ASSESSMENT REPORT 38

SUNRISE GAS PROJECT

ENVIRONMENTAL ASSESSMENT REPORT
AND
RECOMMENDATIONS

by the

OFFICE OF ENVIRONMENT AND HERITAGE

DEPARTMENT OF INFRASTRUCTURE, PLANNING AND ENVIRONMENT

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Northern Territory Government
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ABBREVIATIONS

ALARP	As Low As Reasonable Practicable
AFMA	Australian Fisheries Management Authority
ANZECC	Australian and New Zealand Environment and Conservation Council
API	American Petroleum Institute
AQIS	Australian Quarantine and Inspection Service
BCF	Bio-concentration factor
BOD	biological oxygen demand
BTEX	Benzene, Toluene, Ethyl-benzene and Xylene
CHARM	Chemical Hazard Assessment and Risk Management
CH_4	Methane
cm	centimetre
CO	Carbon monoxide
CO_2	Carbon dioxide
CO_2 eq	Carbon dioxide equivalent
COD	chemical oxygen demand
DA	Designated Authority
DBIRD	Northern Territory Department of Business, Industry and Resource Development
DIPE	Northern Territory Department of Infrastructure, Planning and Environment
DLPE	Department of Lands Planning and Environment (now DIPE se above)
DEIS	Draft Environmental Impact Statement
DES	Derrick Equipment Set
DNV	Det Norske Veritas
EA	Environment Australia
EAA	Northern Territory *Environmental Assessment Act*.
EBF	Ester Based Drilling Fluids
EHD	Environment and Heritage Division (now Office of Environment and Heritage)
E&P	Exploration and Production Forum
EP	Environment Plan
EPBC	*Environment Protection and Biodiversity Conservation Act 1999*
EIS	Environmental Impact Statement
ERP	Emergency response plan
ERP 3220	Woodside Energy Limited Northern Territory and Timor Sea Oil Spill Contingency Plan
Final EIS	Combination of Draft EIS, EIS Supplement and Addendum
FLNG	Floating Liquefied Natural Gas
FPSO	Floating Production Storage Offtake
FSO	Floating Storage Offtake
GCCA	Greenhouse Challenge Co-operative Agreement
GFMWQ	Guidelines for Fresh and Marine Water Quality June 2000
GHG	Greenhouse gas

g/m^2	grams per square metre
GMP	Greenhouse Management Plan
GWP	Global warming potential
HAZID	Hazard identification
HAZOP	Hazard and operability
HOCNF	Harmonised Offshore Chemical Notification Format
HQ	Hazard Quotient
JPDA	Joint Petroleum Development Area
KCL /PHPA	Potassium chloride combined with partially hydrolysed polyacrylamide
kg/m^3	kilograms per cubic metre
kph	kilometres per hour
km	kilometres
km^2	square kilometre
L	litre
LNG	Liquefied Natural Gas
Log_{10} Pow	ratio of equilibrium concentrations of dissolved substances in n-octanol and water
LSA	Low Specific Activity
m	metre
m^3	cubic metre (volume 1m x 1m x 1m also equal to 1000 litres)
MEG	Mono ethylene glycol
mg/cm/day	milligrams per centimetre per day
mg/L	milligrams per litre
mm	millimetre
ms^{-1}	metres per second
MODU	Mobile Offshore Drilling Unit
MOU 1974	Memorandum of Understanding with Indonesia 1974
MSDS	Material Safety Data Sheets
NAGV	Northern Australian Gas Venture
NEPM	National Environmental Protection Measure
NGO	non-government organisation
NOHSC	National Office of Health and Safety Committee
NOx	Nitrogen oxides
NOI	Notice of Intent
NORM	Naturally Occurring Radioactive Materials
NT	Northern Territory
OBF	Oil Based Drilling Fluids
^0C	degrees Celsius
^0S	degrees of latitude South
OEH	Office of Environment and Heritage
OCNS	Offshore Chemical Notification Scheme
OCR	UK *Offshore Chemical Regulations 2002*
OCRL	Offshore Chemical Regulations Notified Chemicals Listing
OIW	Oil in Water
OLNG	Onshore Liquefied Natural Gas
OSCP	Oil Spill Contingency Plan
OSPAR	Olso and Paris Commission

OSPAR Decision 2000/2	Harmonised Mandatory System for the Use and Discharge of Offshore Chemicals
PCUQ	Processing, Compression Utilities Quarters
PEC	Predicted Environmental Concentration
pH	measure of acidity or alkalinity
Phillips	Phillips Petroleum Company
PHPA	partially hydrolysed polyacrylamide
PFW	Produced Formation Water
PLONOR	Pose Little or No Risk to the Environment
PMBH	polyhexamethylene biguanide hydrochloride
PNEC	Predicted No Effect Concentration
ppb	parts per billion
ppm	parts per million
P (SL) A	*Petroleum (Submerged Lands) Act 1967*
P (SL)(MOE)	Petroleum Submerged Lands (Management of Environment) Regulations 1999
P (SL) A Schedule	P (SL) A *Schedule Specific Requirements as to Offshore Petroleum Exploration and Production 1997*
QRA	Quantitative risk assessment
SBF	Synthetic based Drilling Fluids
SSETR	Semi-submersible Self Erecting Tender Rig
SGP	Sunrise Gas Project
SOx	Sulphur oxides
SRB	Sulphate reducing bacteria
TEG	Tri ethylene glycol
ug/g	micrograms per gram
UK	United Kingdom
US EPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound
Wellstream	Multiphase flow produced from a well
WAMPR	Western Australian Department of Minerals and Petroleum Resources
WBF	Water Based Drilling Fluids
WHP	Well Head Platform
WMP	Waste Management Plan
Wye	Wye intersection with the proposed Bayu Undan Gas Pipeline
ZOC	Zone of Cooperation (now known as the JPDA see above)
96 hour LC_{50}	**96 hour lethal concentration toxicity test**
48 hour EC_{50}	48 hour effect concentration test

EXECUTIVE SUMMARY

This report assesses the environmental impacts of the proposal by Woodside Energy Limited (the proponent), on behalf of the Sunrise Gas Joint Venture, to develop the Greater Sunrise gas and condensate fields, approximately 450km north west of Darwin in the Timor Sea. The Sunrise Gas Joint Venture partners are Woodside Energy Ltd, Phillips STL Pty Ltd, Shell Development (Australia) Pty Ltd and Osaka Gas Australia Ltd. The proposal is to install the necessary offshore infrastructure required for gas field development.

This Assessment Report reviews the Environmental Impact Statement (EIS), public comments, the proponent's Supplement to the draft EIS and additional information requested pursuant to Section 14.2 of the *Environmental Assessment Act*. Information, comments and advice provided by Northern Territory Government agencies and previous studies undertaken in the region have also been used in report preparation.

