of 1000 years is felt to be an appropriate balance between modelling an injection period of approximately 50 years followed by a post injection period of approximately 950 years. Although the independent technical panel that undertook the failure modes and effects assessment assessed that CO_2 leakage via the Plato and Godwit Faults as 'Possible', the likelihood can be reduced by changing the bottom hole location of a number of the injection wells proposed in the northernmost portion of Barrow Island. The bottom hole location of Inj-08 shown on Figure 12.3 of the PER has been moved south and east and is now in line with DC-N3. The bottom hole locations have not been finalised and are subject to approval under the *Barrow Island Act 2003* in consultation with the Department of Mining and Petroleum (formerly Department of Industry and Resources) who plan to conduct additional due diligence of the Gorgon Gas Development changes prior to their approval of the development plan. The likelihood of leakage via the Godwit and Plato faults may change from 'Possible' to 'Remote' with relocation of Inj-08 further south and east as well as other management measures. The overall outcome of the risk assessment update relating to CO_2 injection was that there are no additional cumulative risks as a result of the Revised Proposal. The adaptive management approach during the operation of the Gorgon Gas Development will ensure that any excursion of the actual behaviour from the modelled behaviour can be addressed well before adverse impacts are experienced.
2.16	Conservation Council of Western Australia	Given the project life, a more useful comparison of emissions from the project (than that given in Table 12.2) would be to compare to the state 2050 target for greenhouse gas emissions at 26mtpa. This would make the Gorgon project contribute 21% of the states emissions at this time.	It is the GJVs' desire to design and operate one of the world's most efficient developments in terms of greenhouse gas emissions. The GJVs have outlined a number of actions they will undertake to reduce greenhouse gas emissions below approved levels. In considering the impact on greenhouse gas emissions, consideration should be given not just to emissions within one jurisdiction, but also to the full life cycle emissions impact. It is widely accepted that the increased use of natural gas represents a valuable transition fuel to a low emissions future. The use of Gorgon LNG has the potential to lower global greenhouse gas emissions by approximately 45 million tonnes per year compared to the use of traditional fuels such as coal. The GJVs acknowledge that there is no guarantee that if LNG from Gorgon was not

Table 4.25		Greenhouse Gas Emissions	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
			available to international energy markets that the demand would completely be replaced with coal usage but this is certainly a credible scenario given coal's relative abundance and cost, particularly in developing nations that have not signed up for emissions targets or trading schemes.
2.17	Conservation Council of Western Australia	Table 12.1 should include a column for cleaner gas than Gorgon and for renewable energy, which would show close to zero million tones per annum CO_2.	As a general rule, all gas fields contain a certain percentage of reservoir CO_2. In the original EIS/ERMP it was shown that the Gorgon Gas Development would be amongst the most greenhouse gas emissions-efficient LNG project in the world. Based on this benchmarking activity it was felt that further comparison of the Development's overall CO_2 emissions per annum was not required. Carbon intensive fuels such as coal currently dominate the world energy market. Increasing the use of natural gas over other traditional fossil fuels is an effective method of reducing global greenhouse gas emissions. While greenhouse gas emissions in Western Australia will increase by approximately 1.5 million tonnes per annum as a result of the Revised Proposal, global life cycle emissions will be approximately 14 million tonnes lower than if that energy demand had been satisfied by the increase use of traditional fuels such as coal.
3.3	Department of Industry and Resources	The Revised Proposal details changes to the reservoir CO_2 injection system required as a result of the proposed additional LNG production train. Under the Act the Joint Venturers are required to submit an application to inject CO_2, and under the Agreement they are required to submit detailed proposals on the injection system. As part of the approvals process, the Department intends to undertake a detailed review of the CO_2 injection system.	The GJVs will follow the due process (with appropriate agencies) to ensure the acquisition of required approvals and approval of required management plans.
3.4	Department of Industry and Resources	It should be noted that the Department engaged independent consultants to appraise the feasibility of the proposed CO_2 injection system for the Approved Development. The review indicated that, based on the information available at that time, there appeared to be no significant issues to compromise the feasibility of the proposed injection. At this time, the Department believes that any impacts associated with the increased rate of injection detailed in the Revised Proposal can be addressed by the Joint Venturers undertaking appropriate monitoring and management planning.	The GJVs acknowledge the recognition of the independent DoIR review that the Revised Proposal's CO_2 injection system and the associated management and monitoring activities will address the impacts associated with the increased rate of reservoir CO_2 injection.
6.4	WWF	One of the contextual matters that we would identify here in particular (but not to suggest that other matters are any less important) is that of the treatment of greenhouse gases. Again, we would submit that changes in the national and international context	Refer to Table 4.27 (Item 6.4) in this document, which addresses comments regarding management actions and proposed environmental conditions.

Table 4.25		Greenhouse Gas Emissions	
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		must be considered in this new assessment. We believe that Governments must make the safe injection of reservoir carbon dioxide a strict condition of approval for this project. The project should be wholly re-evaluated if this condition cannot be met and this test must be applied before further approvals are given. As we have indicated before, we believe it would be prudent for other geological formations in the general area to be further examined for their potential to safely accommodate and store greenhouse gases. (We also note matters like the Proponent' commentary around the challenges to power generation for the treatment plant and subsequent greenhouse gas management presented by Barrow Island's "remoteness" from alternative sources of energy, p. 255-6).	
7.5	Cape Conservation Group	The increased threat to subterranean fauna, including the EPBC listed Blind Gudgeon, from potential leaks of injected CO_2 into subterranean habitat on the Island appears not to have been considered. This risk will have risen with increased injection rates.	Refer to Table 4.9 (Item 7.5) in this document, which addresses comments regarding subterranean fauna.
7.8	Cape Conservation Group	The scientific understanding of the risks associated with greenhouse gas emissions have only improved in the time since the original proposal was assessed. The risk of failure of the geosequestration project has not diminished through any demonstrated successful projects. 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 the offshore oil and gas reservoirs, this would also decouple the project from Barrow Island, thus allowing an economically, socially and environmentally more acceptable location for the Gorgon projects LNG facilities.	Refer to Table 4.25 (Item 2.12) of this document for a response.
9.10	DEC – Environmental Management Branch	There is a potentially increased risk of detrimental impact on fauna, including subterranean fauna, from possible failure of the expanded CO_2 injection system. Recommendation 24: More information is required regarding how the risks and impacts associated with a leak or release of CO_2 at the greater rate of production (vegetation/fauna/human) have altered, including clarification of the calculation of risks to subterranean fauna from a potential CO_2 escape. The accelerated rate at which reservoir CO_2 is proposed to be injected will require additional injection wells and drill centres, with a corresponding increase in pipelines, and as the pressure is	Refer to Table 4.9 and Table 4.10 (Item 9.10) in this document, which address comments regarding subterranean fauna, and flora and vegetation respectively. Refer to Section 4.17.1of this document for a response.

Table 4.25		Greenhouse Gas Emissions	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
		expected to increase more rapidly in this Revised Proposal, a number of pressure release wells and associated ancillary infrastructure are required. Given the increase in the rate of CO_2 production and requirement for injection, failure of the injection system may lead to larger volumes of CO_2 being leaked/vented/released to the atmosphere. Additional information is required regarding how the risks and impacts associated with a leak or release of CO_2 at the greater volume of production (impacts on vegetation/fauna/human) have altered. Greater rates of injection also may reduce any response time in the case pressure reaches peak levels within the formation. It is not clear that the mitigation and management of the CO_2 sequestration operations are adequate.	
9.28	DEC – Environmental Management Branch	Recommendation 25: The EPA notes that greenhouse gas emissions will increase from four million tonnes per annum CO_2e (carbon dioxide equivalent) for the Approved Development to 5.45 million tonnes per annum CO_2e (an increase of 36 per cent) for the Revised Proposal. Air emissions of combustion products will increase as a result of the extra energy requirements of the third LNG train. The addition of the third train is anticipated to increase the emission of greenhouse gases by 1.45 million tonnes per annum of carbon dioxide equivalent (CO_2e), to 5.45 million tonnes per annum CO_2e.	Atmospheric greenhouse gas emissions associated with the expanded gas processing operations will increase as presented in the Revised Proposal's PER. However, the GJVs note that the emissions per unit of production associated with the Revised Proposal remains consistent with those for the Approved Development reflecting the use of currently applied best practice in terms of energy efficiency and emissions reduction and control. It is also worth noting that increasing the use of natural gas over other traditional fossil fuels is an effective method of reducing global greenhouse gas emissions. While greenhouse gas emissions in Western Australia will increase by approximately 1.5 million tonnes per annum due to the Revised Proposal, global life cycle emissions will be approximately 14 million tonnes lower than if that energy demand had been satisfied by the increase use of traditional fuels such as coal.
9.29	DEC – Environmental Management Branch	The annual average volume of CO_2 anticipated to be injected into the Dupuy Formation has increased from 2.7 million tonnes per annum for the Approved Development to 3.36 million tonnes per annum for the Revised Proposal.	Correct, as acknowledged in the PER. No response required.

4.17.1 Further Information Regarding the Risks and Impacts Relating to Leak or Release of CO_2 at the Greater Volume of Production

The Gorgon Gas Development's risk assessment relating to potential impacts of leaks or release of CO_2 on subterranean fauna was updated to give consideration to potential new environmental impacts that may result from the Revised Proposal. As part of this process, a Failure Modes and Effects workshop was held to consider the Uncertainty Management Plan developed for the Revised Proposal and assess potential failure modes that might result in an adverse environmental impact. This included representatives of the GJV Operator, a technical panel of experts in the field of CO_2 injection, and involved observers from Western Australian and Commonwealth Government agencies. This analysis determined that there are no unacceptable cumulative risks to subterranean fauna as a result of the Gorgon Gas Development. Full details indicating the basis for the risk assessment and the stressors considered can be found in Appendix I of the PER.

Although an increased CO_2 injection rate and volume is planned as part of the Revised Proposal, additional management strategies such as the earlier implementation of a pressure management strategy result in the risk of an unplanned CO_2 release to the surface or near surface from surface facilities or an unplanned migration of CO_2 from deep faults being low.

The Approved Development is subject to a number of environmental approval conditions that regulate emissions and address issues such as the leakage of injected CO_2 into the near-surface cave systems on Barrow Island.

On the first page of Attachment 1 to the DEC submission on the Revised Proposal, it is noted that "Due to the assessment and presentation of only those parts of the project affected by the revised and expanded proposal, it is believed that scale and impact presented within the PER may be underestimated". The GJVs highlight that in assessing the impacts associated with the underground injection of CO_2, the impact of both the Approved Development and the Revised Proposal were considered as it is not possible to assess only the risks associated with the incremental expansion of the CO_2 injection system. The CO_2 injection-related risks contained in the PER are those associated with the overall Gorgon Gas Development. That is, three trains and 15 MTPA.

The risk assessment incorporates the increase in geologic knowledge acquired since the evaluation of the Approved Development. This work incorporates the results of the recently drilled data well on Barrow Island and technical studies addressing the recommendations from the due diligence reviews undertaken by the DoIR (now the Department of Mining and Petroleum), the agency that will ultimately regulate the CO_2 Injection Project.

The risk assessment process used for both the Approved Development and the Revised Proposal was essentially the same, leveraging independent experts to assess the likelihood of potential failure modes and the potential consequences in terms of volume and geographic extent (both through the subsurface and laterally) of the injected reservoir CO_2. Interested readers can directly compare the Failure Modes and Effects tables published in the EIS/ERMP (Chapter 13) for the Approved Development with those in the Appendix I of the PER to gauge how the risks associated with the underground injection of reservoir CO_2 have changed as a consequence of:

- the increased injection rates associated with the Revised Proposal
- the revised Development design including changes in response to the need to manage potential increases in reservoir pressure associated with the increased rates of reservoir CO_2 injection
- improved geological understanding as a result of several more years of technical study and the large amount of technical data obtained via the CO_2 data well.

Refer also to Section 12.5.3 in the PER for a comparison between failure modes and effects assessment as well as Section 4.17.1 in this document which provides further discussion

On page 13 of Attachment 1 to the DEC submission, the DEC states *"Given the increase in the rate of CO_2 production and requirement for injection, failure of the injection system may lead to larger volumes of CO_2 being leaked/vented/released to the atmosphere"*. The GJVs suggest that this conclusion is incorrect and does not recognise that the overall volume of injected reservoir CO_2 is similar between the Approved Development and the Revised Proposal.

The CO_2 pipeline will be designed in accordance with applicable hydrocarbon pipeline code, AS 2885. AS 2885 requires a detailed risk assessment of the potential threats to the pipeline to ensure appropriate design measures are in place to mitigate those threats. A preliminary risk assessment of the risk to the pipeline has been carried out and further assessment including Quantitative Risk Assessment will be conducted in during Phase 4.

As part of the Pipeline License conditions the CO_2 pipeline will require an Operational Pipeline Management Plan (OPMP) to ensure appropriate design, safety and integrity management of the pipeline is in place throughout the pipeline life.

The design of the pipeline ensures:

- Avoidance of routing adjacent to roads and road crossings
- Minimal threat of external interference due to restricted access to Barrow Island, permit to work, barriers in place where required
- Maximum ability to inspect and ensure pipeline and coating integrity with above ground design
- Ability to periodically intelligent pig main pipeline

These measures reduce the likelihood of any potential pipeline leaks.

In order to mitigate further the likelihood of pipeline failure, the GJVs plan to undertake the following design measures to guarantee the integrity of the CO_2 Injection System:

- Detailed AS2885 Risk Assessment
- Quantitative Risk Assessment of pipeline and wellheads

<u>Assessment of Potential Consequence Variation Due to Increase Inventory</u>

The inventory of CO_2 in the expanded injection system (3 drill centres, 8km of pipeline) has increased from an estimated maximum of 300m^3 to 940 m^3 at any time.

The assessment of consequence from a release of CO_2 involves modelling the steady state dispersion distance to a level which could cause fatality or harm to personnel. This has been modelled for both the Immediate Dangerous to Life and Health (IDLH) level of 4% CO_2 and the Lethal Concentration Low (LCLo) level of 10%.

The steady state distance, and therefore the distance that could impact flora and fauna is reached after a relatively short period of time, such that an increase released inventory (300m^3 to 940 m^3) will not increase the consequence effect distance, rather it would increase the time the plume is present.

The distances to IDLH and LCLo are as follows:

Representative Hole Size	Distance to IDLH (m)	Distance to LCLo (m)
10mm	8.5	3.5
50mm	48	17
100mm	105	42

The result of this information for the risk assessment process is that the consequence level for a leak is considered to be the same for both the Approved Development and the Revised Proposal.

The CO_2 Injection System integrity is unchanged by a higher injection rate. Design pressures are unchanged and design requirements, methodologies and regulatory approval processes for the wells and pipeline are unchanged (e.g. pipeline licence required under the *Petroleum Pipelines Act 1969)*. In the event of system unavailability, a greater proportion of CO_2 would need to be vented but this is reflected in the emissions estimate provided in the PER. In the event of a mechanical failure, the stored volume of reservoir CO_2 in the injection equipment is slightly larger for the Revised Proposal but the likely volumes that would be released as a consequence of a failure of the injection compressors or of the injection pipeline remain within the estimates provided for the Approved Development. For example, a failure of the compressors may result in a release of several tens of tonnes of reservoir CO_2, while a pipeline failure may result in a release of several hundred tonnes. These volumes are not anticipated to increase with the Revised Proposal.

The CO_2 Injection System's design and operation is regulated under the *Barrow Island Act 2003* (WA), which requires the GJVs to demonstrate the safety of the design from both subsurface and facility perspectives.

In relation to the release of injected CO_2, the factors that determine the rate and volume released relate to the total volume injected and the size and permeability of the leak conduit. These are effectively independent of the injection rate.

The GJVs note that the total volume of reservoir CO_2 proposed to be injected remains essentially the same between the Approved Development and the Revised Proposal.

The change in injection rate associated with the Revised Proposal impacts upon the pressure within the reservoir, which must be managed in order to avoid fracturing the overlying barriers to the vertical migration of the injected reservoir CO_2. The GJVs have mitigated the increase in pressure associated with the increased rate of injection by the use of additional injection wells, locating the injection wells over a wider geographic area and by bringing forward the reservoir pressure management mitigation strategy involving the use of pressure management wells. The implementation of these design feature changes will result in the increase in reservoir pressure associated with higher injection rates remaining well within acceptable limits.

These factors were considered in detail by the independent review team undertaking the Failure Modes and Effects assessment.

4.17.2 Further Information Regarding the Concentration of Ozone and Comparison to NEPM Limit

To satisfy the requirement to provide additional information, a briefing on the reservoir carbon dioxide injection program including predicted injected CO_2 behaviour over time (including any impacts and mitigations), monitoring and verification and external due diligence for the Revised Proposal was provided to the EPA and representatives from the DEC on 2 October 2008. The content of the briefing was based on the best available information at that time, including:

- information from the EIS/ERMP (Approved Development) and the PER (Revised Proposal)
- updated modelling and improved geotechnical knowledge
- specialist technical input.

While the GJVs have proposed that the basis of assessment should consider that 20% of the reservoir carbon dioxide is vented, the objective is to inject all reservoir carbon dioxide except during periods of plant down time or unexpected reservoir constraints. The GJVs anticipate that actual injection performance will result in closer to 95% of the available reservoir carbon dioxide being injected. Reliability modelling conducted for the 3 x 5 MTPA Gas Treatment Plant (International Risk Consultants 2008) indicates that each of the CO_2 compression trains could be out of service for up to 87 hours a year, or approximately 260 hours (approximately 11 days) in total for the three trains, during which time the acid gas produced by the Acid Gas Removal Units (AGRUs) would be vented. This equates to approximately 3% of the time over a calendar year. Reliability modelling did not include the reliability of the CO_2 injection wells or the performance of the target Dupuy formation.

While there is no direct cause and effect link between acid gas injection and air quality, there is, however, a direct cause and effect link between acid gas venting and air quality. Acid gas venting releases CO_2, minor methane (GHG emissions), BTEX and H_2S (atmospheric pollutants). BTEX is a contributor to the formation of ozone. Acid gas venting has been modelled as a continuous 24 hours a day, 365 days a year operation. Peak ozone levels therefore reflect an unmitigated continuous venting operation, which is highly unlikely to occur. In reality, acid gas venting will only occur episodically over the year, for less than 20% of the calendar year, and not over long periods of time (e.g. over a week or more).

A number of risk reduction options to mitigate the effects of H_2S and BTEX released with the acid gas stream were considered early in the design (e.g. incinerating the acid gas stream after dilution with hydrocarbon gas, BTEX adsorption using activated charcoal or a liquid solvent (TEG), AGRU process modifications). Due to the vented acid gas stream being extremely dilute, low in pressure and high in volume, none of these options are able to deliver a significant risk reduction across HES objectives in a cost effective manner. The Development's design has therefore focused on increasing the reliability of the CO_2 injection system and the vent system design, which facilitates quick dispersion of the acid gas stream.

The air quality modelling work conducted by SKM Pty Ltd for the purposes of the PER considered a continuous 24 hours a day, 365 days a year acid gas venting scenario, whilst in reality such events will be of much shorter duration and will add up cumulatively to less than 20% of the operational plant time, or less than 76 days per year on average. Reliability assessment did not include the reliability of the CO_2 injection wells or the target Dupuy formation, however acid gas venting periods shall not exceed 20% of the operational uptime of the plant (calculated as a five year rolling average).

The top ten ozone concentrations predicted to occur during CO_2 venting events are presented in Figure 4.5. This figure shows that the maximum and second highest concentrations are above the 1-hour National Environment Protection Measures (NEPM) criterion with all subsequent concentrations predicted to be below the 1-hour NEPM criterion.

The 1-hour NEPM criterion is predicted to be exceeded twice over a full year of CO_2 venting modelling. As this is an upset condition, the 4-hour NEPM CO_2 venting criterion is not presented as such an event may occur for less than this time period.

Figure 4.5: Ranking of Ozone Concentrations During CO_2 Venting Scenarios

4.18 Matters of National Environmental Significance

Table 4.26: Matters of National Environmental Significance

Table 4.26		Matters of National Environmental Significance	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
2.7	Conservation Council of Western Australia	Increased light impacts and shipping movements on a major Flatback Turtle rookery. These impacts were considered unacceptable in Bulletin 1221 and thus must remain so with an increase in impacts due to additional industrial infrastructure.	Refer to Table 4.15 (Item 2.7) in this document, which addresses comments regarding marine fauna.
2.8	Conservation Council of Western Australia	Subterranean fauna impacts remain unacceptable and will increase with this proposal. In this PER the Proponent has done nothing to further the understanding of the importance of the habitat included within the project footprint on troglofauna and stygofauna. Sampling has demonstrated that some species (although not *Thysanura Trinemura*) have been found outside of the footprint, but the Proponent has not even attempted to characterise the importance of the disturbed habitat in terms of the distribution of appropriate habitat for troglofauna; nor have they attempted to identify any features of habitat in the project footprint that may differentiate it from other habitat on the Island. It is suspected that, as stated in Bulletin 1221, this is because the habitat is significant. Barrow Island is modelled as having high conservation values of international significance for subterranean fauna.	Refer to Table 4.9 (Item 2.8) in this document, which addresses comments regarding subterranean fauna.
2.9	Conservation Council of Western Australia	The increased risk to subterranean fauna, including the EPBC listed Blind Gudgeon, from potential leaks of injected CO_2 into subterranean habitat on the Island appears not to have been considered. This risk will have increased with increased injection rates. It still appears to be an unknown as to what the impacts of increased acidity in the ground water due to a CO_2 leak would have on the Blind Gudgeon, and how long a leak would take to start harming the population. The three months allowed for a response in the environmental conditions does not appear to be based on any science.	Refer to Table 4.9 (Item 2.9), which addresses comments regarding subterranean fauna.
4.4	Marine Parks and Reserves Authority	The MPRA are also concerned that the extension of the causeway will have a significant impact on Flatback Turtle nesting, on the east coast of Barrow Island. Marine turtles move laterally in shallow waters along the coastline searching for a suitable nesting site.	Refer to Table 4.15 (Item 4.4) which addresses comments regarding marine fauna.
4.5	Marine Parks and Reserves Authority	The existing gas processing facility at Town Point is adjacent to a significant rookery for Flatback Turtles. Light spill and light glow	Refer to Table 4.15 (Item 4.5) which addresses comments regarding marine fauna.

Table 4.26		Matters of National Environmental Significance	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
		from this facility will increase if a third LNG train is commissioned (as indicated in the Revised and Expanded Proposal). The light study, as outlined in the PER, concluded that under normal operating conditions the processing facility would emit light similar to that of a full or quarter moon on a clear night. The MPRA are concerned that this level of light will impact significantly on nesting turtles and may lead to disorientation and/or misorientation of hatchlings. The potential impacts of increased light on turtle nesting were not considered in the PER.	
6.11	WWF	WWF-Australia assesses the risk categories 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. These two populations are a significant component of the regionally and globally important Flatback Turtle population, and potentially represent genetically distinct lineages from other regional nesting populations. WWF-Australia assesses the risk to the collective Barrow Island Flatback Turtle nesting populations on Barrow Island as major (local, long-term or widespread, short-term impact leads to loss of local population/s and reduced viability of the race on Barrow) and likely. WWF-Australia assesses the major stressors as: ♦ Underwater noise associated with the construction, possible blasting and on-going operation of the proposed Development. This is likely to affect the Flatback Turtle nesting population (both internesting and foraging individuals) using the east coast of Barrow Island. The anticipated result is reduced nesting frequency. This stressor and its impact have not been adequately addressed in the documentation and studies. Noise will also affect the behaviour of Green, Hawksbill and Loggerhead Turtle (adult and juvenile) foraging populations along the east coast. The EIS/ERMP does not address this problem or investigate potential impacts. ♦ Light during construction and operation. This is likely to cause Flatback Turtle hatchling disorientation in the two nesting beaches in the vicinity of the proposed Development. This poses a risk through disorientation of hatchlings, potential disorientation with respect to their return to their natal nesting beach as adults, and potentially increased predation of	Refer to Table 4.15 (Item 6.11) which addresses comments regarding marine fauna.