Environmental Assessment is the process of defining those elements of the environment which may be affected by a development proposal and of determining the significance, risk and consequences of the potential impacts of the proposal. Recommendations arising from the assessment address methods to mitigate these impacts.

Major Issues

The principal environmental issues identified by the proponent are:

- Atmospheric emissions from platform operations and cargo tank venting;
- Localised reduction in water quality during construction phase;
- Localised elevation of water temperature and impact on marine organisms;
- Localised reduction in water quality due to release of pipeline hydrotest water
- Smothering effects of accumulated drilling cuttings on marine biota;
- Potential anoxia of sediments due to degradation and/or burial of drilling muds adhered to drilling cuttings;
- Disturbance to seabed and seabed characteristics due to permanent facility
- Waste disposal;
- Noise ,vibration, light and heat and impact on marine species as a consequence of project related activities;
- Potential hydrocarbon discharges to the marine environment
- Potential introduction of exotic marine pest species
- Impact of marine anti-foul agents; and
- Temporary disruption too commercial fishing activities.

(Woodside, 2001)

The potential benefits associated with the proposal as identified by the proponent are:

- Use of natural gas as any alternative to fossil fuels will reduce global greenhouse emissions;
- Short term boost in employment for workers in facility infrastructure construction and in industries providing services and materials; and
- Basing of offshore facility staff predominantly in Darwin.

Conclusions

It is considered that the environmental issues associated with the project have been adequately identified. Some of the issues have been resolved through this assessment process, while the remainder will be addressed through the installation, construction, commissioning, operational and decommissioning environmental plans. Acceptance of environment plans will be subject to review by the Department of Business, Industry and Resource Development in consultation with other relevant Northern Territory and Commonwealth Government agencies.

Initially, the EIS and recommendations detailed in this Assessment Report will form the basis for Woodside Energy's management and monitoring commitments. The environmental plans prepared in compliance with the *Petroleum (Submerged Lands) (Management of Environment) Regulations 1999* (P (SL)(MOE)) will be working documents for each phase of the development of the facility.

Based on the review of the draft EIS, the Supplement and the Addendum in which the proponent responds to issues raised by relevant NT Government agencies and the public it is considered that the Sunrise Gas Project (SGP) can proceed. The Project can be developed and managed in a manner that avoids unacceptable environmental impacts provided the commitments and safeguards made by the proponent are implemented, the recommendations and suggestions in this Assessment Report are adopted and regular reviews and reporting are undertaken.

A summary of the potential environmental impacts

Discharges to the marine environment

Drill cuttings

Studies conducted in the North Sea have indicated that benthic areas impacted by drill cuttings with residual ester based muds have been recolonised within 12 months. Benthic organisms impacted by smothering of the benthos with drill cuttings discharged from the well head platform are excepted to recolonise covered areas in the short term. However, site specific data on re-colonisation after re-smothering should be included in short and long term monitoring commitments. Monitoring should also include cumulative environmental impacts of discharges to the marine environment to verify statements provided in the final EIS.

Water based and residual ester based drilling fluids

Toxicity data on the constituents of water based and ester based drilling fluids which indicates that environmental risk associated with discharge of water based drilling fluids and residual ester based mud adherent to drill cutting at the project site is acceptable. This statement must be qualified by identifying that some of the toxicity data provided in this report is derived from testing conducted on non-Australian marine species and under different environmental parameters than those experienced in the Timor Sea. Therefore, the results of toxicity testing on non-Australian species should be taken as indicative only. Studies have identified that change in water temperature and oxygen availability may alter metabolic rates and potential chemical of concern uptake rates in fish.

Hydrocarbons and production chemicals entrained in produced formation water

In the worst case scenario, that being calm conditions during slack water (turn of the tide), modelling of production chemicals entrained in produced formation water (PFW) indicates that impacts associated with chemical toxicity would not be experienced further than a radial distance of 15 metres and at a depth of 3.3 metres below the point of PFW discharge. Marine organisms unable to move out of the zone of impact may be effected and severity would depend on residence time and dosage.

Hydrotest water

Toxicity testing conducted on hydrotest chemicals indicate that the discharge criteria of 750 ppm need further justification. Risk-based criteria will be used for the assessment of impacts associated with the discharge of hydrotest water. Investigations into the concentration of biocide expected to be released into the environment at the time of discharge should be undertaken.

Sewerage, greywater and foodscraps

Nutrient loading resulting from sewerage and foodscraps is not expected to result in localised or regional environmental impacts. Increased availability of nitrogen and phosphorous in the oligotrophic waters surrounding the proposal site will be mitigated by water depth at point of discharge, the expected small volume of the discharge, rapid dispersion/dilution, biodegradability of the material discharged and distance from sensitive environmental receptors.

Cooling water

The environmental impacts of the discharge of cooling water from the PCUQ have been identified as mortality of plankton and potentially fish unable to move out of the zone of influence. Sessile organisms attached to platform legs in the proximity of continuous water temperature variations in the vicinity of the discharge caisson may also be impacted.

Modelling indicates that the nearest sensitive environmental receptors to the cooling water discharge point, ‘the Lump’ (5km) and the Sunrise Banks (18km) are unlikely

to be impacted by localised water temperature variations as a consequence of cooling water discharges.

Loss of containment of hydrocarbons

Hydrocarbon releases to the environment are not anticipated to impact shorelines or emergent reefs due to high degradation rates and spill trajectories. However, shallow water environments in an arc from the southeast through to the southwest of the project site may be impacted by the passage of dissolved aromatic plumes. These sites being Sunrise Bank and Sunset, Loxton and Martin Shoals in the summer period, Bellona Bank and Echo Shoals during winter and Sunrise Bank during the transitional period. The highest concentration of dissolved aromatic hydrocarbons during any event is predicted as 40 parts per billion at any time of year. Sedimentation of total petroleum hydrocarbons at the above banks or shoals is predicted at less than 0.0001 grams per square meter.

Oil spill contingency plans in conjunction with emergency response plans will be prepared for all stages of the project.

Discharges to the atmosphere

Section 4.7 of this assessment report provides quantification of atmospheric emissions including carbon dioxide, other greenhouse gases and non-greenhouse gas emissions. In response to submissions on the subject of greenhouse gas emissions, issues considered in the report include lifecycle comparisons with alternative fuel sources, greenhouse gas emission inventory, comparison of greenhouse efficiency with similar projects, product lifecycle, minimisation and mitigation measures, opportunities for offsetting emissions, global greenhouse gas issues and impacts due to flaring and pipeline rupture.

The report recommends that regular greenhouse audits, a review of new technologies to identify opportunities to reduce emissions with a view to achieving international best practice in terms of carbon dioxide equivalent emissions per unit of production be conducted. Opportunities for offsetting greenhouse gas emissions, including support for relevant research should also be considered.

Waste disposal

Waste management will be dependent on the final development concept for the SGP. If floating liquefied natural gas (FLNG) is the market for Sunrise Gas waste generated by the remaining components of this proposal, those being the well head platform and the subsea infrastructure, will be taken to the FLNG for disposal onshore. If gas to shore proceeds waste will be transported to shore for processing at Hudson Creek Supply Base. A waste management plan will be prepared for the project, which will include details on waste segregation, handling procedures for non hazardous and hazardous wastes and expected waste types, storage and end use. The proponent will need to conduct further consultation with the owners/operators of suitable waste facilities to ensure the future receiving capacity is sufficient for the categories and volumes of waste expected over the lifetime of the project.

Subsequent to characterisation, naturally occurring radioactive materials from the field, disposal options (if any) will require discussion with relevant Northern Territory government agencies.

Vessel movements

The proponent has acknowledged that discharge of ballast water and bio fouling attached to the hulls of vessels may introduce exotic species to the project site. It has also been identified that species translocated from similar marine environments to the project site are considered to have an improved potential for successful colonisation. Monitoring of facility infrastructure will be conducted and management strategies compliant with Australian Quarantine and Inspection Service, mandatory ballast water exchange requirements will be included in environment plans for each phase of the project.

Infrastructure siting

The impacts of the proposed pipeline corridor on fishing activity depend on the location of the pipeline in relation to the habitat of commercial species. Studies have indicated that within the Timor Sea region there is limited available habitat for commercial fish species and that these are not evenly distributed over the areal extent of the fishery. Exposed light rubble and the sides of shoals are therefore important to the continued viability of commercial fishing activity in the Timor Reef fishery. To this end, careful consideration should be given to selection of the final pipeline corridor. When finalising the pipeline alignment, the proponent shall consult with the Fisheries Group of the DBIRD and the NT Seafood Council.

The 500m exclusion zone around the processing facility will not impact on any commercial fishing activity on the Sunrise Banks.

Hazard analysis and environmental risk assessment conducted for the EIS have been preliminary due to the uncertainty regarding the final development concept. The results of the assessment to date have concluded that environmental risk associated with the project is low and therefore acceptable subject to implementation of mitigation strategies. On selection of a final development concept further detailed analysis of environmental risk should be conducted for the preparation of environment plans for each phase of the activity.

Due to limited baseline data for the project site additional information on the biological and physical environment is required to refine modelling parameters and quantify statements regarding environmental risk. Baseline studies should be commenced well in advance of the installation and construction phase to permit the proponent to identify spatial and temporal scales for monitoring of marine species for environmental impacts. Detailed information on the physical and biological environment will be required for inclusion in environment plans. It is acknowledged that the proponent has already conducted some metocean studies for the project site.

SUMMARY OF RECOMMENDATIONS

Recommendation 1

Woodside Energy shall ensure that the proposal is implemented in accordance with the environmental commitments and safeguards identified in the Sunrise Gas Project Environmental Impact Statement (summarised in Tables 9.1 to 9.5 of the DEIS), the Supplement to the EIS (summarised in Table 3-16 of the supplement), the Addendum and as recommended in this assessment report. All safeguards and mitigation measures outlined in the EIS, Supplement and Addendum are considered to be commitments by Woodside Energy Limited (as the operator).

Recommendation 2

Additional options or proposals associated with the development of the Sunrise Gas Project, which are outside the scope of this environmental impact assessment shall be submitted to the NT and Commonwealth Governments for further assessment under the relevant legislation.

Recommendation 3

The proponent shall prepare and implement a strategy aimed at reducing greenhouse gas emissions including aspects such as:

- **regular audits;**
- **reviews of new technologies with a view to achieve international best practice in reducing greenhouse gases; and**
- **opportunities for offsetting greenhouse gas emissions including relevant research.**

In developing its greenhouse strategy, the proponent shall consult with the Australian Greenhouse Office.

Recommendation 4

Further investigation is required into choice of biocide. Where practicable discharge concentrations of biocide in hydrotest water should be minimised to fulfil the dual objective of controlling sulphate reducing bacteria and mitigating environmental impacts as a consequence of discharge.

Recommendation 5

Suitable indicator species for bio-marking shall be determined prior to commissioning and operation of the facility.

Recommendation 6

The potential for bioaccumulation of heavy metals entrained in residual ester based muds likely to be used in the SGP shall be addressed in the environment plan for the drilling program.

Recommendation 7

A Waste Management Plan is to be prepared for the Sunrise Gas Project to include details of:

- **waste segregation into recyclables (non-hazardous), general (non-hazardous) and hazardous wastes;**
- **handling procedures for recyclables and non-hazardous wastes;**
- **handling procedures for hazardous and chemical wastes;**
- **expected waste types, storage and end use;**
- **identify the facilities available in the Northern Territory capable of receiving hazardous and non-hazardous waste materials expected from the Sunrise Gas Project; and**
- **suitable onshore waste facilities that have the capacity to receive the waste categories and volumes expected over life of the SGP.**

Recommendation 8

The environmental monitoring program shall, in addition to the relevant commitments include:

- **sampling of benthic species to establish rates of degradation of residual drilling fluids and recolonisation of drilling cuttings piles;**
- **monitoring for marine pests;**
- **monitoring of marine organisms to determine impacts of light, noise and vibration; and**
- **dissolved oxygen should be considered for inclusion in the water quality monitoring.**

FIGURES

1 INTRODUCTION AND BACKGROUND

This report assesses the environmental impacts of a proposal by Woodside Energy to install the necessary offshore subsea infrastructure at the Sunrise Bank in the Timor Sea to produce gas and condensate for export. This facility is known as the Sunrise Gas Project (SGP).

This assessment report reviews the draft Environmental Impact Statement (EIS), public comments on the draft EIS, the proponent's responses to these comments in the Supplement to the draft EIS (the draft EIS plus the Supplement constitutes the final EIS) and additional information requested by the NT government. It also relies on information, comments and advice provided by Northern Territory Government agencies, Non Government Organisations and the public, and previous studies undertaken in the region.

Environmental Impact Assessment Process

Environmental impact assessment is based on adequately defining those elements of the environment which may be affected by a proposed development, and on quantifying the significance, risks and consequences of the potential impacts of the proposal at a local and regional level.

The EIS provides a description of the existing environment, the proposed operations and evaluates the environmental impacts and proposed mitigating measures to minimise the expected impacts.