Table 4.26		Matters of National Environmental Significance	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
		hatchlings attracted to jetty and ship lights. The studies in Technical Appendices C6–C9, reaction of turtle hatchlings to different light sources, and the survey of existing lighting, underscores the likelihood of this risk, and does not adequately address the risk from the proposed development when fully operational. ♦ Altered coastal and nearshore currents in the internesting area as a consequence of the construction of the MOF and jetty, causing a potential disorientation of foraging and internesting Flatback Turtles and disruption of behaviour. The altered currents may cause alteration of beach characteristics that could alter nesting and/or hatching success. The modelling in Technical Appendices B3-6 does not adequately address this stressor. ♦ Sedimentation and physical disturbance of internesting habitat from the construction of the causeway, the construction of the jetty and the dredging of nine million cubic meters of sediments for the boat channel and its frequent use by large vessels represents a significant impact on the internesting habitat, and is an almost certain major impact on internesting turtles. ♦ Chemical pollution. No chemical baseline data have been collected from the water and nesting beaches in the Town Point area. This is essential to ensure that the beaches remain pollutant free to enable normal development of the turtle embryos in the sand. A regular monitoring program and relevant management actions would need to be developed for this stressor. WWF-Australia maintains that these risks to a globally and regionally important listed marine species disqualify Barrow as a candidate site for the proposed development. On the basis of this level of risk, approval for the proposed development on Barrow Island should be denied. WWF-Australia calls for the proposed additional work described on p. 273: "Surveys in winter 2005 will determine whether the sandy seabed off Town Point is important to inter-nesting or hibernating Flatback Turtles", to be expanded to include an assessment of juvenile Flatback Turtle habitats.	
6.12	WWF	WWF-Australia notes that the nesting population of Green Turtles	Refer to Table 4.15 (Item 6.12) which addresses comments regarding

Table 4.26		Matters of National Environmental Significance	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
		on the west coast of Barrow is regionally significant and that impacts on this population have not been fully evaluated. The proposed shore crossing and onshore feed gas pipeline option at Flacourt Bay should therefore be avoided. In addition, the foraging areas of resident Green, Loggerhead and Hawksbill Turtles in the waters off Barrow Island, have not been fully identified and the impacts examined. Further work needs to be conducted on species and size composition, habitat use, local movements and home ranges of these populations. The impacts of the proposed dredging and jetty construction including lighting and noise impacts on the resident foraging turtles should be conducted.	marine fauna.
7.3	Cape Conservation Group	Increased light impacts and shipping movements on a major Flatback Turtle rookery. These impacts were considered unacceptable in Bulletin 1221 and thus must remain so with an increase in project size.	Refer to Table 4.15 (Item 7.3) which addresses comments regarding marine fauna.
7.4	Cape Conservation Group	Subterranean fauna impacts remain unacceptable and will increase with this larger proposal. In the PER the Proponent has done nothing to further the understanding of the importance of habitat in the project footprint on troglofauna and stygofauna. Sampling has demonstrated that some species (although not *Thysanura Trinemura*) have been found outside of the footprint, but the Proponent has not even attempted to characterise the importance of the disturbed habitat in terms of the distribution of appropriate habitat for troglofauna and any features of habitat in the project footprint that may differentiate it from other habitat on the Island. It is suspected that, as stated in Bulletin 1221, this is because the habitat is significant. Barrow Island is modelled as having high conservation significance for subterranean fauna.	Refer to Table 4.9 (Item 7.4) which addresses comments regarding subterranean fauna.
7.5	Cape Conservation Group	The increased threat to subterranean fauna, including the EPBC listed Blind Gudgeon, from potential leaks of injected CO2 into subterranean habitat on the Island appears not to have been considered. This risk will have risen with increased injection rates.	Refer to Table 4.9 (Item 7.5) which addresses comments regarding subterranean fauna.
8.1	Western Australian Museum	Consideration of the developments Impact on Flatback Turtles should be more than adequately covered by the undertakings provided.	Refer to Table 4.15 (Item 8.1) which addresses comments regarding marine fauna.
8.3	Western Australian Museum	The proposed expanded proposal does not appear to pose any substantial additional threat to the unique and highly restricted subterranean fauna found on the Island.	Acknowledged.

Table 4.26		Matters of National Environmental Significance	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
9.4	DEC – Environmental Management Branch	The Revised Proposal will further increase risks to the Barrow Island Flatback Turtle population through breeding impacts due to the enlarged causeway disturbance associated with the extended causeway (at 2.1 kilometres, 60 per cent longer than approved). There are a number of changes/additions to the Gorgon development that will potentially increase the risk to turtle populations nesting on Barrow Island. The most significant change is the proposed extension of the solid causeway/materials offloading facility structure from 1.3 to 2.1 kilometres out to sea. The most important Barrow Island Flatback Turtle nesting beaches are located on the east coast of the Island. Marine turtles would normally move laterally along the coastline in shallow waters searching for a suitable site to nest. The causeway obstruction will divide beach access for nesting turtles into northern and southern sections, effectively limiting the availability of nesting sites. Although satellite tracking studies may indicate that some turtles move up to 40 kilometres in range daily, it is considered that fully gravid females forced to swim an additional 4.2 kilometres round trip to navigate around the solid materials offloading facility structure to find their preferred nesting location, will increase energy expenditure and it is highly likely nesting success will be impacted. Recommendation 14: Interpretation of the modelling in the text is inconsistent with the model outputs. It is recommended that a peer review of the model and interpretation of the model results be undertaken. The Revised Proposal includes increasing the length of the solid causeway/materials offloading facility structure by 800 metres to 2.1 kilometres. Modelling undertaken by the Proponent and presented in the PER suggests that there will be shadow zones either side of the causeway, and increased current speed around the end of the materials offloading facility. Quantitative measures as described within Appendix F should have been used in the PER main document when describing actual changes and likelihood of impacts. Further, the descriptions provided in the text of the Appendix are inconsistent with the model results. For example, Section 5 (p 31) states that modelling of Tropical Cyclone Bobby resulted in sedimentation in the magnitude of 0.02 metres, however, on review of the model output (Figure 3.8) it is evident that sedimentation on shore is up to 0.125 metres	Refer to Table 4.15 (Item 9.4) in this document, which addresses comments regarding marine fauna.

Table 4.26		Matters of National Environmental Significance	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
		and even greater in offshore pockets with up to 0.275 metres (i.e. 10 times greater than the stated value). The manner in which the results are presented in the PER, including inconsistencies in the interpretation of the model output, lead to uncertainty as to the impacts on beach profile and fauna and do not allow proper assessment. The interpretation of the model results largely focuses on current speeds, shoreline accretion and erosion, and beach profiles. There is uncertainty about the potential impacts of sediment movement in the marine areas, including impacts on BPPH.	
9.5	DEC – Environmental Management Branch	Lighting impacts of the expanded development, which result in no dark nights near Bivalve and Terminal beaches. The EPA notes that the proposal will have additional impact on the Barrow Island Flatback Turtle population. The long-term impacts of processing plant lighting considered to be equivalent to between a full and quarter moon every night on turtles breeding near Town Point The processing plant is located directly inland of Town Point (location of causeway) and immediately inland of the east coast turtle nesting beaches. Light spill and light glow from this structure will increase due to the presence of the third LNG train, additional flaring and other associated infrastructure. It is expected that light spill and light glow will impact on nesting turtles and may lead to misorientation of hatchlings. The lighting study showed that under normal operating conditions, the plant would emit light of a similar lux to that of a clear night with between a full and quarter moon. Interpretation of the results with respect to impacts on turtles is absent from the PER, however, the results suggest that the plant would always be equally as bright as between a full and quarter moon under normal operations. The effect on turtle breeding of never having dark nights at Bivalve and Terminal beaches is uncertain given the general preference of turtles to nest on moonless/dark nights. Hatchling, juvenile and mature turtles may also be further impacted due to the increase in shipping and offshore lighting. Attempts to monitor hatchling dispersal in the past have proven to be problematic due to the nature of the study (night time dispersal, weather conditions etc.). The increase in shipping noise, potential for collisions and potential for misorientation and disorientation of hatchlings into vessel and shipping berth/jetty light fields is likely to	Refer to Table 4.15 (Item 9.5) in this document, which addresses comments regarding marine fauna.

Table 4.26		Matters of National Environmental Significance	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
		increase the risk to the Barrow Island turtle population. The PER does not provide a means to quantify the increase in shipping and/or offshore lighting and therefore DEC remains uncertain as to the level of risk posed to turtle breeding success, and so to turtle conservation. The Revised Proposal includes the following additional light generating infrastructure and activities: ♦ addition of a third LNG train with associated infrastructure; ♦ additional marine/boil off gas flare; ♦ proportionate increase in flaring requirements; ♦ proportionate increase in potential for shut-downs, start-ups and emergencies with associated flaring and safety lighting requirements; ♦ changes to causeway/materials offloading facility length and configuration; and ♦ additional shipping and associated support vessels and infrastructure. As requested in advice to the EPA on the Revised Proposal Scoping Document (DEC 2008), the Proponent has undertaken a lighting study. This was completed and provided in Appendix D to the PER, however the study did not take into account all lighting (flaring and offshore lighting were not considered), nor were the outputs of the study used/translated to predict potential impacts on fauna. The text in the PER does not reference the results of the study to confirm the predictions of no significant change or additional risk to turtles and seabirds from the changes in the plant configuration, changes to the causeway/materials offloading facility and additional shipping with respect to lighting. 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.	
9.16	DEC – Environmental Management Branch	There are many situations that arise from the Revised Proposal that have the potential to increase the risk to Flatback Turtles, including those discussed above, and other more uncertain risks such as: ♦ The potential for the amplified lighting to lead to increased numbers of Silver Gulls as they feed on insects and other	Refer to Table 4.15 (Item 9.16) in this document, which addresses comments regarding marine fauna.

Table 4.26		Matters of National Environmental Significance	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
		fauna attracted by the light. An increase in the gull population will consequently increase the predation of turtle hatchlings and lead to competition for nesting space with other shorebirds. ♦ Increased tidal current speed around the end of the causeway/materials offloading facility may cause turtles to avoid the area, or hatchlings to become trapped in eddy formations, and it has been suggested that funnelling fauna out past the end of the structure into deeper water could lead to increased predation from marine predators. As discussed in the previous section, in treating each of the individual risk categories in isolation, the PER does not present a cumulative impact assessment of the risk to turtles. It is DEC's view that the risk to turtles from the development will increase if the expansion is approved.	
9.18	DEC – Environmental Management Branch	On a larger scale, there has been substantial and continuing development in the Pilbara and Kimberley regions, which raises the question of the cumulative risk posed to entire marine turtle populations in Western Australia. The contribution of additional and cumulative risk afforded by the revised Gorgon development to the Barrow Island breeding population and subsequently to the Flatback Turtle species as a whole, is considered by DEC to be of serious concern.	Refer to Table 4.15 (Item 9.18) in this document, which addresses comments regarding marine fauna.
9.26	DEC – Environmental Management Branch	Vegetation associations to be impacted have changed slightly from the Approved Development, including additional impact on associations consisting of *Melaleuca cardiophylla*, which are known to be favoured by the White-winged Fairy-wren for habitat. The Revised Proposal increases the clearing of vegetation associations containing *Melaleuca cardiophylla* from 35 to 48.4 hectares. This equates to 11.67 per cent of the mapped extent of vegetation associations containing this species. Although these areas are not exclusive habitat of the Fairy-wren, further clearing is likely to have some additional impact on the species.	Refer to Table 4.5 (Item 9.26) in this document, which addresses comments regarding terrestrial fauna.
15.4	Conservation Commission of Western Australia	The Conservation Commission is concerned about the manner in which various risks have been assessed and in particular with respect to the Island's turtle population. The Barrow Island population of the Flatback Turtle (*Natator depressus*) is of regional significance and the eastern beaches are acknowledged as being very important for this species. Risks to this population are often	Refer to Table 4.15 (Item 15.4) in this document, which addresses comments regarding marine fauna.

Table 4.26		Matters of National Environmental Significance	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
		assessed in the document as single items whereas there needs to be an assessment of the cumulative impacts of a series of impacts on the population. For example, it is often the case that the construction of a causeway structure jutting out from a coastline brings about changes to sand deposition and erosion for adjacent beaches. The scale of this needs to be modelled for possible impacts on the access and use of the eastern beaches by turtles over time rather than single specific events such as cyclones. The range of impacts, such as light impacts, movement of turtles along the coast etc. likewise need to be assessed in total. There are significant deficiencies that need to be responded to through the provision of supplementary information prior to the Environmental Protection Authority's consideration of the proposal.	
15.5	Conservation Commission of Western Australia	Clarification is required as to what is meant by 'significant' when discussing the actions to be undertaken if it is found that the proposal does have a significant impact on the turtle population. The point at which intervention would be considered should be outlined. The documentation provided shows that the risk assessment is poorly related to the quantification of the impact of the expanded proposal for several areas. A key requirement identified in the PER is to address the effects of the Revised Proposal on sea turtle population viability and this has not been clearly demonstrated. For the reasons mentioned, statements such as, *Overall, the impact on nesting activity is not predicted to be different from the Approved Development*, must be questioned.	Refer to Table 4.15 (Item 15.5) in this document, which addresses comments regarding marine fauna.

4.19 Key Management Actions and Proposed Environmental Conditions

Table 4.27: Key Management Actions and Proposed Environmental Conditions

Table 4.27		Key Management Actions and Proposed Environmental Conditions	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
3.5	Department of Industry and Resources	The Revised Proposal states that as the Joint Venturers continue their investigations, Project design will be modelled and changes may result. The Department seeks clarification on how the Environmental Protection Authority might propose to account for any modifications to the Project subsequent to any approvals that	The EPA will be required to evaluate any future development or expansion of the Gorgon Gas Development in accordance with the EP Act. After a statement has been issued in relation to a proposal, the Western Australian Minister for the Environment may approve changing the proposal without a referral to the EPA. However, the Minister must not

Table 4.27		Key Management Actions and Proposed Environmental Conditions	
Item	**Submission from**	**Submitter comment**	**GJVs' Response**
		might be granted.	give approval if they consider that the change or changes to the proposal might have a significant detrimental effect on the environment in addition to, or different from, the effect of the original proposal. If this is the case then the change is required to be referred to the EPA for a decision on the level of assessment for the change. Should changes to the project that may have significant impacts on matters of NES be pursued, a new referral would also be required under the EPBC Act. In terms of the Revised Proposal, the changes were considered to be significant by the Minister and the EPA decided to assess the changes at the level of PER.
3.6	Department of Industry and Resources	The Department looks forward to continued consultation with the Joint Ventures' team on the Project's environmental management plans, and pipeline licence applications, as well as the detailed development proposals under the Agreement and the application for the CO_2 injection system under the Act.	The GJVs recognise and accept the need to continue with the Development's extensive stakeholder engagement program and will continue to follow due process and consult with appropriate agencies to ensure the acquisition of required approvals and the approval of required management plans.
6.4	WWF	One of the contextual matters that we would identify here in particular (but not to suggest that other matters are any less important) is that of the treatment of greenhouse gases. Again, we would submit that changes in the national and international context must be considered in this new assessment. We believe that Governments must make the safe injection of reservoir carbon dioxide a strict condition of approval for this project. The project should be wholly re-evaluated if this condition cannot be met and this test must be applied before further approvals are given. As we have indicated before, we believe it would be prudent for other geological formations in the general area to be further examined for their potential to safely accommodate and store greenhouse gases. (We also note matters like the Proponent' commentary around the challenges to power generation for the treatment plant and subsequent greenhouse gas management presented by Barrow Island's "remoteness" from alternative sources of energy, p. 255-6).	The submission asks that "*changes in the national and international context [in relation to the management of greenhouse gas emissions] must be considered in this new assessment"*. The GJVs support consideration of the national and international context in the assessment of the Revised Proposal. The submission calls on Governments to *"make the safe injection of reservoir carbon dioxide a strict condition of approval for this Project. The project should be wholly re-evaluated if this condition cannot be met and this must be applied before further approval is given"*. The GJVs note that the reservoir CO_2 injection project has been made a condition of approval for the Approved Development. It should be noted that the injection of reservoir CO2 is also subject to Ministerial approval under section 13 of the *Barrow Island Act 2003*. The GJVs in the EIS/ERMP qualified their commitment to the underground injection of reservoir CO_2 by stating that the opportunity must be technically feasible. Clearly, it would be imprudent for the GJVs to continue with the injection of CO_2 if, for example, it was felt that there was a significant risk of containment failure. The GJVs have invested in excess of $100 million investigating the opportunity to inject reservoir CO_2 below Barrow Island and have determined that this opportunity remains technically feasible. This has been further supported by independent

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			technical evaluations commissioned by DoIR, the most recent of which stated that *"the preparatory work gone into this project significantly exceeds other comparable projects"* and that *"many of the major requirements of CO_2 disposal are satisfied".* The submission suggests it *"would be prudent for other geological formations in the general area to be further examined for their potential to safely accommodate and store greenhouse gases*". The GJVs continue to maintain a review of alternative injection locations and appropriate alternative opportunities to offset the emissions that might arise from the venting of reservoir carbon dioxide. The search for a suitable injection location commenced in 1998 and encompassed an area generally within 300 km of Barrow Island. A summary of this work was contained in the EIS/ERMP for the Approved Development. To date there has been no new technical data in this area of interest that might cause the GJVs to reconsider the use of the Dupuy Formation below Barrow Island as the preferred location for reservoir CO_2 injection. Since publication of the EIS/ERMP, ongoing technical studies have focused on improving the understanding of the Dupuy Formation and refining the injection location below Barrow Island. The injection opportunity remains cost-effective compared to alternative offset opportunities. The submission notes *"matters like the Proponent' commentary around the challenges to power generation for the treatment plant and subsequent greenhouse gas management presented by Barrow Island's remoteness from alternative sources of energy"*, although it is unclear if the submission agrees with the GJVs' conclusions or finds exception to these. The GJVs have adopted a policy of applying currently applied best practice to the management of greenhouse gas emissions and have gone significantly beyond currently applied best practice in relation to the management of reservoir carbon dioxide. The selection of the Development's power generation technology and configuration provides a useful study in the application of current best practice technology. While the use of alternative power generation technologies could result in a further reduction of greenhouse gas emissions, it would come at the cost of either increased operational or safety risk, decreased plant reliability (which may result in an overall increase in greenhouse gas emissions associated with depressurising and repressurising and cooling the LNG process trains) or increased environmental impacts. As in all areas of Development design, the GJVs have undertaken detailed reviews that place the appropriate weighting upon a wide number of value drivers, including greenhouse gas emissions. As a result, the GJVs are proposing one of the worlds' most greenhouse gas efficient LNG projects.

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8.1	Western Australian Museum	Consideration of the developments Impact on Flatback Turtles should be more than adequately covered by the undertakings provided.	Refer to Table 4.15 (Item 8.1) in this document, which addresses comments regarding marine fauna.
8.2	Western Australian Museum	Likewise the process for mitigating the impact of Introduced Non-Indigenous Organisms appears to be covered by the protocols and guarantees given.	Refer to Table 4.21 (Item 8.2) in this document, which addresses comments regarding quarantine.
8.4	Western Australian Museum	Of concern is the undertaking to fund a Threatened Species Translocation and Re-introduction Program for selected species from Barrow Island to other Pilbara Islands. The majority of Pilbara islands contain a biota that has evolved in isolation for over 5000 years and the translocation of taxa (usually iconic vertebrates) from Barrow to other islands that have not previously contained such taxa invites the likely extinction of uniquely adapted island species that form the food resource for such translocations. Such an initiative would also appear to be at odds with the objectives of mitigating just such introductions onto Barrow Island under the quarantine requirements that are currently the focus of a Ministerial Condition. The Western Australian Museum suggests that the translocation program be amended to consider the impacts that translocating species from Barrow Island to other islands will have on the fauna of the receiving islands.	Translocations will be required to be conducted by the DEC, and as the primary stakeholder for undertaking these translocations, decisions to select species or islands will be the responsibility of the DEC. All translocations must be approved under a Translocation Proposal, which requires nomination of an area of release, and nomination and discussion of other mitigating circumstances that may pose a risk to native biota at the release site. All Translocation Proposals must be reviewed by at least two referees prior to approval. The GJVs will provide defined funds for a Threatened Species Translocation and Re-introduction Program. The GJVs will not be conducting such exercises.
9.1	DEC – Environmental Management Branch	The proposed revised and expanded development on Barrow Island is larger than the original approved proposal. There will be additional biodiversity impacts from the proposal and it is considered that the PER has not adequately accounted for these. If the EPA is to recommend approval of the expanded development, additional offsets may be required, particularly in relation to impacts and potential impacts predicted for marine turtles.	Refer to Table 4.4 (Item 9.1) in this document, which addresses comments regarding the general terrestrial environment. The following response is in relation to marine turtles. Other than expressing a perception of concern, the submission does not provide an evidence-based argument to support why the existing undertakings regarding funding and management controls will not be adequate. While it is acknowledged that there is some uncertainty regarding the actual impact to marine turtles as a result of the Gorgon Gas Development, this uncertainty was recognised during the EIS/ERMP approval process for the Approved Development, and addressed through the formulation of an appropriate management framework (which included defined funding commitments). The GJVs assert that the Revised Proposal does not present significant additional or different environmental risks to marine turtles in comparison to those for the Approved Development. This conclusion is based on an assessment of currently available scientific information, and a consideration of the above-

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			mentioned management framework. The components of this management framework are restated below: 1. The existing conditions of implementation associated with the Approved Development (Statement No. 748) include: Condition 15. Establishment of Marine Turtle Expert Panel whose role is to provide advice to the GJVs and the Minister for the Environment on marine turtle monitoring and management including: ♦ development and implementation of the Long-term Marine Turtle Management Plan as required by Condition 16 ♦ proposal-specific turtle studies as required by Condition 16.4 ♦ monitoring program design and methodology as required by Condition 16.4 ♦ additional management measures as required by Condition 16.4 ♦ any other marine turtle management matters requested by the GJVs or the Minister. This panel has now been established in accordance with the membership criteria defined in Condition 16.3, and its membership comprises a range of eminent marine turtle experts. Condition 6. Long-Term Marine Turtle Management Plan. The requirements of this Plan are comprehensive and are defined in Condition 17. The requirements include the need to identify measurable limits that specify the extent of the change, which would adversely affect the viability of Flatback Turtle populations. These limits may be used to trigger the need for additional management measures or could trigger the GJVs to undertake or fund further actions to improve recruitment to the turtle population (as described below for the North West Shelf Flatback Turtle Intervention Program). 2. The GJVs have made an undertaking to the Western Australian Government to fund: a) A North West Shelf Flatback Turtle Conservation Program ($32.5 million) The 30-year North West Shelf Flatback Turtle Conservation Program is intended to increase protection of the population in areas away from Barrow Island. The Program is to be administered by an executive committee comprising an independent chair nominated by the State Government and one representative each from the State and Commonwealth Government and the GJV. The Program will include

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			activities to: ♦ survey, monitor and research turtle populations ♦ mitigate the loss by reducing interference to key feeding and breeding locations ♦ establish information programs to support protection. b) North West Shelf Flatback Turtle Intervention Program ($5 million) If the monitoring associated with the North West Shelf Flatback Turtle Conservation Program demonstrates that the Proposal is having a significant impact on the Flatback Turtle population, the GJVs will be required to undertake or fund further actions to improve recruitment to the turtle population, including the establishment of hatcheries. Additional funds will be capped at $5 million. c) Government Auditing and Surveillance of Marine Construction Activities ($2.5 million) The Government's costs ($2.5 million over two years) for auditing and surveillance of marine activities during dredging and marine construction, and ongoing auditing of the marine environment response and recovery. 3. Under Clause 11 of Schedule 1 (Gorgon Gas Processing and Infrastructure Agreement) of the *Barrow Island Act 2003,* the GJVs are required to pay $40 million (indexed) in instalments to fund Net Conservation Benefits. Net Conservation Benefits are defined as demonstrable and sustainable additions to, or improvements in, biodiversity conservation values of Western Australia targeting, where possible, the biodiversity conservation values affected or occurring in similar bioregions to Barrow Island. The GJVs assert that the range and scope of management controls, impact monitoring studies, independent expert oversight, and intervention funding that pertains to marine turtle management for the Gorgon Gas Development is sufficient to cater for the Revised Proposal, and there is no justification for additional offsets above those already committed to for the Approved Development.
9.6	DEC – Environmental Management Branch	Recommendation 5: If the EPA is to recommend approval of the proposal, additional offsets be required for marine turtles, including a lifting of the current cap of $5 million on the contingent intervention in the event of significant impacts being detected. As discussed in the first section, uncertainty remains about the cumulative impact on turtles and how this may add to the	Refer to the GJVs' response to Item 9.1 above.