This report will assess the adequacy of the EIS in achieving the above objectives, and will evaluate the undertakings and environmental safeguards proposed by the proponent to mitigate the potential impacts. Further safeguards may be recommended as appropriate.

The safeguards may be implemented at various levels within the planning framework of a project. These include, but are not limited to:

1. Site selection;
2. Design and layout of facilities;
3. Management of construction activities;
4. Processes used in operations and facilities (ie. inputs and outputs);
5. Management of operations, processes and facilities; and
6. Decommissioning of facilities.

The contents of this report form the basis of advice to the Northern Territory Minister for the Environment and Heritage on the environmental issues associated with the project.

1.2 Exploration History

The Greater Sunrise Field, comprising the Sunrise and Troubadour Gas fields, was initially discovered in 1974 with the success of the Troubadour-1 exploration well and later Sunrise –1 appraisal well in 1975.

Not until 1991 with the signing of the Timor Gap Treaty, which established marine boundaries between Indonesia and Australia and created the Zone of Cooperation (ZOC), was exploration of oil and gas in the Greater Sunrise Field progressed. In 2001, subsequent to East Timorese Independence, ZOC was renamed the Joint Petroleum Development Area (JPDA). (See figure 1.1)

Further appraisal commenced with the drilling of Loxton Shoals-1 well in August 1995. Subsequent appraisal wells have confirmed that both the Sunrise and Troubadour fields extend into the JPDA.

The current estimated 'recoverable' reserves in the Greater Sunrise Field Development " are in the order of 8.35 trillion cubic feet of gas and 298 million barrels of condensate." (pp 1-1Woodside, 2002)

1.3 Project History

In May 1997, the Northern Australian Gas Venture (NAGV), formed as a joint venture between Woodside Energy Limited and Shell Development (Australia) Pty Ltd, formulated a project to develop a liquefied natural gas (LNG) plant based on gas from the Sunrise and Evans Shoals fields. The project was to supply LNG and domestic gas for Darwin and elsewhere in Australia.

In March 1999 Woodside and Shell announced that a technical study had concluded the LNG project was technically feasible but the commercial viability of the project was 'immature' due to a lack of LNG market opportunities. In April 1999 Phillips Petroleum Company (Phillips) acquired Broken Hill Proprietary Limited's interest in several of the Timor Sea permits including Sunrise, Troubadour and Loxton.

In the second half of 1999 a joint study of market opportunities and infrastructure required to bring Timor Sea gas to the Northern Territory and the East Coast was undertaken. The findings of the study and discussions with potential markets prompted the NAGV to develop a concept with the objective of supplying gas exclusively to the Australian domestic market. The change in market focus was due to the 1997 Asian economic crisis.

On 30 November 2000 Woodside and Phillips announced an agreement in principle to investigate the cooperative development of the Bayu Undan and Sunrise projects. The concept was to combine the early delivery of gas from Bayu Undan with the larger reserves of Greater Sunrise Development to "optimise investment in infrastructure" ((pp1-2 Woodside, 2002). Woodside, Shell and Phillips signed the cooperative agreement principles in February 2001.

In March 2001 El Paso LNG signed a letter of intent with Phillips to deliver 4.8 million tonnes per annum of LNG from the proposed LNG plant in Darwin. Recent marketing undertaken by Woodside and the lack of critical market mass in the Darwin region, in addition to the costs associated with supplying more remote customers has concentrated Woodside's efforts toward an LNG based development. (Woodside, 2002)

In September 2001 Shell proposed a Floating LNG (FLNG) concept as an alternative to onshore LNG (OLNG). This concept provides for a reduction in the scope of the Greater Sunrise Development and limits the current proposal to delivery of raw gas.

The final upstream design will reflect the downstream requirements of potential customers. To this end, the EIS considers field development and pipeline infrastructure to satisfy identified downstream markets as described below:

- supply of gas to onshore either on a stand alone basis or in cooperation with the Bayu Undan project; and
- supply of raw gas offshore to FLNG.

"The final design will be accommodated within the environmental conditions determined in the environmental approvals process." (pp1-4 Woodside, 2001)

1.4 Environmental Assessment History

On 20 October 1998 Woodside on behalf of the Northern Australian Gas Venturers submitted a Notice of Intent (NOI) document to the Department of Lands Planning and Environment (DLPE) to initiate the environmental approvals process for the proposal. The NOI included the following scope:

- construction and operation of offshore production facilities , production wells and subsea infrastructure in the Timor Sea;
- construction of a pipeline from the offshore facilities to a gas processing facility in the vicinity of Glyde Point 35km north-east of Darwin;
- construction and operation of a domestic gas plant and supply pipeline to the existing domestic gas network;
- a jetty for loading of products for export;
- a jetty for unloading and loading materials; and
- an area for pipe preparation during the construction phase of the project.

The NOI was examined by the Environment and Heritage Division (EHD) (now Office of Environment and Heritage in the Department of Infrastructure, Planning and Environment) of DLPE. It was considered that the environmental issues associated with the proposal warranted assessment under the *Environmental Assessment Act 1982* at the level of an EIS. The Minister accepted the recommendation that the proposal warranted assessment at an EIS level.

On 13 January 1999 the Commonwealth Minister for the Environment designated the proposal at the EIS level under the Commonwealth *Environment Protection (Impact of Proposal) Act 1974.*

Correspondence between Environment Australia and the DLPE, in August 1998, proposed a joint assessment with the lead assessment role being taken by the Northern Territory. This approach was confirmed by the Commonwealth Minister for Environment in January 1999.

Draft EIS guidelines were prepared and made available for public comment for 2 weeks from 30 January 1999 to 12 February 1999. Final guidelines were prepared taking into account the comments received from government agencies and the public.

The Minister issued the final guidelines and a direction to the proponent to prepare the EIS on 14 March 1999.

On 29 May 2000 Woodside submitted notice to the Northern Territory Government of a reduction in the project scope. Woodside also sought confirmation that the project would remain designated under the Commonwealth *Environment Protection (Impact of Proposals) Act 1974*. The name of the proposal was also changed from Northern Australian Gas Venture to the Sunrise Gas Project. Items omitted from the original NOI were:

- Construction and operation of a gas processing facility at Glyde Point and supply pipeline from the facility to existing gas network;
- Product loading jetty;
- LNG onshore processing plant and storage tanks;
- Onshore power generation facilities;
- Loading jetty for LNG ships
- Tugs and support vessels;
- Major access road and internal roadways;
- Rock quarry
- Construction camp;
- Utilities provision; and
- Service corridor for onshore gas pipeline.