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		significant risk already posed to the Barrow Island population. DEC remains uncertain of potential impacts on beach profiles, BPPH and turtles.	
9.9	DEC – Environmental Management Branch	Quarantine risks remain underestimated. For example, risk identification and management associated with additional causeway rock have been omitted. Recommendation 19: Further information is required in regard to rock/fill materials to be imported from the mainland and the associated quarantine risks and management. Recommendation 20: Additional pathways for the introduction and spread of weeds are apparent for the Revised Proposal and need to be addressed. Consideration of these pathways may also increase the risk level for weed introduction and spread. Recommendation 21: If the development is approved, a condition needs to be included for a Weed Management Plan to be developed and implemented with a whole-of-island integrated approach, to the satisfaction of DEC. The extension to the solid rock causeway and materials offloading facility will require very large amounts (tonnage not specified in the PER) of additional rock to be imported, but management of quarantine associated with this operation has not been discussed in the PER. DEC understands (from information gathered during consultation with Chevron) that the rock will be sourced from existing quarries in either Exmouth or Dampier. Although the causeway and materials offloading facility are to be built from the seaward extent toward the shore (to allow water flow and flushing of sediments during construction), there still remains the potential for invertebrates and rodents to emerge from the rock material and transfer ashore to Barrow Island. Further, there remains the risk that seed stored within the material may be blown or carried by birds or water to the Island. The closer to land the construction of the causeway develops, the greater the risk of invasion by foreign species becomes. The introduction or spread of non-indigenous plant species (weeds) have been determined in the PER to be of low risk due to no additional or new pathways being identified for the Revised Proposal. It is considered by DEC that the additional rock importing required constitutes a significant expanded pathway for the introduction or spread of weeds. The addition of several wells and associated tracks and equipment related to the additional	Refer to Table 4.21 (Items 9.9a to 9.9i) in this document, which addresses comments regarding quarantine.

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		requirements of the CO_2 sequestration operation is also considered to present an expanded pathway for the introduction and spread of weeds. Although the disturbance will be in accordance with the approved 300 hectare limit, the location of tracks and wells within various pockets of vegetation will create several fronts from which weeds may be introduced into areas previously undisturbed, and which may then spread. There is uncertainty about the commitment and mechanism by which the Proponent will manage new and existing weed infestations on Barrow Island in a whole-of-island approach. Weed invasion and spread have been considered by the Proponent as a low level risk for the Revised Proposal. The quarantine risk (including weed spread) was considered unacceptably high by the EPA for the Approved Development, and given the additional clearing and long-term infrastructure, it is considered that the risk cannot have been reduced as a consequence of the Revised Proposal. Commitments are made within the PER to control/eradicate weeds that have been introduced or spread after commencement of the Gorgon project, however, as there are no adequate baseline data available concerning the weed status of Barrow Island, it is unclear as to how they will meet this commitment. The Proponent also commits to managing new and existing weeds as a core component of the Quarantine Management System. The system makes broad reference to sites being maintained weed free and the requirement for reporting new weed occurrences, however, it does not provide adequate information regarding the management of new and existing weed species on the Island or the processes to be undertaken to ensure no new species are introduced. Commitments are also made to adopt a whole-of-island approach to quarantine management. There is, however, no commitment to control existing weed populations outside of the immediate Gorgon footprint, which would be consistent with a whole-of-island approach and would also increase the potential for weeds to spread to Gorgon areas. A survey of Barrow Island is required to determine baseline data for current weed status. This would provide the Proponent with an understanding of the scale of the problem with respect to both the management of existing weed infestations as well as surveillance to ensure early detection and eradication of new weed	

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		occurrences. Such a survey should include high resolution mapping of the extent of current weed infestations. The survey report and baseline weed map should be provided to DEC and used in development planning and conservation management on the Island, and maintained in a GIS format for everyday use by both the Proponent and DEC. A Weed Management Plan is required for Barrow Island. This would provide direction on the scale of the weed problem on the Island, the vectors for spread both past and present, and what to do about these (for instance road maintenance policy, airport management, and vehicle and machinery cleandown). The plan should outline control operations, surveillance methodology and reporting processes. Reports should provide information on outcomes of control operations and management of both new and existing infestations, as well as provide trends over time. This plan should be developed in consultation with, and to the satisfaction of DEC, and be subject to annual reporting and review. The PER states that plans are advanced to license a Quarantine Approved Premises on Barrow Island to facilitate direct shipments of materials and avoid the potential for cross contamination at other Australian ports of entry. This is a new quarantine initiative compared to the Approved Development and as such requires a more detailed discussion within the text. Until additional information is provided on the initiative, its suitability on Barrow Island cannot be assessed.	
9.11	DEC – Environmental Management Branch	Recommendation 3: The Proponent's assertion that existing conditions should be adequate to manage the additional risks requires testing. The EPA may need to consider new and additional conditions further to those contained in Ministerial Statement 748 in the event that these are to be utilised for the Revised Proposal.	In the PER it was acknowledged that the conditions outlined in Statement No. 748 may have to be modified to reflect the nature of the Revised Proposal. However, the environmental risks posed by changes attributable to the Revised Proposal are no greater than the risks identified for the Approved Development, and it is considered that conditions equivalent to or consistent with the conditions for the Approved Development (when applied in conjunction with current regulations) will effectively manage the environmental aspects of the Revised Proposal as was the case for the Approved Development.
9.12	DEC – Environmental Management Branch	The key to risk assessment processes are the definitions of likelihood and consequence. The definitions used by the Proponent (pp 95–100 PER) lack sensitivity when considering impacts on receptors of particular conservation significance, and have resulted in underestimated risk levels. For example: a situation where Flatback Turtles (threatened fauna:	Refer to Table 4.3 (Item 9.12) in this document, which addresses comments regarding the risk-based assessment approach used by the Development.

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		rank vulnerable) cease to nest (behavioural change) on the beach immediately north of the causeway (local) for up to several years (short-term) is regarded as a MINOR consequence when using the Marine Consequence definitions (PER Section 5.1.2.3 p 98). What should be considered, however, is that the cessation of nesting of a vulnerable species (Flatback Turtle), for five years, at a beach that is regarded as a significant nesting site for the species, is likely to have a major detrimental impact on the species and in particular the long-term abundance of turtles utilising Barrow Island. It may not be clear immediately, given the 20+ years between birth and first female breeding, however, the impact will become apparent when the potentially missing generation of hatchlings from those five years fails to return to Barrow Island shores to continue nesting, consequently influencing future population viability. It is considered that the previously accepted offsets for turtle conservation do not adequately cover the increased potential impacts from the expanded proposal. The assessment of impacts on the Barrow Island Flatback Turtle population provides a further example of the underestimation of risk levels: A low risk level was determined by the Proponent in the EIS/ERMP. The EPA, however, considered the risk to be unacceptably high. The current cumulative residual risk assessment for the PER rates the risks to turtles no higher than medium, and considers that there are no significant additional or different risks posed compared to the Approved Development. Given the risk to turtles was considered unacceptably high by the EPA for the Approved Development, and that the proposed changes lead to increased light and noise emissions, increased shipping and most importantly a major increase to the length of the solid causeway (and hence physical barrier to adult turtle and hatchling movement), DEC considers that the cumulative risk to turtles can only have increased, and have increased to significant levels. The Proponent's determination of only a medium risk and statement of no additional risk relative to the original development are fundamentally flawed.	
9.17	DEC – Environmental Management Branch	There is continuing concern that neither the proposed North West Shelf Flatback Turtle Conservation Program and Intervention program (required under the Approved Development as additional	See Table 4.27 (Item 9.1) in this document, for a response.

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		undertakings to increase protection of areas away from Barrow Island for Flatback Turtle conservation), nor conditions under Statement 748, will be sufficient to manage or mitigate the increased risk posed by this proposal to the Barrow Island Flatback Turtle population.	
9.19	DEC – Environmental Management Branch	The PER states that the insignificant changes to the foreshore associated with the presence of infrastructure can be appropriately managed and monitored, but does not suggest how. Section 15 of the PER (p. 306) outlines the Objectives, Key Management Actions and Performance Criteria for the Coastal Stability Management and Monitoring Plan (required under Ministerial Statement 748 for the Approved Development) which the Proponent states is capable of managing potential impacts resulting from the Revised Proposal. On reviewing the Management Actions and Performance Criteria, DEC found that no management or mitigation actions have been identified. The Performance Criteria relate to data acquisition and monitoring instead of representing the benchmarks against which performance of implemented impact avoidance, reduction and management actions shall be measured. It is thought that the Proponent must have pre-identified management strategies (that have also been evaluated and determined to be effective for addressing the range of foreseeable problems that might arise). The Proponent should demonstrate that it is suitably prepared for these and will implement them immediately to avoid or mitigate impacts on early warning indicators/triggers of adverse trends. The DEC remains uncertain of the adequacy of the Proponent's impact management and mitigation; and the potential to create environmental harm through inappropriate management response.	The Performance Criteria relate to data acquisition during the baseline and monitoring programs, which will inform on whether changes are occurring to the foreshore environment that can then lead to further investigations on the triggers for such a change. Statement No. 748 requires that performance of implemented impact avoidance, reduction and management actions shall be described if the monitoring program shows there is a change in beach profiles and grain size beyond the performance standards. Management strategies will depend upon the type of change recorded, and whether the change is natural or anthropogenic.
9.33	DEC – Environmental Management Branch	Recommendation 28: Given that the dredging zone of influence extends into the Barrow Island Marine Management Area and Bandicoot Bay (Benthic Protection) Conservation Area, reference should be made to Key Performance Indicators required under the management plan.	The Key Performance Indicators that are being referred to are presumably from the Management Plan for the Montebello/Barrow Islands Marine Conservation Reserves 2007–2017. DEC proposed Key Performance Indicators require water and sediment quality within the defined Sanctuary Zones to remain within the natural range of variation as compared to appropriate reference sites. The zone of influence from dredging that extends into Bandicoot Bay is associated with the visible plume only. The dredge plume model indicates that there will not be any discernible impacts to benthic primary producers, benthic habitats, water quality, sediment quality, or consequently seabirds within the Bandicoot Bay conservation area due to Development-related

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			dredging. Table 15.2 of the PER outlines the objectives, preliminary key management actions and key performance criteria for the Dredge and Spoil Disposal Management and Monitoring Plan.
12.1	DEC – Marine Ecosystems Branch	The PER is not a stand-alone document. To make a comprehensive appraisal of the PER, it needs to be considered in the context of a number of other documents prepared previously by, and for, the Proponent. The PER also fails to acknowledge the tenor of the EPA's previous advice on the Gorgon LNG proposal. It is very disappointing that despite a central plank of the EPA's advice on the original proposal being 'predictive uncertainty' and the considerable length of time that has passed since the EPA's assessment of the original proposal, little in the way of new information is provided in the PER. Furthermore, there appears to be little evidence that a number of implied/explicit commitments that were made by the Proponent both during and after the original assessment to address predictive uncertainty, particularly for dredging impacts, have been implemented. It is disappointing other changes to the original development, such as the offshore brine discharge, have not been included into the scope of the PER. Inclusion of this revised component of the project into the PER would allow the EPA to provide more comprehensive advice on the application of the Environmental Quality Management Framework (EQMF) to the proposal. More detailed advice on the EQMF and its application is provided later in this memorandum.	Refer to Table 4.1 (Item 12.1) in this document, which addresses comments regarding the description of the Revised Proposal. The scope of the PER was approved by the EPA, with input form the DEC Marine Ecosystems Branch.
15.1	Conservation Commission of Western Australia	A feature concerning the management of the Gorgon proposal affecting Barrow Island is the written commitment by the Proponent to the concept of all of island management. It has been promoted that the standards of operation would be very high and that all operations on the Island, including current activities, would be managed to the same standard. Given the work envisaged with the proposal, the expected dramatic increase in the numbers of people on and visiting the Island, the greatly increased movement of plant and equipment and the risks associated with this, the commitment to a whole of island approach is of crucial importance. Highlighted here is the need to ensure that all aspects are covered in this approach and that this does not just relate to some selected activities. By way of an example would be the opportunities presented to rationalise the infrastructure (e.g. roads) on the Island	A commercial agreement between the Gorgon Joint Venture and Barrow Island Joint Venture parties was executed in September 2008. It includes details regarding responsibilities and obligations of each party to the Barrow Island Coordination Council (BICC). While the Barrow Island Joint Venturers and the Gorgon Joint Venturers continue to have responsibility for the environmental management of their respective operations, the BICC is to be established to ensure there is a single point of contact and interaction for the Department of Environment and Conservation (DEC) (formerly Department of Conservation and Land Management [CALM]) as well as the development of consistent procedures on critical matters such as quarantine management and emergency response. The matters to be coordinated by the BICC include:

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		with rehabilitation occurring wherever practicable.	♦ providing a single point of contact and interaction for the DEC in relation to the management of issues related generally to the operations of the BICC participants on Barrow Island ♦ liaising with the DEC in relation to the terms and implementation of the management plan under Division 1 of Part 5 of the *Conservation and Land Management Act* so far as it relates to the operations of the BICC participants on Barrow Island ♦ establishing, monitoring and reviewing from time to time procedures to apply to quarantine of all people and materials brought to Barrow Island for the purposes of the operations of any of the BICC participants ♦ planning and coordinating the BICC's role in emergency response to and undertaking, where necessary, remediation of any suspected or actual breach of quarantine in the operations of any of the BICC participants ♦ planning and coordinating the BICC's role in emergency response to and undertaking, where necessary, remediation of escape of hydrocarbons or other pollutants from the operations on Barrow Island of any of the BICC participants.
15.2	Conservation Commission of Western Australia	As part of the same concept [whole of island management] is the need to ensure that operational actions occur in a timely and efficient manner. Within this is the need to acknowledge the management responsibilities of the Department of Environment and Conservation (DEC). It is the Conservation Commission's view that DEC needs to be resourced to facilitate effective management involvement on a day to day basis, including a presence on the Island for operational activities prior to any work being undertaken.	Under Clause 12 of Schedule 1 of the *Barrow Island Act 2003*, the GJVs have agreed to provide services and facilities for a permanent DEC management presence on Barrow Island (including accommodation, transport etc.). This will comprise three DEC officers during major construction phases and two officers at other times. The GJVs will also pay certain DEC costs (i.e. salaries and other defined costs) capped at $1 million a year during major construction phases, and $750 000 at other times (indexed). The purpose of DEC's permanent presence on Barrow Island is to: ♦ provide a full-time independent quarantine audit on Barrow Island and the mainland ♦ ensure all onsite and offsite areas are appropriately monitored, researched and managed in relation to direct and indirect impacts and to ensure the ecological knowledge base is being properly developed.
17.6	DPI	The overall approach taken to manage and monitor dredging appears to be fundamentally reactive. It is suggested that a pro-active, predictive and preventative management approach would	The approach to dredge impact prediction and the monitoring program are consistent with current practices in Western Australia, and at the time of the preparation of the EIS/ERMP, the approach was considered to be

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		provide an improved environmental outcome. A description of a recent Environmental Monitoring and Management Plan framework for dredging close to sensitive habitats in Singapore by Doorn-Groen (2007) is attached for your reference. The main principles of this approach are: ♦ Environmental baseline monitoring; ♦ Development of work plans with the dredging contractor; ♦ Assessment of work plans through the use of numerical sediment plume forecasting; ♦ Revision of work plans if forecast impacts are considered too great ♦ Commencement of dredging; ♦ Daily compliance monitoring of dredge spill limits; ♦ Daily monitoring of real time measurements; ♦ Ongoing hindcasting and model calibration; ♦ Ongoing habitat monitoring and review of environmental criteria; and ♦ Ongoing revision of work plans based on hindcasting to mitigate impacts.	better than best practice. The submitter's suggested approach to environmental management associated with dredging has already been addressed to the extent practicable in the approvals documents (EIS/ERMP (Chevron Australia 2005), Additional Information package (Chevron Australia 2005a) and Final EIS/ERMP Part C (Chevron Australia 2006) and the PER). The Dredge and Spoil Disposal Management and Monitoring Plan (DSDMMP) will satisfy Ministerial Statement No. 48 Condition 20 and the Commonwealth EPBC Approval (EPBC Reference Number 2003/1294) Condition 7. This plan will be developed in consultation with: ♦ The Construction Dredging Environmental Expert Panel ♦ The Marine Turtle Expert Panel ♦ DEC ♦ DoF ♦ DPI ♦ DEWHA This document will describe the ecological monitoring and environmental management framework to be implemented for the Gorgon Gas Development dredging program.

4.20 Other Comments

Table 4.28: Other Comments

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1.3	Chamber of Commerce and Industry Western Australia	Apart from servicing international LNG markets, the Gorgon Gas Development will also provide additional supply of natural gas to the Western Australian domestic gas market. CCI believes that it is strategically desirable to secure an additional major long-term supply of gas for WA's industrial and residential consumers. The need for supply diversity has been highlighted recently through the natural gas supply disruption brought about by the explosion of a	Comment acknowledged.

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		processing plant at Varanus Island. This resulted in approximately 300 terajoules of gas per day (or 30 per cent of total supply) being removed from the energy network. This gas supply shortfall had severe downstream impacts, which continue to be felt across industry to this day. Establishment of the Gorgon Gas Development and its provision of additional domestic gas would help mitigate the effects of any future supply crisis.	
1.4	Chamber of Commerce and Industry Western Australia	The Chamber strongly believes that the Gorgon Gas Development will enhance domestic energy security through the supply of additional natural gas to the market and also through supply diversity into the distribution network.	Comment acknowledged.
1.5	Chamber of Commerce and Industry Western Australia	CCI believes that significant consumer benefits are likely to be derived from the Gorgon Gas Development, predominantly in the form of increased supplies of domestic gas to market. This will enhance competitive pressures and ensure gas prices are maintained at reasonable levels.	Comment acknowledged.
1.6	Chamber of Commerce and Industry Western Australia	The Chamber maintains that competitive gas prices will enable downstream gas users who are dependent upon energy to grow their businesses.	Comment acknowledged.
1.8	Chamber of Commerce and Industry Western Australia	One of Western Australia's key competitive advantages is the opportunity for responsible development of its natural resources. The State has a proven track record in the development of liquefied natural gas facilities and the efficient supply of this product to world markets. The Gorgon Gas Development project will ensure this advantage is maintained.	Comment acknowledged..
5.6	Department of Health	No specific, radiological issues have been identified within the PER. However the Proponent should be aware that: ♦ a registration under the *Radiation Safety Act* will be required if radioactive substances are used; and ♦ the processing of materials in the oil and as industry may be associated with a technically enhanced build up of naturally occurring radioactive material (referred to as NORM or TE-NORM). The implications for these issues have previously been considered at an international level and some guidance is available in the following online publications from the International Atomic Energy Agency and ARPANSA: www-pub.iaea.org/MTCD/publications/PDF/Pub1171_web.pdf; www.arpansa.gov.au/pubs/rps/rps15.pdf. The Radiological Council of Western Australia should be consulted	During construction, radiological sources will be used for Non-Destructive Testing (NDT) of pipeline and equipment welds. Radiological sources could also be occasionally used for NDT of piping and equipment during operations and maintenance shutdowns. NDT is normally undertaken by a specialist company with sound HES management processes and procedures, which must be vetted by Chevron prior to contract award. Radiological materials used for NDT will be transported, stored and used in accordance with the *Dangerous Good Regulations and the Radiation Safety Act*, and in general handled in a way that minimises health, safety and environmental exposures and risks to ALARP. In addition, there is no intent to use radiological materials in the Gas Treatment Plant during routine production operations. Radiological tracers could be used to detect problems with poor distribution, flow regimes and liquid carry over in the gas phase or gas carry under in the liquid phase. The frequency of radiological tests and the use of

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		in regard to any radiation matters arising out of this project. Regulatory information is available at: www.radiologicalcouncil.wa.gov.au.	radioactive substances will therefore be dictated by the performance of the Plant. Being non-routine operations, these tests will be conducted by a specialist company and will involve considerable operational planning, hazard identification and risk mitigation and will be managed by dedicated procedures. The potential for NORM deposition in piping and equipment in gas and liquid service has been identified by the GJVs. Potential "hotspots" of NORM deposition are being identified during safety and operability reviews and hazard and operability studies, as well as while completing inventories of waste streams from the Gas Treatment Plant. Wastes will be tested for NORM prior to disposal and NORM-containing materials will be disposed of in accordance with the APPEA Guidelines for Naturally Occurring Radioactive Materials (Australian Petroleum Production and Exploration Association [APPEA] 2002). Requirements for testing and disposal of NORM-contaminated wastes will be listed in the Gorgon Gas Development Operations Waste Management Plan. Occupational health and safety aspects associated with exposure to low levels of radiation during normal operations and planned plant shutdown and maintenance will be incorporated in the implementation of the Chevron Occupational Hygiene Process within the Development's operations phase procedures. The Radiological Council of Western Australia will be consulted in the development of procedures for the use of radiological tracers, and during the development of the Development's Operations Waste Management Plan and Occupational Hygiene Program.
6.3	WWF	In short, there is a new context in which the PER before us now should be considered. This means that previous assumptions should be tested. We would submit that a failure to take advantage of this opportunity now will only increase the risk of further poor decisions being made. You will see in the attachments references to important matters like the implications of including Jansz gas in the project, post the site-selection process and the EIA processes, but without consideration of how this gas (with much lower reservoir CO_2) might affect the case for the use of Barrow Island (and moreover, provide opportunities for more responsible exploitation of gas fields in this region). This, among other matters, is not only germane to the credibility of the assessment processes for this project but of course has much broader implications. It is no exaggeration to suggest that how the Gorgon project has been assessed and is being assessed has important implications	The relationship of the Revised Proposal to the Approved Development is discussed in Section 2.1 of this document. The EPA recommend against the Approved Development in Bulletin 1221. Subsequent to this recommendation, and following appeals, the Western Australian Minister for the Environment and the Commonwealth Minister for the Environment and Water Resources approved implementation of the Gorgon Gas Development on Barrow Island on 6 September 2007 and 3 October 2007 respectively. The scope of the PER is to assess the significance of the environmental impacts of the Revised Proposal that are in addition to, different from, or cumulative with those of the Approved Development, and whether these impacts can be avoided (where possible). Where impacts are unavoidable, the PER includes information to minimise and/or manage the impact.