On 24 July 2000 the Minister for Lands, Planning and Environment was informed of the proposed change in scope. The Minister determined that the proposal still warranted assessment at an EIS level and advised Woodside and the Commonwealth Minister for the Environment accordingly on 15 August 2000.

On 26 September 2000 the Commonwealth Minister for the Environment confirmed the level of assessment at EIS under the *Environment Protection (Impact of Proposal) Act 1974* and agreed that the Northern Territory should continue in the lead role in the joint assessment. The EIS guidelines were amended in consultation with Environment Australia and issued to Woodside on 16 October 2000.

The draft EIS was submitted on 13 December 2001 and placed on public review for 8 weeks from 15 December 2001 to 9 February 2002 (se Appendix 4 for the locations). It was also circulated to government advisory bodies for review and comment. Seven submissions from the public were received and forwarded to the proponent. The Northern Territory government submission on the draft EIS was provided to the proponent on 18 February 2002. Comments from Environment Australia were provided to the proponent on 11 March 2002. The proponent prepared a Supplement to the draft EIS addressing the issues raised by the public and the NT and Commonwealth Governments.

The Supplement was submitted to the Department of Infrastructure, Planning and Environment and Environment Australia on 16 July 2002. The proponent also provided copies of the Supplement to those who made submissions on the DEIS.

DIPE circulated the Supplement to NT Government advisory bodies for review and comment. Following the review and discussion with Environment Australia, further information on the project was requested from the proponent. The request for additional information was made pursuant to clause 14 (2) of the Administrative Procedures of the Northern Territory *Environmental Assessment Act*. An addendum was provided to the Northern Territory Government on 18 October 2002.

The draft EIS, the Supplement, the addendum, the public comments and comments from NT government agencies have been taken into account in the preparation of this report.

A list of respondents to the invitation for comment is presented as Appendix 1. A list of the issues raised in the submissions is presented as Appendix 2 of this assessment report. Appendix 4 provides a summary of environmental plans and management commitments in the final EIS.

Environment Australia will prepared a separate report under he *Environment Protection (Impact of Proposals) Act 1974* to be completed three weeks after the Northern Territory completes its assessment report. The NT Government has consulted with Environment Australia during the preparation of this report to ensure that a common approach has been taken to assessment issues, conclusions and recommendations.

2 THE PROPOSAL

Detailed descriptions of the various components of the proposal are presented in the draft EIS and the supplement. The following is a short description of the proposal.

2.1 Project Objective

The project objective is to install the necessary offshore infrastructure required for gas field development. Additional infrastructure will be used to process gas and condensate reserves for export. Infrastructure and wellstream (multiphase flow produced from a well) processing options will be the subject of separate approval applications under the Commonwealth *Petroleum (Submerged Lands) Act 1967* P(SL) A.

2.2 Proposal Scope

The proposal scope includes:

Greater Sunrise development comprising:

- Production wells and wellstream gathering infrastructure (flowlines and risers);
- A produced formation water reinjection well and infrastructure; and
- Reservoir production management and wells control and services function;

Production processing comprising:

- supply of control and services functions to the Greater Sunrise Field development; and
- reception and initial separation of the raw Sunrise wellstream into hydrocarbon and produced formation water streams.

Infield processing: comprising processing together with appropriate storage and export of the wellstream hydrocarbons into transportable products. Examples are:

- OLNG comprising either two phase hydrocarbon delivered by high pressure subsea pipeline to an onshore point of sale at OLNG plant or further offshore processing to deliver sales gas (pipeline specification) to Darwin and condensate (tanker specification) to offshore points of sale (fig 1.2);or
- FLNG, comprising LNG and condensate (with options for additional products) exported from offshore points of sale (fig 1.3); or
- Export pipeline comprising a high-pressure subsea hydrocarbon pipeline from Sunrise infield processing facilities to a wye point along the proposed Bayu Undan pipeline to Wickham Point.

2.3 Subsea infrastructure

The Sunrise Field development will consist of either a combination of platform and subsea wells or entirely of subsea wells. Subsea wells will be linked to the production facility by intra field pipelines and export/import risers.

2.3.1 Subsea Wells

Under the options provided in Section 3.2.7 of the DEIS the number of subsea wells proposed range from 11 (option 1), 12 (option 2) or 22 (option 3), Since the preparation of the DEIS the number of subsea wells proposed for the field has changed. The proposed drilling program described in the Supplement incorporates 24 wells, 8 to be drilled from the Well Head Platform between 2006 and 2010. The remaining 16 will be subsea wells to be drilled from 2012.

2.3.2 Well Head Drilling Program

The first stage of the well drilling program is to be conducted from the well head platform with either 11 or 10 wells under the options identified in Section 3.2.7 of the DEIS or 8 wells proposed under the FLNG option as provided in Section 1.7 of the Supplement.

It is proposed to drill these wells with the assistance of a Semi Submersible Self-Erecting Tender Rig (SSETR). The SSETR will deliver and install the Derrick Equipment Set (DES) on top of the well head platform. The DES consists of the derrick, draw-works, drill floor, solids control tank and supporting substructure. All drilling services, storage and accommodation are provided by the SSETR tender. The SSETR will be connected to the DES/platform via a telescoping bridge incorporating flow-lines, power and instrument cabling. In addition, the DES is provided with emergency power, high pressure mud pump and circulating tanks to ensure well control is maintained in the event that the SSETR is required to disconnect from the well head platform.

Offshore facility

The primary components of the offshore facility are the Processing, Compression, Utilities and Quarters (PCUQ), Well Head Platform (WHP) and Floating Storage and Offtake facility (FSO). A 60m to 100m trafficable bridge will link the PCUQ and WHP. All wells will be linked to the WHP by intrafield flowlines and export/import risers. Well production will be transported via the bridge linking the WHP to the PCUQ for processing. A FSO facility will be located approximately 2 kilometres south of the PCUQ. Processed condensate will be transported via an 8 inch (20.32cm) pipeline from the PCUQ to the FSO.

2.4.1 Well Head Platform

The well head platform will consist of:

- support for up to 16 conductors for gas production;
- boat landing and main crane deck;
- a topside deck incorporating a DES, wells, venturi flow metering, production manifolding, pipeline and subsea flowlines termination facilities, well controls, emergency shutdown valve, subsea isolation valve risers, J tubes for umbilical and pigging facilities;
- cranage and emergency facilities.

The subsurface structure comprises a four legged jacket attached to the seabed by bucket foundations.

2.4.2 Processing, Compression, Utilities and Quarters

The PCUQ is proposed to be a jack up platform based on a modular design and will incorporate:

- process and compression systems;
- living quarters;
- support, safety and control systems;
- flare tower;
- workshops
- switchrooms; and
- temporary refuge.

The living quarters and structurally integrated helideck will be designated as a living, control and administrative centre of the platform providing facilities for a planned 80 persons.

2.4.3 Floating Storage Offtake Facility

Stabilised condensate produced at the PCUQ will be transferred for storage to the FSO via a 2km-subsea flowline. The FSO will be a new purpose built facility with a storage capacity of 750, 000 barrels of condensate (approx 120,000 m^3).

The FSO will be designed to weathervane around the forward turret. The FSO is intended to be permanently moored on location and will be anchored to foundations capable of withstanding a one in 3,000 year to 10,000 year storm (Woodside 2001).

Offloading operations will be conducted using a stern offloading hose connected to the shuttle tanker. Condensate offloading from the FSO is expected to take place on average once every 17 days and be completed within 24 hours (Woodside, 2001). An inert gas system will be incorporated into the design of the FSO.

Subsea Pipeline

The 218km subsea pipeline follows a southward route from the Sunrise field across the continental shelf, through the JPDA to a wye intersection with the proposed Bayu Undan to Darwin pipeline. The pipeline will be constructed offshore on the lay barge and installed continuously to the seabed as the barge moves forward. The pipeline will be stabilised by using a concrete coating along the entire length. In selecting the pipeline route, deep waters were preferred due to the limited impact of currents and storm surges generated by cyclones. In addition, the deepwater route requires no trenching or backfilling of the pipeline.

Alternatives to the proposal

The alternatives considered by Woodside include:

- The no development option;
- The location of development sites and pipeline routes;
- Alternative facilities;
- Alternative environmental process options; and
- Management of Greenhouse Gas emissions.

An analysis of alternatives was conducted and the preferred site, pipeline route and processing methods determined.

Wellstream processing

Two wellstream-processing options under consideration are:

- **OLNG Option**: Processing by way of PCUQ facilities. Gas would be exported to Darwin via the main export pipeline to the proposed Darwin Liquefied Natural Gas (LNG) terminal or other potential customers; and
- **FLNG Option**: Wellstream exported directly to an offshore floating facility via a series of flowlines and risers. The LNG and condensate would be exported from the FLNG facility to the available markets.

Both wellstream-processing options are outside the scope of the current assessment and approvals being sought for the development of the Greater Sunrise field. Wellstream processing options will be the subject to separate assessment and approvals processes.

Production from the Greater Sunrise Field will commence when suitable markets are established and the final development concept receives approval from regulatory authorities.

3 REGIONAL SETTING

The project is located approximately 450km north west of Darwin in Timor Sea permits NT/P55, NT/RL2, ZOCA96-20and ZOCA95-19. The pipeline extends 218km from the proposal site to the Bayu-Undan wye piece.

3.1 Offshore Region

The Greater Sunrise field is situated on the northern and upper slope of the Sahul platform, on the outer margin of the Australian continental shelf, in the Timor Sea. Water depths over the gas field are approximately 160m with the seabed sloping northward to a depth of 300m, over a distance of 15km.

The pipeline route crosses the shelf break, the Sahul platform, localised gullies, the upper Melita Valley and the edge of the Bathurst Terrace prior to reaching the wye intersection with the proposed Bayu-Undan pipeline. Water depths along the pipeline route range from 72m to 151m. Surface soil types along the proposed pipeline route range from carbonate sandy silt to carbonate clay and carbonate sand.

3.2 Areas of conservation significance

The Greater Sunrise Gas Field and pipeline route does not traverse any marine parks, reserves or specially protected conservation areas.

The heritage and conservation impacts associated with the reminder of the pipeline route, from the wye piece to Wickham Point, have been discussed in Assessment Report No 24 “Darwin Liquefied Natural Gas Plant and Subsea Pipeline”.

3.3 Socio-Economic Environment

The socio-economic impact of the proposal will be on a national and regional level. Nationally the project will input payment into the Commonwealth government’s Petroleum Resource Rent tax. Regionally the proposal will impact on employment, service industries, commercial and traditional fishing and shipping operations. These are discussed below.

3.3.1 Fisheries

There are currently no major fishing interests or activities in the Sunrise Gas Field area. Australian Fisheries Management Authority (AFMA) has indicated that only one vessel has fished in the Sunrise development area in the past few years (Woodside, 2001). The closest Australian managed fishery to the proposal area is the Timor Box Fishery 75km south east which is incorporated within the north west boundary of the Northern Prawn Fishery (Northern Territory). The proposed Sunrise Gas pipeline corridor traverses the western section of the Timor Box Fishery and terminates at the “wye” within the north-west corner of the Northern Prawn Fishery (Northern Territory).

3.3.2 Traditional fisheries

The Greater Sunrise development though well outside the 1974 Memorandum of Understanding boundaries is still likely to be utilised by traditional fishers.

3.3.3 Commercial Shipping

Two shipping lanes pass to the west of the gas field. The proposed pipeline corridor will cross these shipping lanes.

The types of vessels utilising the shipping lanes are rig tenders, navy ships, tankers, livestock, bulk cargo and care carriers, container and general cargo vessels, barges and passenger vessels.

3.3.4 Employment and service industries

The benefits of the project to the local and regional economy are described in Section 2.1.1 of the DEIS. Local construction and service industries will provide labour and support for installation of infrastructure. Service industries will experience an increase in demand for goods.

The proponent has identified that during the installation phase local employment will experience a short-term increase. Some skills transfer will occur as a result of the project. Staff requirements for the operations phase of the project will be limited to skilled personnel predominantly based in Darwin. The proponent is uncertain as to the number of staff required during the operations phase.

Logistical support for the project is likely to be based in Darwin.

3.3.5 Recreation and tourism

There are no recreational fishing or tourist interests in the proposal area.

4 ENVIRONMENTAL IMPACT ASSESSMENT

4.1 Introduction

The information provided in the EIS, Supplement and the Addendum have been assessed and then used, along with the submissions from advisory bodies and public comment on the EIS, to determine the adequacy of the information provided by the proponent and the accuracy and acceptability of predicted impacts and safeguards. Comments and recommendations, based on submissions and comments from Government advisory bodies, are then made.

It is acknowledged that during implementation, flexibility is necessary and desirable to allow for minor and non-substantial changes to the proposal outlined in the EIS and examined as part of this assessment. It is considered that subsequent statutory approvals for this project could make provisions for such changes, where it can be shown that the changes are not likely to have a significant effect on the environment.

It is important for interpretation purposes that the recommendations (in bold) are not considered in isolation, as the text identifies concerns, suggestions and undertakings associated with the project.