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		for environmental impact assessment in Western Australia, Australia and internationally. As you would well appreciate, the stakes are very high.	
6.8	WWF	We would like to make it clear that this *submission in no way should be read as a summary of the full range of concerns that WWF-Australia has with this proposal* – it does not attempt to be encyclopaedic. Instead, we focus on three key sets of issues- those concerning turtles, quarantine, and dredging. We believe that the levels of risk and uncertainty associated with any one of the three should be sufficient to halt this proposal, but in the interest of describing our concerns we have presented them all.	This comment was actually made in regard to the EIS/ERMP for the now Approved Development; however, it has been responded to in regard to the Revised Proposal. Refer to Table 4.15 and Table 4.21 in this document, which address comments regarding marine fauna and quarantine respectively. Refer to Section 4.8.2 of this document for additional information regarding the Development's dredging methodology, the dredge model and potential impacts. The environmental risks posed by the Revised Proposal are not considered by the GJVs to be greater than the risks identified for the Approved Development, for which the required environmental approvals under Part IV of the State EP Act (Statement No. 748) and the Commonwealth EPBC Act (EPBC Reference: 2003/1294) have been granted.
9.10	DEC – Environmental Management Branch	There is a potentially increased risk of detrimental impact on fauna, including subterranean fauna, from possible failure of the expanded CO_2 injection system. Recommendation 24: More information is required regarding how the risks and impacts associated with a leak or release of CO_2 at the greater rate of production (vegetation/fauna/human) have altered, including clarification of the calculation of risks to subterranean fauna from a potential CO_2 escape. The accelerated rate at which reservoir CO_2 is proposed to be injected will require additional injection wells and drill centres, with a corresponding increase in pipelines, and as the pressure is expected to increase more rapidly in this Revised Proposal, a number of pressure release wells and associated ancillary infrastructure are required. Given the increase in the rate of CO_2 production and requirement for injection, failure of the injection system may lead to larger volumes of CO_2 being leaked/vented/released to the atmosphere. Additional information is required regarding how the risks and impacts associated with a leak or release of CO_2 at the greater volume of production (impacts on vegetation/fauna/human) have altered. Greater rates of injection also may reduce any response time in the case pressure reaches peak levels within the formation. It is not clear that the mitigation and management of the CO_2	Refer to Table 4.25 and Table 4.9 in this document, which provide a response regarding the risks associated with the expanded reservoir CO_2 injection system and its potential impacts on subterranean fauna respectively. Risks to terrestrial fauna are addressed in Table 4.5 in this document. This response relates specifically to human impacts. Exposure of personnel to dangerous concentrations of CO_2 in the ambient environment will be avoided through the appropriate design of the acid gas venting system. The number of vents and their locations, heights and diameters will be dictated by the need to minimise proliferation of hazardous atmospheres around the Gas Treatment Plant and the need to disperse the acid gas as best and as soon as possible to prevent plume slumping and 'hanging' around the Plant site. The heights of the acid gas disposal vents, in particular, will be such that personnel working on platforms and personnel within the LNG modules and at ground level will not be exposed to oxygen-deprived atmospheres due to the presence of CO_2. A number of operational controls will be considered in order to reduce the risks of exposure of personnel to oxygen deprived atmospheres; for example: ♦ CO_2 and H_2S gas monitors/sensors strategically located around the plant will be able to detect the presence of dangerous concentrations of H_2S and will alert operators via a sound alarm ♦ switch over from acid gas injection to acid gas venting will cause an

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		sequestration operations are adequate.	alarm within the Central Control Room, which will be amplified in the field. This will alert personnel to commence safe egress from the area ♦ a permit to work system will be put in place for any work carried out in the vicinity of the Acid Gas Removal Units (AGRUs) and the CO_2 compression trains. As a final safeguard, adequate PPE will be provided in strategically located areas around the plant to allow safe and controlled egress from affected work areas.
9.13	DEC – Environmental Management Branch	Throughout the PER, reference is made to the Revised Proposal not presenting any significant new or additional risks, but it is unclear what the Proponent considers as a significant new or additional risk. In summary, the magnitude of risks and impacts on Barrow Island conservation values, and consequently the adequacy of management and mitigation requirements, remain unclear.	Refer to Table 4.3 in this document, which addresses comments regarding the risk-based assessment approach used by the Development. This table includes discussion of the levels of likelihood and consequence used to conduct a risk assessment for each of the environmental factors addressed. A number of management plans/programs/systems are proposed to manage additional impacts to ecological receptors. The management approach will be adaptive, involving monitoring, which will provide the basis to design appropriate responses where performance targets are not met. This provides for contingency actions to be undertaken to ensure that risks are kept to acceptable levels.
9.31	DEC – Environmental Management Branch	Recommendation 26: The Proponent commits to a whole-of-island strategic approach to limiting disturbance wherever possible and to remediate unused areas. This should incorporate a planning exercise to identify areas for ongoing remediation, and identify possible improvements to common use areas and strategic locality of infrastructure. A commitment should be made to a whole-of-island approach to strategic development and sharing of infrastructure. It would also ensue that the commitment would include the planning and implementation of remediation and rehabilitation of areas no longer used or necessary for use by parties on the Island. The current irregular placement of infrastructure, roads, pipelines and ancillary services on the Island suggests there is no current strategic planning. Not only would such planning potentially lead to the concentration of disturbance to common areas, but would also make operations simpler for management.	While Chevron Australia is the operator for both the existing oilfield operation on Barrow Island and the proposed Gorgon Gas Development on Barrow Island, it is important to understand and recognise the operating parameters associated with the existing Barrow Island oilfield operation and the Gorgon Gas Development. 1. The existing oilfield operation and the Gorgon Gas Development are owned by separate joint venture entities, and responses to the submissions in regard to the Gorgon Gas Development Revised and Expanded Proposal can legally only make commitments on behalf of the Gorgon Joint Venture. It also follows that EPA recommendations and conditions of any Ministerial approval for the Gorgon Gas Development can only legally be applied to the Gorgon Joint Venture, not to the existing Barrow Island oilfield operation. 2. In regard to site rehabilitation and infrastructure sharing, the existing Barrow Island oilfield, which has a history of more than 40 years of operation, is not under the control or responsibility of the Gorgon Joint Venture. The Gorgon Joint Venture cannot impose, nor has any operational control of the ongoing remediation and rehabilitation of existing disturbed areas on the Island other than those areas that will be

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			part of the Gorgon Gas Development's land tenure. Land disturbance to be undertaken for the purpose of the Gorgon Gas Development is regulated by the Ministerial environmental approval conditions for the Gorgon Gas Development and Clause 9 of the *Barrow Island Act 2003* (WA) (i.e. no more than 300 ha of uncleared land can be cleared for the purpose of gas processing facilities on Barrow Island). The following responses are made in this context. The GJVs are committed to limiting land disturbance and rehabilitating land where facilities are no longer required. In order to reduce environmental disturbance and impacts on Barrow Island, the Gorgon Joint Venturers are committed to sharing facilities with the Barrow Island Joint Venture. Opportunities for sharing include the airport, accommodation, supply base, access roads and some production and maintenance facilities, training facilities and utilities such as water, power and waste disposal. The GJVs will ensure that no facilities are shared that could adversely impact safety or environmental performance, or impose a limitation on either party's production capability. A commercial agreement between the Gorgon Joint Venture and Barrow Island Joint Venture parties was executed in September 2008. It includes details regarding responsibilities and obligations of each party to the Barrow Island Coordination Council (BICC). While the Barrow Island Joint Venturers and the Gorgon Joint Venturers continue to have responsibility for the environmental management of their respective operations, the BICC is to be established to ensure there is a single point of contact and interaction for the Department of Environment and Conservation (DEC) (formerly Department of Conservation and Land Management [CALM]) as well as the development of consistent procedures on critical matters such as quarantine management and emergency response. The matters to be coordinated by the BICC include: ♦ providing a single point of contact and interaction for the DEC in relation to the management of issues related generally to the operations of the BICC participants on Barrow Island ♦ liaising with the DEC in relation to the terms and implementation of the management plan under Division 1 of Part 5 of the *Conservation and Land Management Act* so far as it relates to the operations of the BICC participants on Barrow Island ♦ establishing, monitoring and reviewing from time to time procedures to apply to quarantine of all people and materials brought to Barrow

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			Island for the purposes of the operations of any of the BICC participants ♦ planning and coordinating the BICC's role in emergency response to and undertaking, where necessary, remediation of any suspected or actual breach of quarantine in the operations of any of the BICC participants ♦ planning and coordinating the BICC's role in emergency response to and undertaking, where necessary, remediation of escape of hydrocarbons or other pollutants from the operations on Barrow Island of any of the BICC participants. Sharing of existing Barrow Island oilfield infrastructure, such as laydown areas, roads, airport, barge landing facilities, accommodation, wastewater and solid waste management facilities is occurring for the purpose of the pre-construction preparatory works, and will continue into the construction and operations phases of the Gorgon Gas Development. Post-construction, the Gorgon Gas Development MOF and accommodation facilities will be made available for use by the existing oilfield operations.
9.32	DEC – Environmental Management Branch	Recommendation 27: The Proponent should commit to sharing information with the Government and WA Oil, including consultants' reports and GIS database information relating to conservation of flora and fauna. In this regard, increased DEC involvement is required in planning and implementation of on-ground activity associated with the management of impacts of the proposal on key values on Barrow Island.	The GJVs have already implemented a process for sharing ecological data with WA Oil (Barrow Island oilfield operation) and the DEC (and any other research or government agencies that request data). Examples of data sets that have been shared to date include marine primary producer habitat maps, turtle tagging data which has been integrated into the DEC turtle tagging database and specific consultants' reports relating to environmental aspects of Barrow Island as part of the PER documentation, and previously as part of the EIS/ERMP. It is also a requirement of Statement No. 748, issued for the Approved Development, that the baseline environmental data for both the terrestrial and marine environments be provided to government departments. These baseline data sets will form the basis for monitoring programs and the management of potential impacts to the environment. The reports are currently in preparation by the GJVs. Provisions for DEC involvement in the planning and implementation of the Gorgon Gas Development on-ground activity (associated with the management of impacts of the proposal on key values on Barrow Island) are already stipulated in the *Barrow Island Act 2003* and Statement No. 748 for the Approved Development. Clause 12 of Schedule 1 of the *Barrow Island Act 2003* requires the GJVs to provide services and facilities (offices, accommodation, laboratory,

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			vehicle, etc.) for a permanent DEC management presence on Barrow Island (including provision of $1 million per year during construction and $750 000 per year (indexed) at other times for DEC costs). The purpose of the permanent presence of DEC on Barrow Island is to: ♦ provide a full-time independent quarantine audit on Barrow Island and the mainland ♦ ensure all onsite and offsite areas are appropriately monitored, researched and managed in relation to direct and indirect impacts and to ensure the ecological knowledge base is being properly developed. Consistent with Schedule 1, the GJVs are also required to make arrangements with the Barrow Island Joint Venture (existing Barrow Island oilfield operation) to form and operate a Barrow Island Coordination Council to: ♦ provide a single point of contact and interaction for DEC on Barrow Island ♦ liaise with DEC on the management of Barrow Island. As stated on page 3 of the Preamble to Ministerial Statement No. 748, the GJVs have made an undertaking to the Western Australian Government to fund the Government's costs ($2.5 million over two years) for auditing and surveillance of marine activities during dredging and marine construction, and ongoing auditing of the marine environment response and recovery. Conditions of Statement No. 748 require the GJVs to consult with DEC in the development of the: ♦ Annual Audit Compliance Report (Condition 4) ♦ Terrestrial and Subterranean Baseline State and Environmental Impact Report (Condition 6) ♦ Terrestrial and Subterranean Environment Protection Plan (Condition7) ♦ Fire Management Plan (Condition 12) ♦ Groundwater Abstraction Plan (Condition 13) ♦ Coastal and Marine Baseline State and Environmental Impact Report (Condition 14) ♦ Long-term Marine Turtle Management Plan (Condition 16)

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			♦ Marine Facilities Construction Environmental Management Plan (Condition 17) ♦ Dredge Spoil Disposal Management and Monitoring Plan (Condition 20) ♦ Horizontal Directional Drilling Management and Monitoring Plan (Condition 22) ♦ Offshore Gas Pipeline Installation Management Plans (Condition 23) ♦ Coastal Stability Management and Monitoring Plan (Condition 25) ♦ Best Practice Pollution Control Design (Condition 28) ♦ Air Quality Management Plan (Condition 29) ♦ Post-construction Rehabilitation Plan (Condition 32) ♦ Project Site Rehabilitation Plan (Condition 33) ♦ Decommissioning and Closure Plan (Condition 34). Over and above these mandatory consultation requirements, the GJVs are proactively engaging with DEC to conduct a review of the other deliverables that are being developed to satisfy the requirements of Statement No. 748, prior to the deliverables being formally submitted to the Minister for the Environment for approval. It is expected that similar conditions would be imposed on the approval to implement the Revised Proposal. Furthermore, DEC has representatives formally appointed to the Quarantine Expert Panel (Condition 9), the Marine Turtle Expert Panel (Condition 15) and the Construction Dredging Environmental Expert Panel (Condition 19). All three panels have now been established. A commercial agreement between the Gorgon Joint Venture and Barrow Island Joint Venture parties was executed in September 2008. It includes details regarding responsibilities and obligations of each party to the Barrow Island Coordination Council (BICC). While the Barrow Island Joint Venturers and the Gorgon Joint Venturers continue to have responsibility for the environmental management of their respective operations, the BICC is to be established to ensure there is a single point of contact and interaction for the Department of Environment and Conservation (DEC) (formerly Department of Conservation and Land Management [CALM]) as well as the development of consistent procedures on critical matters such as quarantine management and

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			emergency response. The matters to be coordinated by the BICC include: ♦ providing a single point of contact and interaction for the DEC in relation to the management of issues related generally to the operations of the BICC participants on Barrow Island ♦ liaising with the DEC in relation to the terms and implementation of the management plan under Division 1 of Part 5 of the *Conservation and Land Management Act* so far as it relates to the operations of the BICC participants on Barrow Island ♦ establishing, monitoring and reviewing from time to time procedures to apply to quarantine of all people and materials brought to Barrow Island for the purposes of the operations of any of the BICC participants ♦ planning and coordinating the BICC's role in emergency response to and undertaking, where necessary, remediation of any suspected or actual breach of quarantine in the operations of any of the BICC participants ♦ planning and coordinating the BICC's role in emergency response to and undertaking, where necessary, remediation of escape of hydrocarbons or other pollutants from the operations on Barrow Island of any of the BICC participants.
9.36	DEC – Environmental Management Branch	A number of tables within the PER were difficult to review due to the non-connecting page layouts such as Tables 5.2 and 5.3 and Table ES0.2	The tables referred to were long tables that spanned a number of pages; for ease of reading, the column headings were repeated for each new page of the table and the cells were not broken across pages.
9.37	DEC – Environmental Management Branch	References to table numbers throughout the text of Section 3 of the PER are incorrect and require editing.	Acknowledged.
9.39	DEC – Environmental Management Branch	The current WA Oil operation, managed by Chevron Australia (previously WAPET), has been in operation on Barrow Island since 1967. The operations are managed under the *Petroleum Act 1936*. Informal arrangements have been successively developed over the years between DEC and Chevron Australia in order to improve management of the oilfield in accordance with biodiversity conservation objectives. To further ensure protection of environmental values on the Island, DEC has the opportunity to provide advice to the Department of Industry and Resources with regard to the L1 H Barrow Island Petroleum Lease which is due for renewal prior to its expiry in February 2009. Advice will include the addition of conditions on the lease for a series of environmental	Noted.

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		management plans covering issues such as, but not limited to, quarantine, weeds, waste, closure and decommissioning.	
16.1	NOPSA	NOPSA's role under its enabling legislation relates specifically to occupational health and safety of the offshore petroleum industry. NOPSA's role does not extend to address environmental issues or onshore aspects of the Gorgon Development. As a consequence, NOPSA has no comment to make in relation to the PER.	Noted.
17.1	DPI	DPI acknowledges that the Gorgon Gas Processing and infrastructure Project Agreement (the Agreement) (Schedule One of the Barrow Island Act 2003) sets out the requirements and approvals for the proposed development. Our comments to the EPA relate to how the proposal complies with the Western Australian Planning Commission's (WAPC) State Planning Policy No.2.6 State Coastal Planning Policy (SPP2.6) based on the knowledge that the EPA will provide conditions on the development, not the Western Australian Planning Commission. It is noted that the location of the proposed development has been identified following high level strategic assessment and that a number of on and offshore components have previously been approved by the EPA. However, pursuant to Section 5(1) of the Agreement, the Joint Venture is required to cooperate and consult with the State, State policies and development objectives. Set out below are matters arising from SPP2.6 for your consideration.	Noted.
17.2	DPI	Planning for Climate Change It does not appear that the impacts of climate change have been taken into account in the planning of development. It is important that the siting and design of the facility take into consideration the potential impacts of climate change over the next 100 years in accordance with SPP2.6.	The Statement of Planning Policy No. 2.6 proposes a median sea level rise of 0.38 m be allowed for in the design of the Gorgon Gas Development. The planning for LNG infrastructure adopts appropriate design codes based on rigorous metocean condition analysis well in excess of the considerations for sea level rise due to climate change. For example, key infrastructure on the MOF is designed to be approximately 16.5 m above LAT. This equates to approximately 11.1 m above the 1-in-100 year tide plus storm surge level.
17.4	DPI	Development in cyclone prone areas Locations north of the 30 degree line of latitude are considered to be within a cyclone prone area as per SPP2.6. Storm surge that accompanies coastal cyclones can inundate large areas a significant distance inland from the high water mark and pose potential risks to infrastructure and safety of lives. It is recommended that development be set back from any areas that would potentially be inundated by the ocean during the passage of	Cyclonic storm surge and the associated winds and waves are the key criteria for the design of terrestrial and marine facilities associated with the development. The marine structures accommodating product pipelines are designed to survive a 1-in-500 year event; compared to public infrastructure, which is generally designed to withstand a 1-in-100 year event. The Gas Treatment Plant site is also terraced with several metres height difference between the various terrace levels. The coastal dunes at Town

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		a category 5 cyclone tracking to model its associated storm surge. Furthermore, any development that may pose a pollution risk in the case of leakage or damage from a passing cyclone should be set back sufficiently to reduce the impacts on adjacent coastal and marine environment.	Point and their vegetation will be retained and will provide a natural barrier against potential high storm surges and their impact on the plant facilities. The main chemical-containing inventories in use in the front end of the Gas Treatment process, i.e. Inlet Facilities, MEG Separation and Acid Gas Removal are located approximately one kilometre from the foreshore areas. All chemical storage tanks and other high-risk leak equipment will be bunded. Although large hydrocarbon inventories are located in relatively close proximity to the beach, i.e. the LNG and condensate storage tanks, the design of these facilities will ensure that any LNG or condensate spills will be contained within secondary containment facilities (as part of LNG tank design or condensate tanks bunds). The site bunding and open drains systems design takes into account potential for storms to result in contaminated stormwater and allows for stormwater from potentially contaminated with chemicals and hydrocarbons areas of the plant to be collected, stored, treated for dispersed hydrocarbon removal and disposed via injection, if found to be contaminated, or if clean, disposed to the terrestrial environment in a manner which emulates the natural stormwater movement and drainage pattern. The design principles for the site drainage systems are outlined in the Gorgon Environmental Basis of Design (Chevron Australia 2008d) and the Gorgon Venting and Drainage Systems Specification (KJVG 2008a). A bunds and drains inspection and maintenance procedure will be developed for implementation in Operations and will be supported by spill and emergency response plans and procedures.
18.6	Department of Fisheries	DoF's responsibility centres around the management of fish resources (under the *Fish Resources Management Act, 1994*) as well as the management of the threat of introduced exotic marine species through inter- and intra-state shipping and other vectors (under the *Biosecurity and Agricultural Management Act 2007*). In a previous submission by DoF, the Department raised concerns regarding the amount of Departmental resources required to adequately provide for the demands and services expected by Chevron for the project. Now, the Proponent are seeking an expansion of the original project that will subsequently increase the demands on DoF. Taking into account the magnitude of this project, the requirement for expert advice (DoF has been requested to participate on two Expert Panels), and the need for the development and operation of a vessel biosecurity clearance program for the duration of the project, the DoF is concerned with its ability to fulfil these requirements. In particular, the inability of	The GJVs are encouraged by the preparedness of DoF to support the Gorgon Gas Development and work constructively to manage the biosecurity risk that Development activity might present. However, the GJVs are of the view that DoF has overestimated the demand on DoF's resources, as most of the vessels will be on long-term charter. This requires a complete pre-mobilisation biosecurity risk assessment, which may include dry docking for the implementation of a corrective action. Similarly, spot charters will undergo the same assessment with the only difference being not demanding a complete inspection prior to the assessment but the same corrective action methodology will apply bearing in mind the spot charter vessel will stay in Barrow Island waters for less than seven days. This approach was the outcome of advice sought from independent marine biosecurity experts. Given this commitment, the demand on DoF resources would be no different that had the Development been based anywhere else on the mainland of Australia. Therefore the GJVs believe

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		DoF to react quickly to Chevron's request for vessel biosecurity clearance has the potential to impact on the construction process, and I encourage specific consideration of how the Department can work constructively with Chevron to address these issues. The DoF previously indicated that a full time (FTE) for the period of the major construction (approx 2 years) with an ongoing requirement for one half an FTE for the life of the project (subject to review on the basis of need) would cover the requirements for the DoF's involvement in the project. However this request was not supported nor included in the conditions of the previous approvals process. The Department again reiterates that to work constructively with the Proponent in the development of this project to minimise marine biosecurity risks, and to avoid delays in vessel clearances, it requires financial support. This support is minimal compared to the potential costs that would be incurred by the Proponent in the advent that high cost vessels (e.g. barges, dredges etc.) are delayed due to the Department not having dedicated staff working on these matters. The DoF would like the opportunity to discuss this matter further with the Proponent to achieve a mutually beneficial outcome.	this demand is in line with standard business practices. As for the representation on the respective expert panels, the GJVs have already agreed to fund the activities of the State relating to the Approved Development as per Statement No. 748. The distribution of this funding is not within the scope or authority of the GJVs. The custodian of this funding is the Minister of Environment and Conservation who also requested the participation of DoF on the respective expert panels.

5.0 REFERENCES

Allen Consulting Group, The. 2003. *Proposed Access to Barrow Island for Gas Development: Advice on Social, Economic and Strategic Considerations*. Report to the Western Australian Department of Industry and Resources, Perth, Western Australia

Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand. 2000. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality. National Water Quality Management Strategy Paper No 4.* Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand. Canberra, Australian Capital Territory.

Australian Petroleum Production and Exploration Association. 2002. *Guidelines for Naturally Occurring Radioactive Materials*. Australian Petroleum Production and Exploration Association, Canberra, Australian Capital Territory.

Biota Environmental Sciences. 2007. *Barrow Island Gorgon Gas Development: Summary of 2004–2006 Subterranean Fauna Surveys.* Report prepared for Gorgon Joint Venture, Perth, Western Australia.

Burton, S. 2007. *Coastal Land-Based Hydrogeological Assessment – Summary Of Data Review And Field Investigations for the Gorgon Project Barrow Island LNG Plant*. Unpublished report prepared for Chevron Australia by Groundwater Consulting Services, Perth, Western Australia. (G1-TE-M-4500-REP4502)

Campbell, T. and Wedepohl, E. 2005. *Geophysical Investigation of the Proposed Gorgon Gas Plant Site on Barrow Island*. Draft report prepared for ARUP Australia.

Chevron Australia. 2004a. *Risk-based Assessment of Quarantine Threats, Infection Modes and Effects Analysis Workshop Report, Barges and Tugs Pathway, Marine Invertebrates and Plants, 23 April 2004*. Chevron Australia, Perth, Western Australia. (G0-TE-H-0000-REPX015)

Chevron Australia. 2004b. *Guidelines for the development of procedures for the skid, steel and loose equipment pathway*. Chevron Australia, Perth, Western Australia. (G0-TE-H-0000-REPX017)

Chevron Australia. 2004c. *Guidelines for the development of procedures for Crated Material, equipment and goods*. Chevron Australia, Perth, Western Australia. (G0-TE-H-0000-REPX022)

Chevron Australia. 2005. *Draft Gorgon Environmental Impact Statement/Environmental Review and Management Programme for the Proposed Gorgon Development*. Chevron Australia, Perth, Western Australia.

Chevron Australia. 2005a. *Draft Gorgon Environmental Impact Statement/Environmental Review and Management Programme for the Proposed Gorgon Development: Additional Information Package*. Chevron Australia, Perth, Western Australia.

Chevron Australia. 2005b. *Risk-based Assessment of Quarantine Threats Infection Modes and Effects Analysis and Preliminary Hazard Analysis Workshop Report Marine Vessel 'Topsides' Pathway Terrestrial Vertebrates 5 April 2005*. Chevron Australia, Perth, Western Australia. (G0-TE-H-0000-REPX027)

Chevron Australia. 2005c. *Quarantine Hazard Analysis (QHAZ) Workshop Report For Proposed Quarantine Barriers, Sand and Aggregate Pathway Terrestrial Invertebrates, Vertebrates, Plants 22–23 September 2005*. Chevron Australia, Perth, Western Australia. (G1-TE-H-0000-REPX002)

Chevron Australia. 2006. *Final Environmental Impact Statement/Environmental Review and Management Programme for the Gorgon Gas Development*. Chevron Australia, Perth, Western Australia.

Chevron Australia. 2006a. *Quarantine Hazard Analysis (QHAZ) Workshop Report For Proposed Quarantine Barriers Domestic Marine Vessel 'Wetsides' Pathway Marine Organisms 9 March 2006*. Chevron Australia, Perth, Western Australia. (G1-TE-H-0000-REPX019)

Chevron Australia. 2006b. *Quarantine Hazard Analysis (QHAZ) Workshop Report, For Proposed Quarantine Barriers, Domestic Marine Vessel 'Topsides' Pathway, Terrestrial Invertebrates, Vertebrates, Plants, 8 March 2006*. Chevron Australia, Perth, Western Australia. (G1-TE-H-0000-REPX018)

Chevron Australia. 2006c. *Risk-based Assessment of Quarantine Threats, Quarantine Hazard Analysis (QHAZ) Workshop Report For Proposed Quarantine Barriers, Direct Shipments Pathway, Marine Organisms, 16 May 2006*. Chevron Australia, Perth, Western Australia. (G1-TE-H-0000-REPX025)

Chevron Australia. 2007. *Quarantine Guidelines: Development of Procedures for Special and Sensitive Goods and Equipment Pathway*. Chevron Australia, Perth, Western Australia. (G1-NT-PPRX0000009)

Chevron Australia. 2008. *Gorgon Gas Development Revised and Expanded Proposal Public Environmental Review*. Chevron Australia, Perth, Western Australia.

Chevron Australia. 2008a. *Gorgon Project Environmental Risk Management Implementation Plan*. Chevron Australia, Perth, Western Australia. (G1-NT-PLNX0000144)

Chevron Australia. 2008b. *Revised Proposal, Environmental Scoping Document, EPA Assessment No. 1727 – Gorgon Project, Gas Development*. 26 June 2008. Perth, Western Australia. (G1-NT-REPX0001324)

Chevron Australia. 2008c. Gorgon Project: *BOG Flare Light Spill Minimisation Options Review*. Chevron Australia, Perth, Western Australia (In preparation) Chevron Australia, Perth, Western Australia. (G1-TE-H-0000-REPX029)

Chevron Australia. 2008d. *Gorgon Gas Development Environmental Basis of Design*. Chevron Australia, Perth, Western Australia. (G1-TE-H-0000PDBX001).

Chevron Australia. 2008e. *Gorgon Gas Development, Application for Consideration under Section 45C of the Environmental Protection Act 1986, Submission Document*. Chevron Australia, Perth, Western Australia. (G1-NT-REPX0001165)

ChevronTexaco Australia. 2003. *Environmental, Social and Economic Review of the Gorgon Gas Development on Barrow Island*. ChevronTexaco, Perth, Western Australia.

Commonwealth Government of Australia, Minister for the Environment and Water Resources, Hon. Malcolm Turnbull, 2007. *Approval – Gorgon Gas Development (EPBC Reference: 2003/1294), 3 October 2007*. Canberra, Australian Capital Territory.

Damara Pty Ltd. 2006. *Gorgon Project – Review of Possible Impact of Proposed Causeway and Jetty*. Report Prepared for Department of Planning and Infrastructure, Perth Western Australia.

Department of Environment and Conservation. 2007. *Management Plan for the Montebello/Barrow Islands Marine Conservation Reserves 2007–2017. Adopted by the Marine Parks and Reserves Authority; Marine Management Plan No. 55*. Department of Environment and Conservation, Perth, Western Australia.

Department of Environment and Conservation. 2008. *Advice to the EPA on the Revised Proposal Scoping document*. Report prepared for the Environmental Protection Authority, Perth, Western Australia.

Department of the Environment, Water, Heritage and the Arts. 2008. *EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales*. Department of the Environment, Water, Heritage and the Arts, Canberra, Australian Capital Territory.

Doorn-Groen, S.M. 2007. Environmental monitoring and management if reclamations work close to sensitive habitats. *Terra et Aqua*, September 2007.

Environmental Protection Authority. 2000. *Environmental Protection of Native Vegetation in Western Australia – Clearing of Native Vegetation with Particular Reference to the Agriculture Area, Position Statement No. 2.* Environmental Protection Authority, Perth, Western Australia.

Environmental Protection Authority. 2004. *Guidance Statement for the Assessment of Environment Factors: Guidance Statement No. 29 Benthic Primary Producer Habitat Protection*. Environmental Protection Authority, Perth, Western Australia.

Environmental Protection Authority. 2006. *Gorgon Gas Development, Barrow Island Nature Reserve, Report and Recommendations of the Environmental Protection Authority, Bulletin 1221, June 2006*. Environmental Protection Authority, Perth, Western Australia.

Environmental Protection Authority. 2008. *Change to – Gorgon Gas Development on Barrow Island Nature Reserve – Statement 748, Attachment 1 to Statement 748 – Change to Proposal, May 2008*. Environmental Protection Authority, Perth, Western Australia.

Finston, T. 2007. *Molecular Diversity in Amphipods from Barrow Island, Western Australia.* Report prepared for Gorgon Joint Venture, Perth, Western Australia

Fletcher, W.J. and Head, F. (eds) 2006. *State of the Fisheries Report 2005/06*. Department of Fisheries, Perth, Western Australia.

Fletcher, W.J. and Santoro, K. (eds) 2007. *State of the Fisheries Report 2006/07*. Department of Fisheries, Perth, Western Australia.

Global Environmental Modelling Systems. 2008. *Dredging Program Simulation Studies for the Chevron Gorgon Project*. Unpublished report prepared for Chevron Australia. Melbourne, Victoria.

Golder Associates. 2008. *Coastal Land Based Hydrogeological Assessment - Summary of Data Review & Field Investigations*. Unpublished report for Chevron Australia, Perth Western Australia.

Government of Western Australia, Minister for the Environment, David Templeman MLA, 2007. *Statement that a Proposal may be Implemented - Gorgon Gas Development: Barrow Island Nature Reserve (Ministerial Statement No. 748), 6 September 2007*. Perth, Western Australia.

Imber, M.J. 1975. Behaviour of Petrels in Relation to the Moon and Artificial Lights. *Notornis*, 22: 302–306.

International Risk Consultants Pty Ltd. 2008. *Gorgon Downstream RAM Analysis*. October 2008. (AO-REP-08-0028-001) Report prepared for Chevron Australia, Perth, Western Australia.

Kellogg Joint Venture Gorgon. 2006. *Hydrogeological Report – Groundwater Exploration Drilling & Testing for the Gorgon Project Barrow Island LNG Plant*. Unpublished report prepared for Chevron Australia, Perth, Western Australia. (G1-TE-C-4500-REP5001)

Kellogg Joint Venture Gorgon. 2008a. *Venting and Drainage Basis of Design for the Gorgon Project Barrow Island LNG Plant*. Unpublished report prepared for Chevron Australia. Perth, Western Australia. (G1-TE-H-0000-SPC1003)

Kellogg Joint Venture Gorgon. 2008b. *Gorgon Project Barrow Island LNG Plant, Basis of Design for Lighting.* November 2008. Kellogg Joint Venture Gorgon, Perth, Western Australia. (G1-TE-E-0000-PDB002)

Kellogg Joint Venture Gorgon. 2008c. *Gorgon Water Balance (Pre-FID Through To Operations)*. Report prepared for Chevron Australia, Perth, Western Australia. (G1-TE-P-4500-CAL1501)

Lorne, J.K. and Salmon, M. 2007 Effects of Exposure to Artificial Lighting on Orientation of Hatchling Sea Turtles on the Beach and in the Ocean. *Endangered Species Research,* 3: 23–30.

Majer, J. and Edwards, K. 2008. *Targeted Short-range Endemic Survey of the Revised Proposal for the Gorgon Gas Development LNG Plot, July 2008*. Report prepared for Chevron Australia, Perth, Western Australia.

Majer, J., Callan, S, Graham, R. and Edwards, K. 2008. *Report on the Baseline Survey of Terrestrial Invertebrates for the Gorgon Gas Development on Barrow Island – Part 1: Gorgon Gas Plant "GP" Survey 2006.* Unpublished report prepared for Chevron Australia by the Department of Environmental Biology, Curtin University of Technology, Perth, Western Australia.

MetOcean Engineers Pty. Ltd. 2005. *Gorgon Downstream Cyclonic Channel Siltation Modelling*. Report prepared for Chevron Texaco Australia, Perth, Western Australia.

Nicholson, L. 2002. *Breeding Strategies and Community Structure in an Assemblage of Tropical Seabirds on the Lowendal Islands, Western Australia*. PhD Thesis, Murdoch University, Perth, Western Australia.

Pendoley Environmental. 2006a. *Preliminary findings of the Gorgon flatback satellite tracking program 2005–2006 nesting season*. Unpublished report prepared for Chevron Australia, Perth, Western Australia.

Pendoley Environmental. 2006b. *Interim satellite tracking flatback turtles (Natator depressus) in Western Australia Perth*. Unpublished report prepared for Chevron Australia, Perth, Western Australia.

Pendoley Environmental. 2007. *Gorgon Project: Sea Turtle Light Glow Arena Experiments, February 2007*. Unpublished Report prepared for Chevron Australia, Perth, Western Australia

Pendoley Environmental. 2008. *Gorgon Project Flatback Tagging Program 2005/06, 2006/07 and 2007/08 Nesting Seasons*. Unpublished report prepared for Chevron Australia, Perth, Western Australia.

Pruett-Jones, S. and Tarvin, K.A. 2001. Aspects of the Ecology and Behaviour of White-winged Fairy-wrens. *Emu*, 101: 73–78.

RPS BBG. 2006. *Field Survey of Nest Site Selection by the White-winged Fairy-wren (Malurus leucopterus edouardi) on Barrow Island*. Report prepared for Gorgon Joint Venture, Perth, Western Australia.

RPS BBG. 2007. *Marine Baseline Survey, Gorgon Project on Barrow Island. Field Report July/August 2006*. Report prepared for Gorgon Joint Venture, Perth, Western Australia.

RPS MetOcean. 2008. *Coastal Modelling Barrow Island.* Perth, Western Australia. (Report Number R1385V2) Unpublished report prepared for Chevron Australia, Perth, Western Australia.

Sedgewick, E.H. 1978. A Population Study of the Barrow Island Avifauna. *Western Australian Naturalist,* 14: 85–108.

Standards Australia/Standards New Zealand. 1998. *AS/NZS 3931:1998 Risk Analysis of Technological Systems – Application Guide*. Sydney, Australia/Wellington, New Zealand.

Standards Australia/Standards New Zealand. 2004a. *AS/NZS 4360:2004 Risk Management*. Sydney, Australia/Wellington, New Zealand.

Standards Australia/Standards New Zealand. 2004b. *HB 203:2004 Environmental Risk Management – Principles and Process.* Sydney, Australia/Wellington, New Zealand.

Wenziker, K.J., McAlpine, K.W., Apte, S.C. and Masini, R.J. 2006. *Background Quality for Coastal Marine Waters of the North West Shelf, Western Australia. Interim Technical Report No.18, June 2006. North West Shelf Joint Environmental Management Study*. CSIRO and Department of Environmental Protection, Perth, Western Australia.

6.0 SHORT TITLES AND ACRONYMS

The table below lists the short titles and acronyms used in this document.

Short Titles and Acronyms	Long Title
$	Australian Dollars
%	Percentage
µg/L	Micrograms per litre
µm	Micrometres
Agreement	Gorgon Gas Processing Infrastructure Project Agreement
AGRU	Acid Gas Removal Unit
ALARP	As Low As Reasonably Practicable
ANZECC	Australian and New Zealand Environment and Conservation Council
APPEA	Australian Petroleum Production and Exploration Association
Approved Development	Approved Gorgon Gas Development
AQIS	Australian Quarantine and Inspection Service
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
AS/NZS	Australian Standard/New Zealand Standard
Barrow Island Act	*Barrow Island Act 2003* (WA)
BICC	Barrow Island Coordination Council
BOG	Boil Off Gas
BPP	Benthic Primary Producer
BPPH	Benthic Primary Producer Habitat
BTEX	Benzene, toluene, ethylbenzene, and xylene
CALM	Former Western Australian Department of Conservation and Land Management (now DEC)
CCG	Cape Conservation Group
CCI	Chamber of Commerce and Industry Western Australia
CDEEP	Construction Dredging Environmental Expert Panel
CMBSEIR	Coastal and Marine Baseline State and Environmental Impact Report
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CSD	Cutter Suction Dredges
CSIRO	Commonwealth Scientific and Research Organisation
Cth	Commonwealth of Australia
DEC	Western Australian Department of Environment and Conservation
DEWHA	Commonwealth Department of the Environment, Water, Heritage and the Arts
DLN	Dry Low NOx (nitrogen oxides)
DMP	Western Australian Department of Mining and Petroleum
DNA	Deoxyribonucleic Acid
DoE	Commonwealth Department of the Environment
DoF	Western Australian Department of Fisheries
DoH	Western Australian Department of Health
DoIR	Western Australian Department of Industry and Resources
DoW	Western Australian Department of Water
DPI	Western Australian Department for Planning and Infrastructure

Short Titles and Acronyms	Long Title
EIA	Environmental Impact Assessment
EIS/ERMP	Environmental Impact Statement/Environmental Review and Management Programme (for the Proposed Gorgon Development dated September 2005 as amended or supplemented from time to time).
EP Act	Western Australian *Environmental Protection Act 1986* (WA)
EPA	Western Australian Environmental Protection Authority
EPASU	Western Australian Environmental Protection Authority Services Unit
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (Cth)
EPBC Reference: 2003/1294	Commonwealth environmental approval for the Approved Development issued 3 October 2007.
EQMF	Environmental Quality Management Framework
EQO	Environmental Quality Objective
ESD	Environmental Scoping Document
ESE	Environmental, Social and Economic
EV	Environmental Value
FESA	Fire and Emergency Services Authority of Western Australia
FTE	Full-time Equivalent
GHG	Greenhouse Gas
GJVs	Gorgon Joint Venturers
Ground Truth	To verify the correctness of remote sensing information by use of ancillary information such as field studies.
H_2S	Hydrogen sulfide
ha	Hectare
HAZID	Hazard Identification
HDD	Horizontal Directional Drilling
HES	Health, Environment and Safety
HIPPS	High Integrity Pressure Protection System
IDLH	Immediate Dangerous to Life and Health
IMEA	Infection Modes and Effects Analysis
ISQG	Interim Sediment Quality Guideline
kg	Kilograms
KJVG	Kellogg Joint Venture Gorgon
km	Kilometres
kPa	Kilopascal
L	Litre
LAT	Lowest Astronomical Tide
LCLo	Lethal Concentration Low
LD_{50}	A dose that is lethal in 50 per cent of test animals.
LED	Light Emitting Diode
LNG	Liquefied Natural Gas
LOAEL	Lowest Observed Adverse Effect Level
m	Metres
m^3	Cubic metres
MDF	Marine Disturbance Footprint
MEB	Western Australian Department of Environment and Conservation – Marine Ecosystems Branch
MEG	Monoethylene Glycol

Short Titles and Acronyms	Long Title
MFO	Marine Fauna Observer
mg/kg	Milligrams per kilogram
Minister	Western Australian Minister for the Environment
mm	Millimetres
mm/s	Millimetres per second
MOF	Materials Offloading Facility
MPRA	Marine Parks and Reserves Authority
MTEP	Marine Turtle Expert Panel
MTPA	Million tonnes per annum
MW	Megawatt
NDT	Non-destructive Testing
NEPM	National Environment Protection Measure
NIS	Non-indigenous Species
NOPSA	National Offshore Petroleum Safety Authority
NORM	Naturally Occurring Radioactive Material
NOx	Oxides of nitrogen
NWSV	North West Shelf Venture
PBA	Preliminary Barrier Assessment
PER	Public Environmental Review
PFW	Produced Formation Water
PM_{10}	Particulate matter of 10 micrometres or less
PPE	Personal Protective Equipment
PSD	Particle Size Distribution
QAP	Quarantine Approved Premises
QEP	Quarantine Expert Panel
QHAZ	Quarantine Hazard and Operability Analysis
QMS	Quarantine Management System
Revised Proposal	Gorgon Gas Development Revised and Expanded Proposal
RO	Reverse Osmosis
SIAC	Western Australian State Government's Standing Inter-Agency Committee of CEOs
SKM	Sinclair Knight Mertz
SPP2.6	State Planning Policy No. 2.6 State Coastal Planning Policy
SRE	Short-range Endemics
Statement No. 748	Western Australian Ministerial Implementation Statement No. 748 (for the Approved Development) issued 6 September 2007.
TDF	Terrestrial Disturbance Footprint
TJ/day	Terajoules per day
TSHD	Trailer Suction Hopper Dredge
TSS	Total Suspended Solids
UCS	Unconfined Compressive Strength
UV	Ultraviolet
UWA	University of Western Australia
WA	Western Australia
WAPET	West Australian Petroleum Pty Ltd
WEL	Woodside Energy Limited
WHO	World Health Organization

Short Titles and Acronyms	Long Title
WWF	World Wide Fund for Nature Australia
WWTP	Wastewater treatment plant

APPENDIX A: SUMMARY OF RESPONSE TO SUBMISSIONS

Table A1.1: Summary of Comments Received by Each Submitter

Submitter	Item No.	Short description of comment	GJVs Response
Chamber of Commerce and Industry	1.1	General statements of support for proposal.	Refer to Table 4.1.
	1.2	Asserts that the assessment should only address the aspects of the Revised Proposal not included in the previous approval process.	Refer to Table 4.1 and Section 2.0.
	1.3	Diversification of gas supply is supported.	Refer to Table 4.28.
	1.4	Gorgon Gas Development will enhance domestic energy security.	Refer to Table 4.28.
	1.5	Increased supplies of domestic gas will enhance competition pressures and ensure gas prices are maintained at reasonable levels.	Refer to Table 4.28.
	1.6	Competitive gas prices will enable downstream gas users dependent upon energy to grow their businesses.	Refer to Table 4.28.
	1.7	Gorgon Gas Development represents an opportunity for Western Australia to utilise its natural resources to forge better environmental outcomes on an international scale.	Refer to Table 4.25.
	1.8	Gorgon Gas Development will ensure Western Australia's competitive advantage for responsible development of its natural resources is maintained.	Refer to Table 4.28.
Conservation Council of WA	2.1	Recommends EPA to oppose Gorgon Gas Development on Barrow Island.	Refer to Table 4.1 and Section 2.0.
	2.2	Industrial development should not be located on Barrow Island given an A-Class Nature Reserve status and surrounding waters include a Marine Park and other equivalent value ecosystems.	Refer to Table 4.1 and Section 2.0.
	2.3	The Approved Proposal was considered by the Conservation Council to be the 'thin end of the wedge' – allowing some development inevitably means that future development receives a lower level of scrutiny.	Refer to Table 4.1.
	2.4	The reasons for EPA opposing the project have not changed; rather the reasons have increased in scale for the Revised Proposal.	Refer to Table 4.1.
	2.5	Changed economics is the justification for the new LNG train, therefore the arguments for locating the Approved Project on Barrow Island were flawed. A new site assessment for the Gorgon Gas Development Project should be undertaken.	Refer to Table 4.1.
	2.6	Other companies are piping gas with a high CO_2 content over 800 km, which makes a mockery of the Chevron argument that transporting gas is uneconomic.	Refer to Table 4.1.
	2.7	Impacts on Flatback Turtles from increased light and shipping movements are unacceptable.	Refer to Table 4.15.
	2.8	Increased and unacceptable impacts on subterranean fauna.	Refer to Table 4.9.
	2.9	Increased risk to subterranean fauna from potential leaks of injected CO_2 into subterranean habitat. Environmental conditions relating to response to leaks do not appear to be based on any science.	Refer to Table 4.9.
	2.10	Quarantine risk increased directly and indirectly.	Refer to Table 4.21.
	2.11	Impacts from dredging remain unacceptably high.	Refer to Table 4.16.
	2.12	Risk of failure of the geosequestration project; if other proven technology was utilised this may also result in re-	Refer to Table 4.25.