Safeguards and mitigation measures undertaken by the proponent in the EIS are summarised in Tables 9.1 to 9.5 of the DEIS and Table 3-16 of the Supplement. Tables of commitments provided by the proponent have been presented as Appendix 5 of this assessment report.

Subject to decisions that permit the project to proceed, the primary recommendation of this assessment is:

Recommendation 1

Woodside Energy shall ensure that the proposal is implemented in accordance with the environmental commitments and safeguards identified in the Sunrise Gas Project Environmental Impact Statement (summarised in Tables 9.1 to 9.5 of the DEIS), the Supplement to the EIS (summarised in Table 3-16 of the Supplement), the Addendum and as recommended in this assessment report. All safeguards and mitigation measures outlined in the EIS, Supplement and Addendum are considered to be commitments by Woodside Energy Limited (as the operator).

4.2 Issues raised in submissions

The issues raised as a result of the public review are provided below.

1. Consultation process;
2. Project scope;
3. Information on decommissioning;
4. Further information on existing environment;
5. Details on pigging operations and route selection of pipelines;

6. Details requested on hazard and risk analysis undertaken;
7. Details of transport and shipping servicing the facility;
8. Further details on greenhouse gas emissions including sources and total emissions required;
9. Impacts on marine environment in terms of fate and effects;
10. Further details on hydrotest water, produced formation water discharges, cooling water and production chemicals;
11. Environmental monitoring; and
12. Cumulative impacts.

The remainder of Section 4 deals with the issues raised in the public and government submissions to the EIS and the proponent's commitments to environmental management, provided within the draft EIS, the Supplement and the Addendum. In addition, recommendations to complement or strengthen environmental management strategies and safeguards will be presented.

Many issues have been suitably addressed in the supplement and do not require further discussion. The outstanding environmental issues that remain are addressed below.

4.2.1 Issues Outside the Scope of this assessment

The following issues raised in the public submissions are outside the scope of this assessment.

Onshore Liquefied Natural Gas

One submission identified three separate issues regarding onshore liquefied natural gas (OLNG), which are summarised below:

- a preference for the FLNG proposal over OLNG;
- environmental concerns with onshore processing; and
- aesthetic degradation resulting from the OLNG and associated downstream facilities.

The preference for the FLNG processing option over OLNG has been noted.

Reduction of Methane Emissions

One submission identified the reduction of methane emissions to negligible levels by combustion of regeneration offgas. The proponent has identified that reduction of methane to negligible levels is not within the scope of the SGP EIS but is being considered for the Shell FLNG EIS. The proponent also stated that CO_2 stripping is not a process directly associated with the scope of the SGP EIS.

Development of the Sunrise/ Troubadour gas reserves at this time

Several respondents to the proposal identified the timing and perceived requirement to develop the Sunrise and Troubadour gas reserve for markets and interests other than Australia's, as an issue. The proponent response was that the development of the reserve is being driven by a number of forces some of which are shareholder interest,

current market demand and underpinning the East Timorese economy for the next 20 to 30 years. Comments on issues related to Australian government policy are outside the scope of this assessment.

Relationship of Signatories to Kyoto Protocol and Potential Markets for LNG

Another submission stated that by not becoming signatories to the Kyoto protocol, markets within those countries excluded themselves as viable customers for the LNG. The proponent has responded that the use of LNG rather than other more polluting fuels is preferable in those markets and that the proponent had limited influence in the decision-making processes of other nations.

Aid to East Timor

One submission stated that "aid to East Timor should not be conditional on any particular venture". The proponent responded by noting the above statement and indicating that policy issues of aid to East Timor are outside the scope of the EIS.

4.2.2 Public Review and Consultation

Four respondents indicated that the lack of consultation with non-government organisations (NGOs) was of concern.

The proponent has acknowledged that the level of in depth consultation outlined in the DEIS may not have occurred with some interest groups. However, the proponent states that the reason for limited consultation with some interest groups was the scope of the project altered from onshore processing to offshore processing with a pipeline connecting at 'the wye' with the Bayu-Undan pipeline.

The proponent has committed to 'engaging stakeholders' as a key component in all stages of the project.

One of the respondents was concerned that the public review period incorporated the Christmas period.

DIPE and EA agreed to the public review period over the Christmas/New Year holiday provided it was for 8 weeks, twice the minimum requirement. In addition, a public display was held at Casuarina Shopping Centre on 19 January 2002.

Concerns were also expressed regarding the transparency of the environmental assessment process. One respondent "understood that the original public comment documents do not accompany the final EIS to the decision maker" (pp 123 Woodside, 2002). The concern was that comments maybe summarised and the intention of the comment altered.

The DIPE forwarded all public submissions to the proponent in their entirety. Copies of the original public submissions are presented in Appendix A in Volume 1 of the EIS Supplement.

4.3 Scope of the EIS

The scope as provided in the DEIS has been modified by reducing the number of wells to be installed during the WHP and subsea drilling programs.

A submission raised the issue that environmental approvals should be provided after a final concept has been established. The proponent responded by saying that it is common practice to carry a number of alternative proposals into the environmental approval process. To this end, the proponent indicated that carrying a number of concepts also provides statutory and non-statutory organisations the opportunity to consider the environmental impacts of the suggested concepts.

In consideration of the above it must be remembered that the scope of the SGP EIS is for a stand alone production and processing facility to provide gas and condensate to a number of market options or customers. OLNG and FLNG are potential customers. Other markets may also be considered, although these have not been identified by the proponent. As with FLNG and OLNG, other downstream processing options will be subject to separate environmental approval processes. The SGP EIS seeks environmental 'approval' for the proposed alternative field development and production concept for the Sunrise Gas Field, if FLNG or other OLNG customers do not eventuate. If FLNG is the eventual customer for Sunrise Gas the issue of risk associated with simultaneous operations will need to be considered. In addition, the proponent will need to identify if any discharges to the marine environment from any preliminary wellstream processing at the well head platform will occur.

4.3.1 Wellstream processing

Submissions were also received from interested groups regarding processing of wellstream products. As identified previously FLNG and OLNG are not part of the scope of the SGP EIS. The proposal identifies that wellstream fluids produced from the field will be either:

- Processed to specific quality requirements with condensate and partially refined natural gas being separated on the PCUQ. Condensate will be stored in the FSO located 2km south of the facility. Natural gas will be transported onshore via subsea pipeline to the wye piece then via the Bayu Undan to Darwin pipeline for further processing at Phillip's Darwin LNG plant; or
- raw well fluids will be transported from the WHP via a short subsea pipeline to Shells proposed FLNG facility for processing into LNG and condensate. If constructed Shell's FLNG facility will be located adjacent to the Sunrise Gas Development.