Submitter	Item No.	Short description of comment	GJVs Response
		location of the facility from Barrow Island.	
	2.13	Risk of failure of injection of CO_2 into the Dupuy Formation is high.	Refer to Table 4.25.
	2.14	Seismic monitoring associated with CO_2 plume tracking and impact on marine environment (particularly cetaceans) is not clear.	Refer to Table 4.11: and Table 4.25.
	2.15	Uncertainty associated with injection of CO_2 and consequences for WA greenhouse gas emissions, the marine, subterranean and terrestrial environment.	Refer to Table 4.25.
	2.16	Gorgon Project will contribute 21% of state greenhouse gas emissions in 2050.	Refer to Table 4.25.
	2.17	Table 12.1 should include comparisons of emissions resulting from utilising cleaner gas than Gorgon or renewable energy.	Refer to Table 4.25.
	2.18	Unacceptable levels of cumulative impacts result from air pollution, increased visitation, light pollution, noise pollution etc.	Refer to Table 4.4.
	2.19	EPA must be consistent in its opposition to major industrialisation in an A-Class Nature Reserve and Marine Park.	Refer to Table 4.1 and Section 2.0.
DoIR	3.1	Revised Proposal is consistent with the intent of the Approved Development; the existing conditions of the Approved Development should apply to the Revised Proposal and any differences in environmental risk should be addressed via changes to the environmental management plans.	Refer to Table 4.1.
	3.2	Provides a description of the land reservation on Barrow Island that has been made under the provisions of the *Barrow Island Act 2003* and the *Gorgon Gas Processing Infrastructure Project Agreement* (the Agreement), and procedure for Proponents to gain access to remaining available land.	Refer to Table 4.10.
	3.3	CO_2 injection system and applications required to be submitted under the *Barrow Island Act 2003* and the Agreement; DoIR will undertake a detailed review of the system during these approvals processes.	Refer to Table 4.25.
	3.4	Independent consultants appraised the feasibility of the CO_2 injection system for the Approved Development and DoIR believes appropriate monitoring and management planning can address any impacts associated with the increased rate of injection.	Refer to Table 4.25.
	3.5	Query regarding how the EPA will account for any modifications to the Revised Proposal subsequent to any approvals that might be granted.	Refer to Table 4.27.
	3.6	Support for continued consultation with the Proponent in regards to the Gorgon Gas Development.	Refer to Table 4.27.
Marine Parks & Reserves Authority	4.1	Concerned in relation to potential impacts on the Marine Conservation Reserves.	Refer to Table 4.1.
	4.2	Cumulative impacts not considered to be addressed, particularly risks to turtle populations and marine communities.	Refer to Table 4.3, Table 4.15 and Table 4.20:.
	4.3	Statement regarding potentially very harmful effects on marine communities from sedimentation resulting from expansion of the existing causeway.	Refer to Table 4.17 and Table 4.20:.
	4.4	Concerned about the impact on marine turtle movement and nesting resulting from expansion of the existing causeway.	Refer to Table 4.15.
	4.5	Concerned about the effects of increased light levels on rare and endangered Flatback Turtles.	Refer to Table 4.15. Refer also to Section 4.9.1.

Submitter	Item No.	Short description of comment	GJVs Response
	4.6	The cumulative impacts of dredging not addressed adequately.	Refer to Table 4.3 and Table 4.16.
	4.7	Statement regarding the cumulative effects of increased vessel movements, increasing the risks associated with introduced marine pests, accidental spillages and ballast water effects.	Refer to Table 4.21.
	4.8	Concern regarding the scale and location of the Gorgon Gas Development.	Refer to Table 4.1.
Department of Health	5.1	Requirement for a Drinking Water Protection Management Plan if the Proponent is to construct a desalination plant to provide potable water.	Refer to Table 4.1.
	5.2	*Health Act 1911(WA)* is relevant to the Revised Proposal.	Refer to Table 4.2.
	5.3	Disposal of effluent from wastewater treatment plants through ponds and deep well injection needs to meet the requirements of Health (Treatment of Sewage and Disposal of Effluent and Liquid Waste) Regulations.	Refer to Table 4.1.
	5.4	Disposal of effluent from wastewater treatment plants through deep well injection and impacts on the quality of the aquifer and stygofauna has not been adequately addressed.	Refer to Table 4.9.
	5.5	DEC consultation required regarding discharge licences for aquifer disposal of effluent from the wastewater treatment plant.	Refer to Table 4.2.
	5.6	Need to manage radiological issues associated with the processing of materials.	Refer to Table 4.28.
	5.7	Statement regarding the economic opportunities for the Aboriginal people in Roebourne and Onslow.	Refer to Table 4.2.
	5.8	Nuisance and disease vector quarantine and impacts will need to be considered as part of the quarantine strategy.	Refer to Table 4.21.
WWF	6.1	WWF concur with concerns of the EPA that the original project posed an unacceptably high risk to the natural values of Barrow Island and that the Revised Proposal remains unacceptable.	Refer to Table 4.1 and Section 2.0.
	6.2	Site selection process flawed and location of project on Barrow Island unnecessary and unjustified.	Refer to Table 4.1 and Section 2.0.
	6.3	Alterations to project should require re-assessment of overall project to consider cumulative impacts.	Refer to Table 4.28.
	6.4	Safe injection of reservoir CO_2 should be a strict environmental condition.	Refer to Table 4.27.
	6.5	Global importance of Barrow Island requires existing development to be phased out and Island rehabilitated.	Refer to Table 4.1.
	6.6	Acknowledge efforts to address quarantine but concerned no management can reduce risks to reasonable levels.	Refer to Table 4.21.
	6.7	WWF not opposed to LNG but seeks to minimise footprint from development.	Refer to Table 4.1.
	6.8	Statement that the level of risk and uncertainty associated with turtles, quarantine and dredging should be sufficient to halt the Gorgon Gas Development.	Refer to Table 4.28 and Section 4.8.2.
	6.9	Insufficient information presented to allow clear assessment of risks.	Refer to Table 4.3.
	6.10	Flaws in risk assessment process and setting of levels of likelihood and consequence.	Refer to Table 4.3.
	6.11	Impacts on Flatback Turtles through nesting behaviour modification (including light), underwater noise, altered coastal and nearshore currents, sedimentation and physical disturbance and chemical pollution are not addressed adequately.	Refer to Table 4.15.
	6.12	Impacts on marine turtles from habitat disturbance and impacts associated with dredging and jetty construction should be addressed.	Refer to Table 4.15.

Submitter	Item No.	Short description of comment	GJVs Response
	6.13	Management measures fail to adequately address quarantine issues.	Refer to Table 4.21.
	6.14	The level of impact from sedimentation, contamination and pollution of marine benthic primary producers and shallow benthic and coastal communities has been underestimated.	Refer to Table 4.20:.
	6.15	The impact of direct disturbance on marine benthic primary producers and shallow benthic and coastal communities from construction of the causeway, jetty and access channels and the dumping grounds.	Refer to Table 4.20:.
	6.16	Incomplete baseline data and modelling of sedimentation and coastal and nearshore currents due to construction of MOF causeway, offloading facility and jetty and under cyclone conditions.	Refer to Table 4.20:.
Cape Conservation Group Inc.	7.1	Recommends EPA oppose Gorgon Gas Development on Barrow Island.	Refer to Table 4.1.
	7.2	Statement of opposition to the Gorgon Gas Development.	Refer to Table 4.1.
	7.3	Impacts on Flatback Turtles from increased light and shipping movements are unacceptable.	Refer to Table 4.15.
	7.4	Increased and unacceptable impacts on subterranean fauna.	Refer to Table 4.9.
	7.5	Increased risk to subterranean fauna from potential leaks of injected CO_2 into subterranean habitat. Environmental conditions relating to response to leaks do not appear to be based on any science.	Refer to Table 4.9.
	7.6	Quarantine risk increased directly and indirectly.	Refer to Table 4.21.
	7.7	Impacts from dredging remain unacceptably high.	Refer to Table 4.16.
	7.8	Risk of failure of the geosequestration project; if other proven technology was utilised this may also result in re-location of the facility from Barrow Island.	Refer to Table 4.25.
	7.9	Unacceptable levels of cumulative impacts result from air pollution, increased visitation, light pollution, noise pollution etc.	Refer to Table 4.4.
	7.10	Recommends EPA restate its opposition to the Gorgon Gas Development.	Refer to Table 4.1.
Western Australian Museum	8.1	Impact on Flatback Turtles can be adequately managed by proposed key management actions and environmental conditions.	Refer to Table 4.15.
	8.2	Mitigation of impacts from Introduced Non-Indigenous Organisms is addressed by proposed key management actions and environmental conditions.	Refer to Table 4.21.
	8.3	Revised Proposal does not appear to pose any substantial additional threat to subterranean fauna.	Refer to Table 4.9.
	8.4	Concerned about the commitment to fund a Threatened Species Translocation and Re-introduction Program, in terms of impact on the receiving environment.	Refer to Table 4.27.
DEC – Environmental Management Branch	9.1	Revised Proposal will result in additional biodiversity impacts and thus, additional offsets may be required.	Refer to Table 4.4, Table 4.11: and Table 4.27.
	9.2	Proponent approach to residual risk and offsets; position that no additional offsets are required for the Revised Proposal is not adequately justified.	Refer to Table 4.3.
	9.3	Difficulty in completing a cumulative risk and impact assessment given only the Revised Proposal has been presented.	Refer to Table 4.3.
	9.4	Statement regarding risks to Flatback Turtles from causeway.	Refer to Table 4.15.
	9.5	Statement regarding risks to fauna from lighting, particularly Flatback Turtles.	Refer to Table 4.15.

Submitter	Item No.	Short description of comment	GJVs Response
			Also refer to Section 4.9.1.
	9.6	Additional impacts on turtles and requirement for additional management and offsets.	Refer to Table 4.27.
	9.7	Impacts and management of marine drilling, blasting and seismic requirements not addressed.	Refer to Table 4.20:, Section 4.8.1, Section 4.8.2 and Section 4.8.3.
	9.8	Calculation of cumulative loss of coral and benthic primary producer habitat (BPPH) is uncertain, including lack of appropriate marine habitat classification scheme, information on dredge model methodology and extent of zone of influence.	Refer to Table 4.20: and Section 4.8.2.2.
	9.9	Underestimated quarantine risks and need for Weed Management Plan.	Refer to Table 4.21.
	9.10	Possible failure of the expanded CO_2 injection system and potential increased risk of detrimental impact on fauna.	Refer to Table 4.5, Table 4.9, Table 4.10, Table 4.25, Table 4.28 and Section 4.17.1.
	9.11	Assertion that existing conditions should be adequate to manage the additional risks requires testing.	Refer to Table 4.27.
	9.12	Definitions of likelihood and consequence lack sensitivity when considering impacts on receptors of conservation significance, resulting in underestimated risk levels.	Refer to Table 4.3.
	9.13	Definition of 'significant' is not clear.	Refer to Table 4.28.
	9.14	Statement regarding the increased risk associated with vessel strike as turtles have to navigate deeper water to move around MOF, and increasingly subjected to the facility's light fields.	Refer to Table 4.15.
	9.15	Questions regarding approach employed to study turtle movement and lack of adequate information to properly assess potential risks from proposed shipping facilities.	Refer to Table 4.15.
	9.16	Cumulative impacts on marine turtles (including from increased gull population and increased tidal current speed around the end of the causeway/MOF) are not addressed adequately.	Refer to Table 4.15.
	9.17	Concern that key management actions and current (Statement No. 748) and/or proposed environmental conditions will not be sufficient to manage or mitigate the increased risk to Barrow Island Flatback Turtle population.	Refer to Table 4.27.
	9.18	Concern regarding cumulative risk to all marine turtle populations in Western Australia based on development in Pilbara and Kimberley regions, including Gorgon Gas Development.	Refer to Table 4.15.
	9.19	Management or mitigation measures need to be identified for changes to the foreshore.	Refer to Table 4.27.
	9.20	Need to address impacts on marine fauna from noise-generating activities.	Refer to Table 4.15 and Section 4.8.1.
	9.21	Further analysis of noise-generating infrastructure and activities is required.	Refer to Table 4.15 and Section 4.8.1.
	9.22	The Revised Proposal involves an additional 40 ha of land which is to come out of the 100 ha designated for long-term gas development; this leaves limited area for future expansion.	Refer to Table 4.10.
	9.23	The short-range endemic and subterranean fauna surveys and monitoring work is incomplete.	Refer to Table 4.5 and Table 4.9.
	9.24	Additional excavation to ensure stability of the plant site will remove karst and therefore additional troglofauna habitat.	Refer to Table 4.9.

Submitter	Item No.	Short description of comment	GJVs Response
	9.25	Increased land area required may also lead to additional areas impacted by altered runoff, sedimentation, recharge, compaction and erosion, affecting terrestrial and subterranean habitat.	Refer to Table 4.4 and Table 4.9.
	9.26	Increase in the impact on vegetation associations consisting of *Melaleuca cardiophylla*, is likely to have some additional impact on the White-winged Fairy-wren.	Refer to Table 4.5 and Section 4.5.1.
	9.27	Noting the increase in clearing of several sensitive areas such as creek line vegetation.	Refer to Table 4.10.
	9.28	Noting the increase in greenhouse gas emissions.	Refer to Table 4.25.
	9.29	Noting the increase in the average volume of CO_2 anticipated to be injected into the Dupuy Formation.	Refer to Table 4.25.
	9.30	Calculation of risks to subterranean fauna from a potential CO_2 leak may be incorrect.	Refer to Table 4.3.
	9.31	Recommendation that the Proponent commit to a whole-of-island approach to limiting disturbance and remediating unused areas.	Refer to Table 4.28.
	9.32	Recommendation that the Proponent commit to sharing information relating to conservation of flora and fauna.	Refer to Table 4.28.
	9.33	Recommendation that Key Performance Indicators required under the management plan should be developed for the Barrow Island Marine Management Area and Bandicoot Bay Conservation Area, given the dredging zone of influence affects these areas.	Refer to Table 4.27.
	9.34	DEC, EPA Service Unit (EPASU) and Australian Government Department of the Environment, Water, Heritage and the Arts were observers to the risk assessment workshops and did not participate in the decision-making process.	Refer to Table 4.3.
	9.35	DEC would like to know the author and contributors of the subterranean fauna study undertaken by the University of Western Australia to ensure that any independent reviewers of the management plans required for the Approved Development were not involved in this study.	Refer to Table 4.9.
	9.36	Difficulty reviewing tables due to the non-connecting page layouts.	Refer to Table 4.28.
	9.37	References to table numbers in Section 3 are incorrect and require editing.	Refer to Table 4.28.
	9.38	Comments regarding biodiversity values of Barrow Island and surrounding marine areas (including Barrow Island Marine Park, Barrow Island Marine Management Area).	Refer to Table 4.4 and Table 4.11:.
	9.39	Note that DEC is providing advice to DoIR regarding additional conditions on WA Oil operation that require a series of management plans addressing issues such as (but not limited to) quarantine, weeds, waste, closure and decommissioning.	Refer to Table 4.28.
Fire & Emergency Services Authority of Western Australia	10.1	No information or comment provided at this time.	Refer to Table 4.1.
Individual	11.1	An analysis of alternative locations has not been undertaken and given the original proposal has not been implemented; the analysis should consider both the Approved Development and Revised Proposal.	Refer to Table 4.1 and Section 2.0.
	11.2	Undertake alternative location analysis that incorporates sustainability considerations.	Refer to Table 4.1.

Submitter	Item No.	Short description of comment	GJVs Response
	11.3	The precedent of an even bigger LNG plant on an island that is an A-Class nature reserve should not be allowed.	Refer to Table 4.1.
DEC – Marine Ecosystems Branch	12.1	Although the Revised Proposal PER should be considered in the context of other documentation associated with the Gorgon Gas Development, there is a lack of additional information presented and a requirement for inclusion of other changes to the development in this PER (i.e. offshore brine discharge).	Refer to Table 4.1.
	12.2	Vague and inconsistent information provided regarding marine infrastructure and dredging, and levels of risk associated with these activities.	Refer to Table 4.3.
	12.3	Query regarding the approval or non-approval of marine blasting in relation to the Approved Development; deficiency of information and risk assessment associated with the marine blasting aspect of the Revised Proposal; and queries regarding the management measures proposed.	Refer to Table 4.1 and Section 4.8.1.
	12.4	Queries regarding benthic habitat mapping (including surveys undertaken) classification frameworks and mapping processes.	Refer to Table 4.20:.
	12.5	Queries regarding dredge plume modelling and zones of influence.	Refer to Table 4.20:, Section 4.8.1 and Section 4.8.2.
	12.6	Concerned about the 'coral health thresholds' applied in the impact prediction framework.	Refer to Table 4.20:.
	12.7	Queries regarding seismic data acquisition.	Refer to Table 4.1 and Section 4.8.3.
	12.8	Comment regarding consideration of environmental effects in the context of the Environmental Quality Management Framework.	Refer to Table 4.3.
	12.9	Potential effects of Revised Proposal on coastal processes, including notes regarding modelling predictions.	Refer to Table 4.16.
	12.10	Water and sediment quality and further research required to support statements regarding elevated concentrations of cadmium and silver.	Refer to Table 4.17.
	12.11	Concerned about extensive use of qualitative terms to describe environmental impacts.	Refer to Table 4.3.
	12.12	Statement regarding discrepancies in dredge volume from recent presentation and that which has been approved.	Refer to Table 4.1.
	12.13	Comment regarding impacts on Flatback Turtles from disturbance to sea pen communities, and statement regarding use of a DEC reference.	Refer to Table 4.20:
	Email dated 13 Feb 2009 (Pt 1)	Identification of significant data gaps in the time-series for TSS/Sediment deposition shown in figures 7.8 and 7.9 of the PER. DEC MEB have requested an explanation of how these data were assessed against the thresholds which require at least 6 hourly values of TSS for daylight hours. Requested an explanation of how the GJVs have used the modeled sediment deposition rates (mg/cm2/d) to calculate daily loads which are required to evaluate against the sediment deposition load based thresholds (again given the apparent data gaps).	Refer to Table 4.17
	Email dated 9 Mar 2009	Request for confirmation that hourly time series data sets for TSS and Sedimentation were used to calculate extent of zones of impact.	Refer to Table 4.17

Submitter	Item No.	Short description of comment	GJVs Response
	Email dated 13 Feb 2009 (Pt 2)	Is the particle size distribution for the CSD used in the modeling from crushed cores (as stated on p13 of the GEMS modeling report) or from Geraldton (p 84 in response to submissions)?	Refer to Table 4.17
	Email dated 13 Feb 2009 (Pt 3)	With respect to assumptions related to the production of fines, recent documentation leaves the DEC MEB unclear about what has been modeled.	Refer to Table 4.17
	Email dated 13 Feb 2009 (Pt 4)	With respect to assumptions related to the release of fines expressed as a 'percentage', DEC MEB are still unclear about the net 'load' of fines that would be generated from the approach of utilizing a work method whereby the CSD cut and sidecast followed by TSHD removal versus the standard CSD approach of filling barges.	Refer to Table 4.17
DoW	13.1	Statement that the DoW has no legislative responsibilities for the land on which the Revised Proposal is based and water management issues are being addressed by DEC; technical information will be provided to DEC as required.	Refer to Table 4.1.
DEC – Air Quality Management Branch	14.1	Comment regarding PM_{10} concentrations and the requirement to consider background concentrations.	Refer to Table 4.22.
	14.2	Comment regarding modelling and interpretation of impacts in relation to concentrations of ozone released during CO_2 venting periods.	Refer to Table 4.22 and Section 4.8.3.
	14.3	Major contributors to emissions should have been more clearly identified.	Refer to Table 4.22.
	14.4	Predicted H_2S concentrations, particularly during CO_2 venting periods, are significant and they should have been compared to ambient odour criteria.	Refer to Table 4.22.
	14.5	Limitations of the agency review are outlined.	Refer to Table 4.22.
Environmental Protection Authority	Verbal query 0n 19 Feb 2009	Query as to whether modelling accounted for other Pibara emissions sources, including Varanus Island.	Refer to Table 4.22.
Conservation Commission of Western Australia	15.1	Statement that the commitment to a whole-of-island approach to management is of critical importance.	Refer to Table 4.27.
	15.2	Expressed the view that DEC needs to be resourced to facilitate effective management involvement on a day-to-day basis.	Refer to Table 4.27.
	15.3	Acknowledges the high standard of work intended with respect to quarantine and states the need to ensure that any breaches are quickly acted upon.	Refer to Table 4.21.
	15.4	Statement of concern regarding the assessment of risks, particularly in relation to the Island's turtle population.	Refer to Table 4.3 and Table 4.15.
	15.5	Query regarding definition of 'significant' and statement that the risk assessment is poorly related to the quantification of the impact of the Revised Proposal.	Refer to Table 4.3 and Table 4.15.
NOPSA	16.1	Comment that NOPSA's role does not extend to address environmental issues or onshore aspects of the Gorgon Development and they have no comment on the PER.	Refer to Table 4.28.

Submitter	Item No.	Short description of comment	GJVs Response
DPI – Climate Change and Coastal Planning Branch	17.1	General statement regarding the scope of comments and acknowledging that most comments relate to matters arising from State Planning Policy No. 2.6 State Coastal Planning Policy.	Refer to Table 4.28.
	17.2	Comment that it does not appear that climate change has been considered in the planning of the development and that it is important the siting and design of the facility takes into consideration the potential impacts of climate change.	Refer to Table 4.28.
	17.3	Discussion of coastal setback requirements and the requirement for the Proponent to demonstrate that the development is dependent on a foreshore location.	Refer to Table 4.1.
	17.4	Comment regarding the location of the Revised Proposal within a cyclone-prone area and the requirement for any development that poses a pollution risk to be set back sufficiently to reduce impacts on the adjacent coastal and marine environment.	Refer to Table 4.28.
	17.5	Comment regarding drainage and the requirement that discharge of waste and/or stormwater does not degrade the coastal environment, including coastal and marine waters and ecosystems.	Refer to Table 4.4 and Table 4.11:.
	17.6	Comment that the overall approach to manage and monitor dredging appears to be fundamentally reactive and provided an example of a more proactive, predictive and preventative management approach.	Refer to Table 4.27.
	17.7	A number of comments regarding the adequacy of the Dredge Plume Modelling and the lack of information provided about the modelling.	Refer to Table 4.1 and Section 4.8.2.
	17.8	A number of issues have been raised regarding the Coastal Processes Modelling, including insufficient information/detail and whether particular aspects of the Revised Proposal were incorporated into the model.	Refer to Table 4.16.
Department of Fisheries	18.1	Concerns regarding Revised Proposal with a focus on dredging, marine biosecurity and resource implications for the DoF.	Refer to Table 4.1.
	18.2	Any increased dredging likely to have a negative impact on fish habitats in and around the Island.	Refer to Table 4.15.
	18.3	Potential negative affects of the dredging and spoil disposal program on commercial fisheries.	Refer to Table 4.15.
	18.4	Ongoing liaison between GJV and DOF.	Refer to Table 4.15.
	18.5	Potential increase in risk profile or change in identified risks as a result of changed vessel movements and increased modularisation.	Refer to Table 4.21.
	18.6	DoF in current capacity has limited ability to dedicate resources to the project and requests dedicated funding.	Refer to Table 4.28.

APPENDIX B: DREDGING SIMULATION STUDIES TO SUPPORT THE PER FOR THE REVISED PROPOSAL (GEMS 2008)

GEMS

GLOBAL ENVIRONMENTAL MODELLING SYSTEMS

GLOBAL ENVIRONMENTAL MAPPING SYSTEMS

GLOBAL ENVIRONMENTAL MONITORING SYSTEMS

CHEVRON AUSTRALIA

Gorgon Development

Dredging Simulation Studies to Support the PER for the Revised Proposal

November 2008

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About GEMS

Global Environmental Modelling Systems (GEMS), a wholly owned Australian company, has expertise in the development and application of high-resolution computer models to realistically predict atmospheric and oceanographic conditions for use in riverine, coastal and oceanic settings.

The GEMS team is made up of qualified and experienced physical oceanographers, meteorologists, numerical modellers and environmental scientists. GEMS is a leading developer of numerical models in Australia. It has developed a system of validated environmental models and rigorous analytical procedures that provide solutions to a variety of environmental, engineering and operational problems.

Disclaimer

This report and the work undertaken for its preparation, is presented for the use of the client. Global Environmental Modelling Systems (GEMS) warrants that the study was carried out in accordance with accepted practice and available data, but that no other warranty is made as to the accuracy of the data or results contained in the report.

This GEMS report may not contain sufficient or appropriate information to meet the purpose of other potential users. GEMS, therefore, does not accept any responsibility for the use of the information in the report by other parties.

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1 INTRODUCTION

Global Environmental Modelling Systems (GEMS) carried out the original simulations of the hydrodynamics and the dredging of the Materials Offload Facility (MOF) and the LNG shipping access channel for the EIS/ERMP for the Chevron Gorgon Development at Barrow Island (GEMS 2005a and b; Chevron 2005). The plume modelling output was analysed to predict zones of impact due to sedimentation and turbidity, according to predefined coral health criteria. This modelling was subsequently revised during the public review period and released with the Final EIS and Response to Submissions on the ERMP (Chevron 2006).

Since the EIS/ERMP studies were undertaken, Chevron has made some alterations to the dredge plan, mainly driven by the desire to avoid cutting through (or drilling and blasting) the hard rock at the original location of the MOF. This process produces significant amounts of "rock flour" and is also quite slow. Additional geotechnical data indicate that a lot of drilling and blasting would be necessary to break up the harder rock.

The Revised Proposal is to locate the MOF further from the coast, resulting in a longer causeway and a shorter access channel to the MOF (see Figure 1.1). A further important change is that the MOF will be developed prior to the causeway joining it to the land thus allowing much better flushing during dredging in this area than the original method which involved building the causeway first.

The remaining components of the dredge plan are substantially the same as for the original studies except that the LNG access channel has been realigned slightly to avoid dredging through a shallow area of coral at the outer end of the channel.

Chevron Australia commissioned GEMS to conduct further dredge plume modelling in support of the PER for the Revised Proposal. The additional modelling was requested to determine whether the changes to the Approved Development, in particular the dredging component of marine infrastructure construction, have changed the size and location of the effect zones (impact zones) substantially from those approved as part of the Approved Development.

This report describes the methods and outcomes of this new simulation.

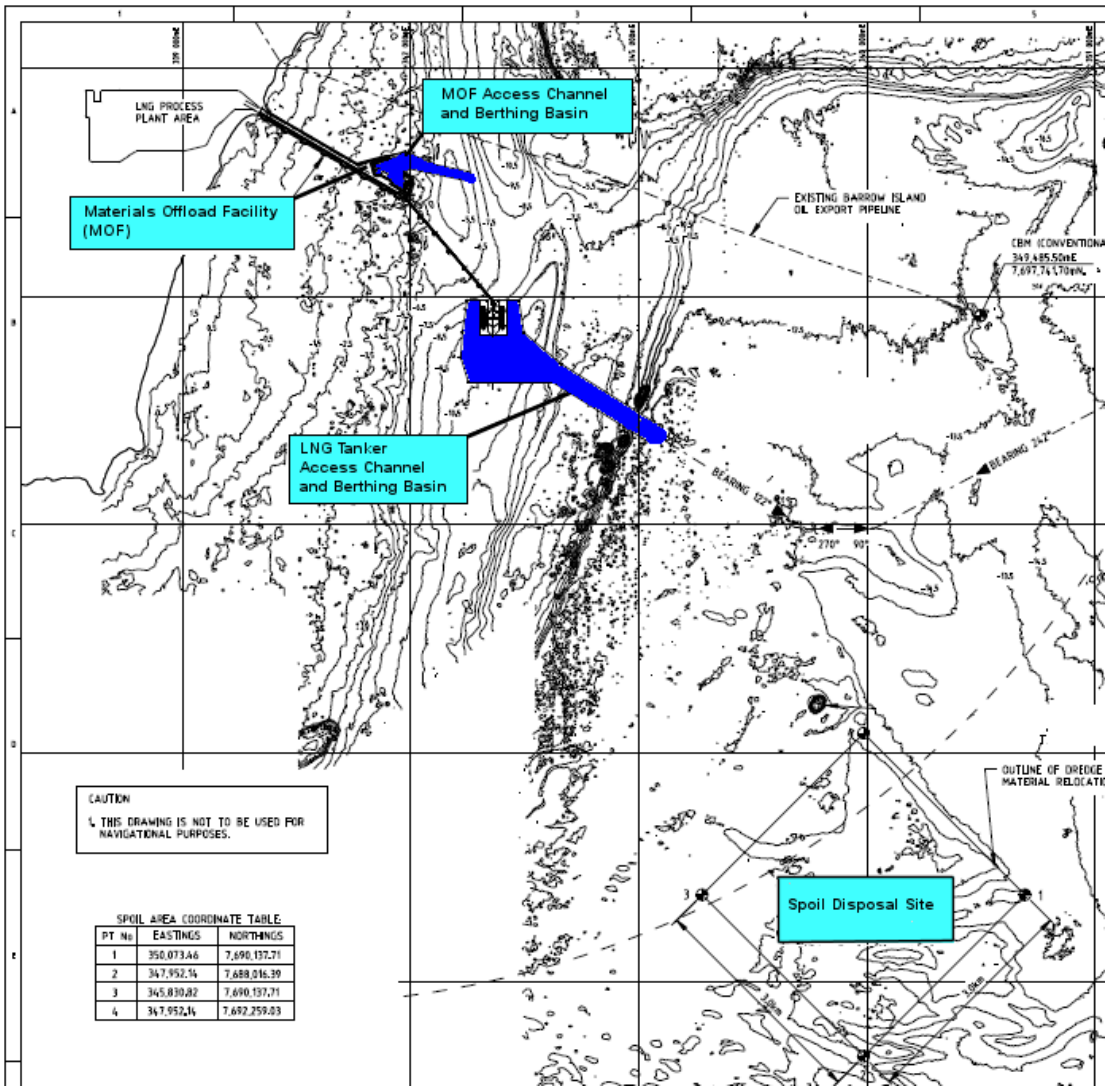

Figure 1.1: The dredging footprint for the LNG access channel and the relocated MOF.

2 APPROACH TO MODELLING

The current modelling study took the opportunity to include improvements/changes to the dredge modeling methodology which have become available since the release of the EIS/ERMP. The improvements/changes in methodology relevant to this study are explained in this report. In general however, the same assumptions were included to ensure consistency in approach and to increase the comparability of the outputs from the two modelling runs.

In broad detail, the dredge modelling took the following approach:

- Detailed dredge logs describing the best estimate of dredging the adjusted configuration were established by Baggermann's (the dredging advisors) in conjunction with GEMS (the dredge modellers).
- The major variations in this study were the adjusted dredge plan and associated footprint and the abandonment of the use of barges to dispose of material cut by the CSD in the LNG channel. Instead the CSD cuts/crushes the harder material in the channel and the TSHD comes along later to remove this material to the spoil ground.
- Due to the above change in dredging methodology, the assumptions regarding generation of fines, release of fines at the Cutter Suction Dredge (CSD) cutter head, overflow of fines from CSD barges and the Trailer Suction Hopper Dredge (TSHD) and release of fines at the spoil ground which were used during the original EIS/ERMP studies were adjusted. It was necessary to include the extra process of the CSD laying down material which is later picked up and transported to the spoil ground by the TSHD. The assumptions adopted for the release of fines were:

  a) 30% released at CSD cutter head

  b) 20% released during the process of leaving the cut and crushed material on the seabed

  c) 30% released during the pick-up and overflow by the TSHD

  d) 20% released during the dumping at the spoil ground

  These assumptions are somewhat conservative as they assume all the fine material is released, whereas in fact some of the fines will be trapped in the spoil ground.

- Substantially the same particle size distributions and settling rates used in the studies for the EIS/ERMP were used in this study however they were defined in more detail as discussed later (ref Table 1).
- The new dredge plan has been simulated for the "base case" for the "normal" period of meteorology established in the original EIS/ERMP studies in order to

provide a “sensitivity study” so that the expected environmental impacts of the new dredge plan can be compared with those submitted in the EIS/ERMP.

- The same impact criteria used in the original EIS/ERMP studies were used to analyse the results and produce impact boundaries which can be compared with the boundaries established for the EIS/ERMP.

These studies were undertaken using the output of three sophisticated numerical computer models to drive the GEMS 3D Dredge Simulation Model (DREDGE3D) to determine the fate of particles released into the water column during the dredging operations. The three models providing input to DREDGE3D were:

- The Bureau of Meteorology (BoM) high resolution (10km) atmospheric model (MESOLAPS) hindcast fields for atmospheric pressure, wind speed and direction;
- The GEMS 3D Coastal Ocean Model (GCOM3D) to simulate the complex three-dimensional ocean currents surrounding Barrow Island; and
- The SWAN wave model run on four nested grids telescoping from the Indian Ocean down to the Northwest Shelf.

The dredging simulations were commenced in September and lasted for approximately 13 months. In this time period it was assumed that two coral spawning periods took place, one in April and the other in September, just before completion of the dredging. A third coral spawning in the month of commencing dredging was not included as it was assumed that dredging would be planned to commence after completion of the coral spawning.

The basic tasks undertaken were:

- Run SWAN for the “typical” 13 month period driven by MESOLAPS winds (waves were not simulated in the original studies) to provide orbital velocities for re-suspension calculations;
- Work with the dredging advisors (Baggermanns) to enable them to develop new dredge logs for the simulations based on the altered dredge plan;
- Run the full dredge scenario for the MOF and the LNG access channel for the “typical” 13 month period.
- Analyse output from the simulation to derive impact zones, based on model output and the RPS coral health criteria established for the EIS/ERMP (Chevron 2005).

3 DREDGE PROGRAM SIMULATIONS

As described in the original studies, DREDGE3D is driven by a "dredge log" which sets out the detailed activities of the dredges as they execute the dredge plan. Of course the actual dredge log during the dredge program will be different but every effort is made to include all the realistic activities involved in the dredge plan to develop a "representative" dredge log for the simulations. It is over 2 years since the original studies and the detail included in the dredge logs has increased considerably, providing another source of difference with the original simulations.

The key assumptions/parameters used in the simulations and variations from the original studies are discussed below.

3.1 REVISED DREDGE PLAN

The major changes to the current dredge plan from the EIS/ERMP are:

- Location of the MOF further from the coast, resulting in a longer causeway and a shorter access channel to the MOF (see Figure 1.1);
- Development of the MOF prior to the causeway joining it to the land thus allowing much better flushing during construction.
- The dredging of the deeper parts of the LNG access channel with a Cutter Suction Dredge (CSD) and leaving the material on the seabed instead of using overflowing barges to take the material to the spoil ground. The material cut and crushed by the CSD is picked up later from the seabed by the TSHD.

3.2 DEVELOPMENT OF THE DREDGE LOGS

A further significant change in these studies is the greater detail included in the dredge logs. For the original PER studies GEMS developed the dredge logs based on information provided by Chevron and Baggermanns (the dredging advisors). For these studies the dredge logs were initially developed by Baggermanns and then adapted to the dredge model by GEMS. This approach allows for the dredging knowledge and experience of Baggermanns to be the driving force in development of the logs. This has introduced a much more detailed representation of dredging behaviour to the simulation process which now reflects a cut by cut approach to the dredge logs along defined paths rather than the original approach where a particular volume was dredged from a sector of the channel in a given time. Much of the information below has been extracted from detailed, commercial-in-confidence, drawings and spreadsheets provided by Baggermanns.

The assumptions/specifications from Baggermanns for the dredging of the MOF with a CSD loading hopper barges is given in Table 2. A sample of the first 18 hours of dredge log information provided by Baggermanns, based on these assumptions for the MOF dredging is shown in Table 3.

3.3 MODELLING ASSUMPTIONS

3.3.1 MOF

For the model simulation of the dredging for the Material Offload Facility (MOF) the following assumptions are included in the dredge log:

- The volume of cut and fill is estimated to be 1,000,000 m^3.
- The majority of the material to be dredged is crystalline limestone with a capping of calcarenite (supported by latest geotechnical data).
- The characteristics of the spoil are anticipated to be similar to that generated at Geraldton (i.e. a high proportion of fines/flour and coarse limestone rubble).
- The duration of the dredging/reclamation program is estimated to be 18 weeks plus 2 (or more) weeks weather downtime.
- The MOF will be dredged with a Jumbo CSD with a nominal cut width of 150 m and step height of 2 m. The step length varies according to the strength of the material but generally will be between 2 and 0.3 m.
- The cutting sequence is done as single layers or as multiple layers off a single anchor position.
- The dredging method assumes softer materials are removed in a single layer followed by the harder material.
- The number of moves per anchor position depends on the number of steps per spud position and assumes a 6 metre spud carriage travel length.
- A mean dredge work rate of 84 hours of dredging per week (the actual rate will vary depending on hardness of rock).
- Lost time is due to the dredge stopping and changing teeth every few hours in the softer rock and every 20-30 minutes in the harder rock and for maintenance or refuelling activities.

- The dredge will start at outer end of the access channel and gradually work towards the shore creating a 6.5m deep channel (LAT).
- Maintenance will occur as needed. However when dredging rock there will be shut downs each 7 to 14 days in harder material and longer in softer materials. Refuelling will be undertaken each four to six weeks for 2 days.

3.3.2 LNG ACCESS CHANNEL

The LNG Channel and Turning Basin Dredging Method will be undertaken in 3 stages:

Stage 1: Remove Overburden of soft sandy sediments from Channel Alignment with a TSHD.

Stage 2: Cut and Crush Rock with a CSD and leave on bottom of Channel.

Stage 3: Remove Crushed Rock with a TSHD.

The following basic assumptions were made:

- The total volume to be dredged is estimated to be 6.6 million m^3.
- Roughly 40% of the total volume in the LNG Access Channel and turning basin is sediment which can initially be removed by TSHD.
- In general maintenance will be undertaken travelling to and from the spoil grounds but the TSHD will cease operations for two days every 4 to 6 weeks to refuel and undertake major maintenance.
- Overflow will operate for the last 60 minutes of dredging and will be released under the keel of the TSHD (-6 m depth).
- Overflow discharge rate will be approximately 8 m^3/sec (2 x 4 m^3 /sec dragheads).

The TSHD in Stages (1) and (3) will:

- When dredging move at a speed of 1-2 knots across the seafloor zig zagging from one side of the channel to the other.
- The effective operational length for the TSHD loading is 1 to 2 kilometres at which point the vessel will normally turn.
- When travelling to and from the spoil ground the TSHD can reach speed of 13 knots. For this work the average speed achieved by the TSHD is taken as 10 knots. This allows for the acceleration and deceleration of the TSHD as it departs the dredging area and arrives at the spoil ground.
- When loading the TSHD progressively shaves thin layers off the surface of the seafloor generally penetrating 0.10 to 0.5 insitu density of the material.
- The TSHD dredging and disposal cycle period will be approximately 2.5 hrs (based on 90 minutes of dredging, 1 hour of travel to and from spoil ground including 10 minutes for dumping at the spoil ground).
- TSHDs are less weather dependent than CSDs and will be able to deliver about 134 hours production per week which equates to 53 loads per week on average.

In stage 2 of the works the CSD will:

- Operate over a 100 to 170 metres cut width and slowly advance the work faces.
- The CSD dredge behaviour and production rates are anticipated to be similar to the MOF dredging rates described above (effective production of 96 hours/week).
- The duration of CSD dredging is anticipated to be 48 weeks.

3.3.3 REPRESENTATION OF THE PARTICLE SIZE DISTRIBUTION AND SETTLING VELOCITIES OF THE DREDGED MATERIAL

The particle size of components of the dredged material is critical to their fate. If a particle is less than, say, 40 microns then it will most likely remain in suspension, or be resuspended, and from part of the dredge plume which moves with the 3D ocean currents.

To take this example further a particle with a diameter of 40 microns settles at a rate of approximately 1.25 mm/sec or 75mm/minute or 4.5 metres/hour. Settling at such a slow

rate, and being so light, exposes such particles to the effects of ocean turbulence and resuspension even if it does make it to the sea bed.

Of course particles of diameter 50 microns will also settle slowly and be part of the turbid plume, but perhaps for a lesser time period and so on until the particles are of sufficient size and weight to predominantly settle to the sea bed within a short distance of release and be unlikely to be resuspended.

As an example, a particle of diameter 250 microns settles at a rate of approximately 50 mm/sec or 3 metres/minute or 180 metres/hour. This particle is still relatively light but will certainly settle to the seabed a short distance from its release and be unlikely to be resuspended or move very far (because it will settle again).

As a result, from a simulation point of view, the size of particles much larger than 250 microns (say) are not very important to the outcomes. In other words, a particle of size 1000 microns will end up on the seabed not far from a particle of size 2000 microns etc..

Hence the size distribution of particles within the dredged volume is very important below approximately 250 microns and increasingly less important above that value.

With these thoughts in mind the Particle Size Distributions (PSD) and Settling Velocities used for material dredged by the CSD and by the TSHD are summarized in Table 1.

Note that:

1) **the real dredged product may actually contain small boulders and rubble but the PSD is based on an analysis of crushed cores and so there are no very large particles. This process introduces a further degree of conservatism to the results.**

2) **The PSD for the material cut and crushed by the CSD and picked up later by the TSHD is defined throughout as the CSD distribution shown in Table 1.**

3.3.4 APPLICATION OF THE "GERALDTON" ASSUMPTION

During the Geraldton dredging project it was found that there were approximately twice as many fines below 40 microns as determined by analysis of crushed cores. This outcome was due to the grinding motion of the CSD cutter teeth on hard rock, producing "rock flour".

This assumption has been included in Table 1 for the PSD adopted for dredging with the CSD.

3.3.5 THE RELEASE OF FINES INTO THE WATER COLUMN

A further issue to consider is the mechanism via which the very fine material which can constitute a sustained turbid plume is released into the water column. There are several stages of the dredging process whereupon this can occur, namely the cutting, overflowing, crushing and rehandling of the material and the disposal at the spoil ground.

A further consideration is that the dredging and disposal process varies as a function of location and dredge type. To clarify the methodology used in the dredging simulations, the assumptions adopted for distribution of the release of material below 75 microns across the various dredging methods and dredges were as follows:

1) CSD dredging the MOF and loading barges which overflow and then release the hopper contents at the spoil ground
    - 30% released at the CSD cutter head;
    - 35% released during overflow from the barge;
    - 35% released during dumping at the spoil ground
2) CSD dredging the LNG channel and depositing on the seabed for later pickup by the TSHD and dumping at the spoil ground
    - 30% at the CSD cutter head;
    - 20% release when material dredged by the CSD is crushed and deposited on the sea bed;
    - 30% released when material is picked and overflowed by the TSHD
    - 20% released during dumping at the spoil ground
3) TSHD dredging of the upper levels of the LNG channel and dumping at the spoil ground
    - 30% at the TSHD drag head;
    - 40% released when material is overflowed by the TSHD
    - 30% released during dumping at the spoil ground

Note this assumes a 100% release of fines below 75 microns and that none is bound up in the spoil ground, which is a conservative assumption.

Above 75 microns these percentages are linearly reduced such that they reach zero at a particle size of 250 microns.

Table 1: Particle size distributions and associated settling rates used for material cut by the CSD and TSHD

Diameter (micron)	Settling Rate (mm/s)	Material cut by CSD (including disposal by TSHD) %	Material dredged by TSHD %
1000.0	796.0	14.0	13.0
502.4	200.2	8.0	6.0
399.1	126.3	23.0	7.0
251.8	50.29	23.0	25.0
158.9	20.03	8.0	21.0
126.2	12.63	6.0	17.0
89.3	6.330	3.0	1.0
79.6	5.028	2.0	1.0
63.3	3.173	1.0	1.0
50.2	2.002	1.0	1.0
39.9	1.263	1.0	1.0
31.7	0.7970	1.0	1.0
25.2	0.5029	1.0	1.0
15.9	0.2003	1.0	1.0
10.0	0.0796	1.0	0.0
8.0	0.0503	1.0	1.0
6.3	0.0317	1.0	0.0
4.0	0.0126	1.0	1.0
2.0	0.0032	1.0	0.0
1.0	0.0008	1.0	1.0
0.5	0.0002	1.0	0.0
	Total:	**100.0**	**100.0**

Table 2: MOF - CSD LOADING HOPPER BARGE SPECIFICATIONS (supplied by Baggermanns)

Number of Barges	3	Units	**Barges**	Time Period	Units
Dump Distance	11	Kms	Travel To Dump	35.64	mins
Return Distance	11	kms	Dump & Turn	10.00	mins
Travel Speed (mean)	10	knots	Return from Dump	35.64	mins
			Cycle	81.27	mins
Volume Transported	879,278	m^3	Loading Time	27.09	mins
			Total Cycle Time	108.37	mins
Barge Capacity	3700	m^3	Solids Filling Rate	1097	m^3/hour

Table 3: MOF - CSD INITIAL 18 HOUR DREDGE LOG (supplied by Baggermanns)

From	To	Description	Volume (m^3)	Advance (m)	Barges	Accum Volume (m^3)	Overflow (mins)	Overflow Rate (m^3/s)	Volume Overflow (m^3)	Acum overflow (m^3)
6:00		Move from anchor position to dredging area								
10:00		Position Barge alongside								
	10:30	Commence Dredging								
10:30	10:57	Load Barge 1	494	1.93	1	494	17	3.8	3,902	3,902
10:57	11:11	Change teeth, advance, mechanical etc							0	
11:11	11:38	Load Barge 2	494	1.93	2	988	17	3.8	3,876	7,778
11:38	11:52	Change teeth, advance, mechanical etc							0	
11:52	12:19	Load Barge 3	494	1.93	3	1,482	17	3.8	3,876	11,654
12:19	12:33	Change teeth, advance, mechanical etc							0	

12:33	13:00	Load Barge 1	494	1.93	4	1,976	17	3.8	3,876	15,530
13:00	13:14	Change teeth, advance, mechanical etc							0	
13:14	13:41	Load Barge 2	494	1.93	5	2,470	17	3.8	3,876	19,406
13:41	13:55	Change teeth, advance, mechanical etc							0	
13:55	14:22	Load Barge 3	494	1.93	6	2,964	17	3.8	3,876	23,282
14:22	14:36	Change teeth, advance, mechanical etc							0	
14:36	15:03	Load Barge 1	494	1.93	7	3,458	17	3.8	3,876	27,158
15:03	15:17	Change teeth, advance, mechanical etc							0	
15:17	15:44	Load Barge 2	494	1.93	8	3,952	17	3.8	3,876	31,034
15:44	15:58	Change teeth, advance, mechanical etc							0	
15:58	16:25	Load Barge 3	494	1.93	9	4,446	17	3.8	3,876	34,910
16:25	16:39	Change teeth, advance, mechanical etc							0	
16:39	17:06	Load Barge 1	494	1.93	10	4,940	17	3.8	3,876	38,786
17:06	17:20	Change teeth, advance, mechanical etc							0	0
17:20	17:47	Load Barge 2	494	1.93	11	5,434	17	3.8	3,902	42,687
17:47	18:01	Change teeth, advance, mechanical etc							0	0
18:01	18:28	Load Barge 3	494	1.93	12	5,928	17	3.8	3,876	46,563

4 RESULTS

For the “base” case DREDGE3D was used to simulate the behaviour of particles released into the water column by the dredges using the dredging program assumptions outlined in the previous section. The dredging was started on September 1, 2000 and finished on October 5, 2001 to cover the period of most average conditions. The X, Y and Z coordinates of all particles tracked by DREDGE3D were stored hourly throughout the study area.

4.1 TURBIDITY AND SEDIMENTATION IMPACT ZONE ANALYSES

The impact criteria provided by RPS for the EIS/ERMP studies are reproduced in Table 4. These criteria were used to analyse the model output to produce effect zones showing regions affected by turbidity or sedimentation that result in high impact, moderate impact or influence (but no impact) (see Figures 4.1 and 4.2). It should be noted that the “clover leaf” shape of the contours at the spoil ground are entirely a function of choosing 5 different locations (4 corners and one in the middle) within the spoil ground to release material. If more points had been chosen then a “squarer” result would have been obtained.

In addition to the impact zones, time series of turbidity and daily sedimentation were extracted from the modeling results at locations, shown in Figure 4.3, in the vicinity of the dredging of the MOF.

The time series of turbidity at these locations are shown in Figure 4.4 and the daily sedimentation rates are shown in Figure 4.5. These plots do not extend to the full 377 days of dredging as there is minimal impact at these locations during the dredging of the LNG channel.

Table 4: Cumulative Impact Zones defined for Dredging at Barrow Island

- Exposure for at least six hours during daylight hours was regarded as satisfying the criteria
- The minimum TSS level for the zone of influence (zone 3) was 2mg/litre
- The minimum sedimentation for the zone of influence (zone 3) was 1mg/cm^2

Zone 1: Zone of High Impact			
Variable	Timeframe	Concentration	Time (cumulative days)
TSS	Short	≥25 mg l^{-1}	5 in 15
	Medium	≥10 mg l^{-1}	20 in 60
	Long	≥5 mg l^{-1}	80 in 240
Sedimentation	Daily	≥100 mg cm^{-2} d^{-1}	1
	Short	≥25 mg cm^{-2} d^{-1}	5 in 15
	Medium	≥10 mg cm^{-2} d^{-1}	20 in 60
	Long	≥5 mg cm^{-2} d^{-1}	40 in 120
Zone 2: Zone of Moderate Impact			
TSS	Short	≥25 mg l^{-1}	2 in 6
	Medium	≥10 mg l^{-1}	7 in 21
	Long	≥5 mg l^{-1}	20 in 60
Sedimentation	Daily	≥50 mg cm^{-2} d^{-1}	1
	Short	≥25 mg cm^{-2} d^{-1}	2 in 6
	Medium	≥10 mg cm^{-2} d^{-1}	7 in 21
	Long	≥5 mg cm^{-2} d^{-1}	20 in 60
Zone 3: Zone of Visibility (Influence)			
TSS	Any	≥2 mg l^{-1}	1
Sedimentation	Any	≥1 mg cm^{-2} d^{-1}	1

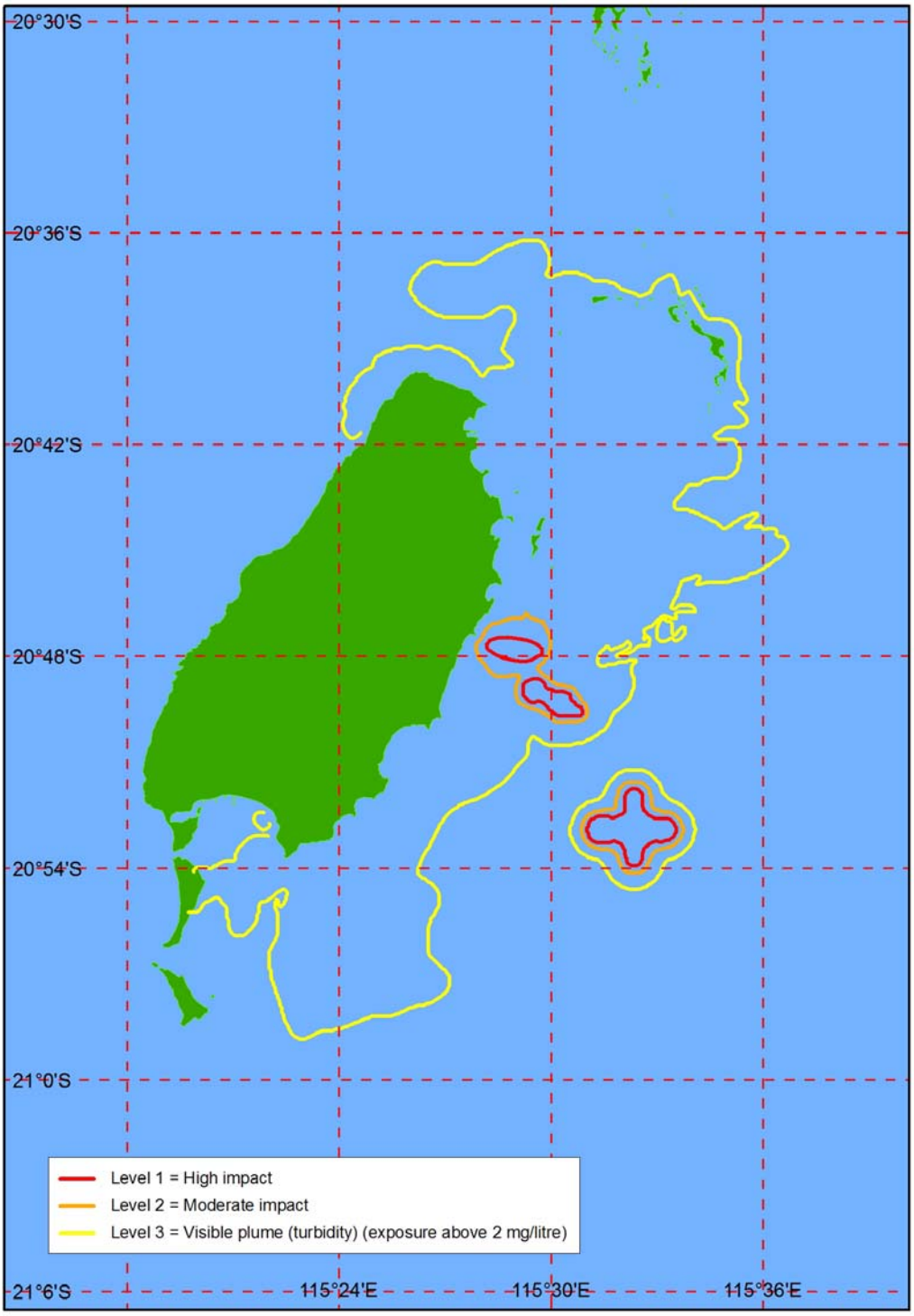

Figure 4.1 Mortality zones derived from DREDGE3D predictions of TSS for the "Base" case.

Level 1(red) = high impact,
Level 2 (orange) = moderate impact,
Level 3 (yellow) = visible plume (turbidity) (exposure above 2mg/litre).

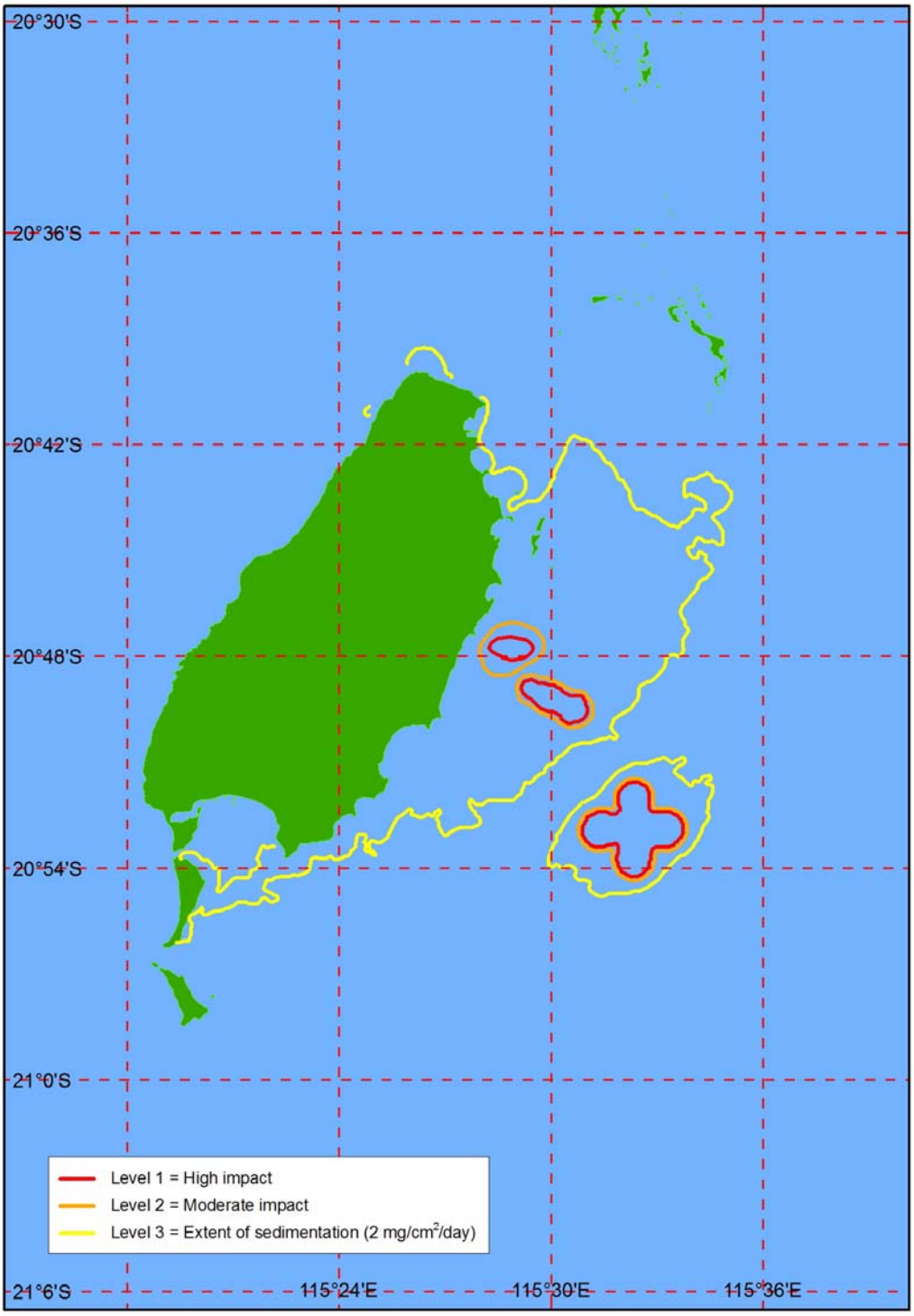

Figure 4.2: Mortality zones derived from DREDGE3D predictions of sedimentation rates for the "Base" case.

Level 1 (red) = high impact,
Level 2 (orange) = moderate impact,
Level 3 (yellow) = extent of sedimentation (above 2 mg/cm^2/day).

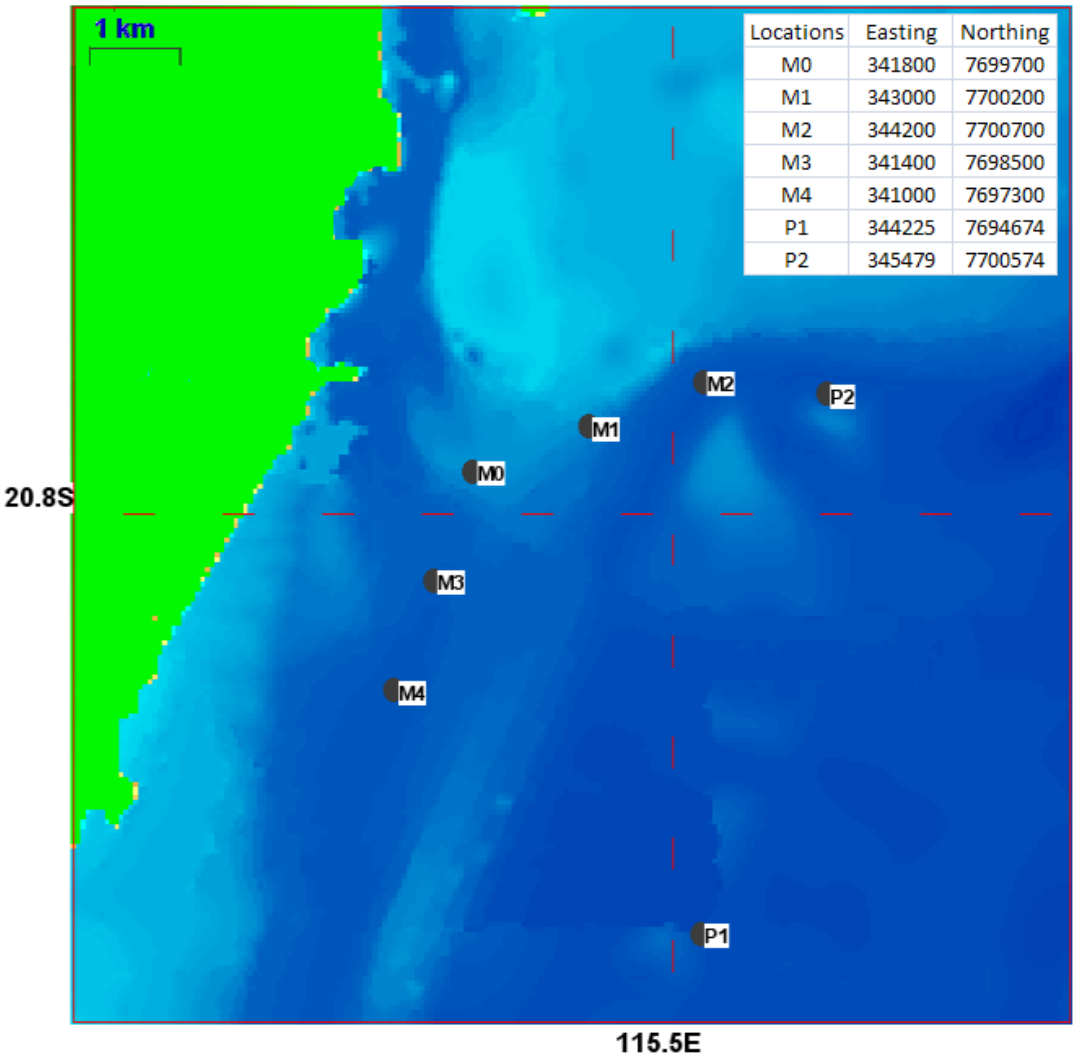

Figure 4.3: Locations within the vicinity of the MOF dredging where time series of turbidity and daily sedimentation were extracted.

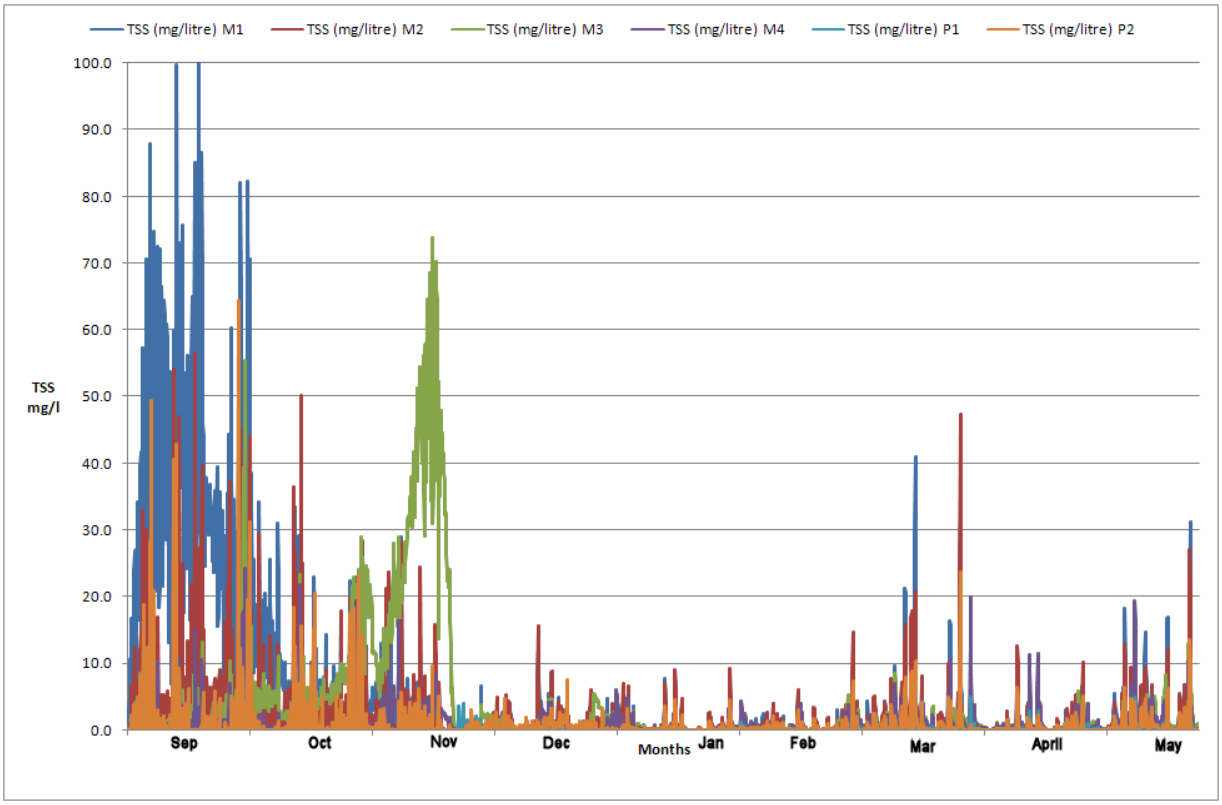

Figure 4.4: Time series of turbidity at the locations shown in figure 4.3.

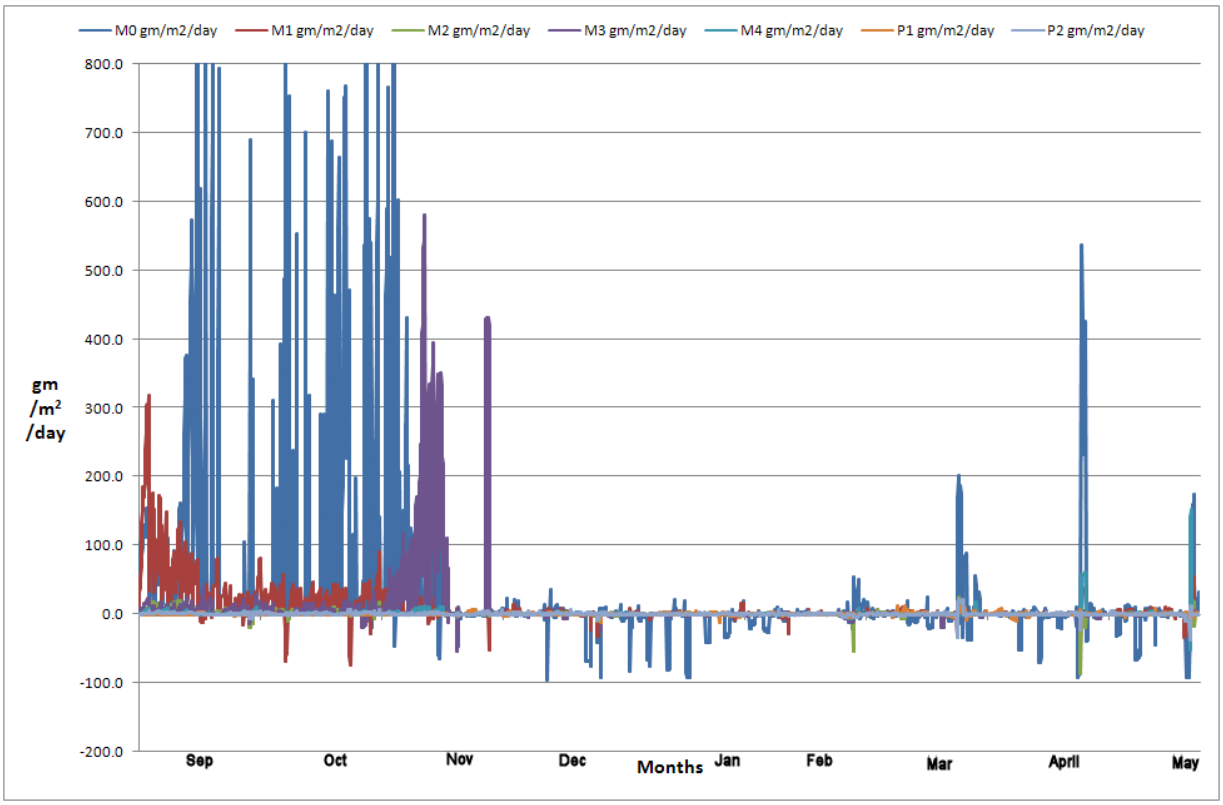

Figure 4.5: Time series of daily sedimentation at the locations shown in figure 4.3.

5 DISCUSSION

The revised dredge plumes appear similar in magnitude to previous estimates. While the dredging impact zones may be slightly smaller due to improvement in the accuracy of the detail included in the dredge log, and improvements to facility design, the model is not sufficiently precise to delineate minor differences. However, it can be assumed the impact zones will not be larger than those presented in the EIS/ERMP

Some areas of potential impact from sedimentation or turbidity that were identified in the EIS/ERMP are not predicted under the revised study. The changed alignment of the LNG channel removed the need to dredge the small ridge to the east of the turning basin and consequently the small impact zones around this area do not appear in the revised simulation outputs.

Similarly, the impact zones to the south of the MOF near Shark Point and the smaller moderate impact zone on the Lowendal Shelf, associated with dredging for the approved proposal (Figure 18; Chevron 2006), do not appear in the revised simulation.

These variations are probably a result of changes such as:

- The reduced amount of rock to be cut for the MOF due to its relocation further out to sea, resulting in less “rock flour” being produced.
- The improved flushing near the MOF due to the absence of the causeway from Barrow Island during the dredging.
- The reduction in the amount of dredging in shallow water and conversely the increased amount of dredging in deeper water allowing better flushing of fine material.
- The change from using overflowing barges for removing the material cut by the CSD in the LNG channel to leaving it on the seabed and removing the material later to the spoil ground with the TSHD
- The use of the SWAN wave model to simulate orbital velocities for resuspension of material from the seabed instead of the less accurate algorithms used in the previous studies. This improvement resulted in better simulations of the resuspension and flushing of fine materials from the region.
- The development of significantly more accurate dredge logs by Baggermanns reflecting much more fine detail of the dredge plan
- The changed alignment of the LNG channel.

6 REFERENCES

Chevron Australia 2005. *Draft Environmental Impact Statement/Environmental Review and Management Programme for the Proposed Gorgon Development. Main Report Volume II.* Chevron Australia. Perth Western Australia. September 2005.

Chevron Australia 2006. *Final Environmental Impact Statement/Response to Submissions on the Environmental Review and Management Programme for the Proposed Gorgon Development.* Chevron Australia. Perth Western Australia. May 2006

GEMS 2005a. *Gorgon Development Dredging Program Simulation Studies.* Global Environmental Modelling Systems. Perth, Western Australia. July 2005.

GEMS 2005b. *Gorgon Development Measurement and Model Prediction of Ocean Currents and Tides at Barrow Island, North Western Australia.* Global Environmental Modelling Systems. Perth, Western Australia. October 2005.