In response to a submission the proponent has stated that the option of a separate gas pipeline to shore "is not longer required under the existing Sunrise scope" (pp 33 Woodside, 2002). If the gas to shore option is reconsidered or any other proposal outside the scope of this assessment then a separate environmental approvals process will be required.

It should be noted that the Commonwealth has already determined that an EIS will be required for Shell's FLNG proposal. Environment Australia will take the lead role in the assessment with an input from the NT Office of Environment and Heritage

Recommendation 2

Additional options or proposals associated with the development of the Sunrise Gas Project, which are outside the scope of this environmental impact assessment, shall be submitted to the NT and Commonwealth Governments for further assessment under the relevant legislation.

4.3.2 Need for revision of the EIS guidelines

Respondents commented on the relevance of the original EIS guidelines following the changed scope of the proposal from onshore and offshore to only offshore. One submission suggested that new guidelines should have been prepared. The proponent responded that 'a number of items' in the original scope of the SGP were no longer required. The items removed from the original scope are listed in Section 1.4 of this assessment report. The proponent does not agree that new guidelines should have been prepared.

Changes in the final development concept resulted from the proponent's intention to alter the focus from onshore to offshore processing. Reasons for the change in scope range from the impact of the Asian economic crisis and depressed demand for LNG (Woodside, 2000). The removal of the onshore LNG component was considered to warrant an internal review of the EIS guidelines by DIPE and EA.

4.3.3 Legislation and the environmental impact assessment process

The involvement of the NT Government in the assessment process was questioned due to the removal from the project scope of the onshore LNG facilities. The original referral for assessment under the NT *Environmental Assessment Act* (EA A) was from the then Department of Mines and Energy (now Department of Business, Industry and Resource Development (DBIRD)). One of DBIRD's responsibilities is to administer the provisions of the Commonwealth *Petroleum (Submerged Lands) Act 1967* (P (SL) A) on behalf of the Commonwealth in NT adjacent waters (Commonwealth Waters). Under the provisions of Section 11 of the P(SL) A the NT EA A applies to the SGP by virtue of it being a petroleum related activity.

In addition, the proponent has identified that the early involvement of NT regulatory agencies, which will have a role in regulating the project, will assist in the comprehension of the development proposal.

4.3.4 Assessment of petroleum related activities

A submission noted that seismic surveys were undertaken without reporting to the public on environmental impacts to deep-sea mammals and furthermore "appraisal drilling was free from the constraints of environmental assessment".

In relation to environmental assessment of the SGP, preliminary investigations undertaken prior to 1999 were required to comply with the environmental protection clauses of the *Petroleum (Submerged Lands) Act Schedule of Specific Requirements as to Offshore Petroleum Exploration and Production in Commonwealth Waters*.

Since September 1999 preliminary project activities such as drilling, geophysical and geotechnical surveys principally manage environmental risk through acceptance of an environmental plan (EP) required under the *Petroleum (Submerged Lands) (Management of Environment) Regulations 1999* (P (SL) A (MOE)). An 'accepted' EP must be in force before a petroleum activity can commence.

Each EP contains information detailing the operators corporate environmental policy, environmental legislation applicable to the activity, a description of the proposed activity, a description of the environment, an assessment of environmental risks and effects, environmental performance objectives, standards and criteria, implementation strategy, reporting arrangements and consultations.

Concerns were also raised that financial investment undermined the integrity of the environmental assessment process "exposing it as a formality rather than a safeguard". It is a comment that requires further discussion.

Financial investment in the initial stages of a project is required to obtain essential field information required to ascertain project feasibility. However, before considerable investment is committed, the environmental aspects of proposed petroleum related field activities are assessed against the provisions of the P (SL) A (MOE) as described above. In addition, the proponent is required to consider whether matters of "national environmental significance" as described in the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC A) are likely to be affected.

Preliminary environmental investigations also identify at any early stage any environmental risk associated with the activity. Environmental aspects are usually identified as part of preliminary investigations ranging from desktop studies to limited field surveys. At this point the proponent may factor in the environmental opportunities and constraints as part of the decision making process whether to progress with or abandon the project.

4.4 Benefits

A submission requested that the benefits of the proposal be better defined especially those involving the Northern Territory and the onshore gas option. The proponent's response was to reiterate the benefits described in the EIS.

The benefits to the Northern Territory economy remain as described in section 3.3.4 of this assessment report.

In the Supplement the proponent makes reference to Article 8 of the Timor Sea Treaty in which the Commonwealth Government intends to "support development decisions based on the commerciality of individual proposals". However, as of the time of writing, the Timor Sea Treaty has yet to be ratified by the Australian Government.

In Section 3.7 of the Supplement the proponent provided data on the economic benefits that the Laminaria/Corallina field has brought to the Northern Territory economy. Projected figures indicate that of the $41.7 million spent $19.51 million

went into the Northern Territory economy (Woodside, 2002). Expenditure in the NT includes fuel supplies, leasing of the supply base at Hudson Creek, supply base services and accommodation in Darwin.

4.5 Alternatives

Chapter 5 of the DEIS outlined the economic and social consequences of not proceeding with the proposal and identified options considering the feasibility of onshore versus offshore development. Options included the type and operations of processing facilities, pipeline routes, offshore platform locations and drilling rigs. The environmental impacts of the process options were also considered in conjunction with technologies available to reduce environmental risk.

Comparison of environmental consequences of each development was requested including selection criteria establishing why the current proposed development has been chosen. An outline of how this was addressed is given in Section 3.5 of the Supplement.

Environmental risk and design workshops were conducted at the outset of the project. Environmental risks, which would require consideration during the concept selection and design phases, were placed on a risk register. The design review established environmental design issues attendant to the SGP, considered technology available to mitigate design issues and propose an 'environmental design philosophy' for inclusion in the basis of the project design. The proponent has indicated that the "need for comparative studies to assess the environmental performance between design criteria and concepts where identified as part of this review." (pp 45, Woodside, 2002).

Studies required to clarify environmental impacts associated with the project have been undertaken. These are listed on page 45 of the Supplement and where relevant included in Volume Two of the Supplement. Further studies relevant to this project are being conducted for the FLNG EIS (in preparation).

The environmental studies of the Sunrise Bank, Sunrise West Bank and Sunrise South Bank considered community composition, species diversity, abundance and coverage of marine organisms. The results of the studies indicated that the southern half of Sunrise Bank South was the most suitable site due to sparse and undeveloped community structure in comparison with the other banks surveyed. Sunrise Bank South was also the site selected for geo-technical coring prior to platform site selection. Section 5.3.3 of the DEIS indicates that the shallow water platform option was abandoned because of the additional costs of using extended corrosion resistant flowlines. A deepwater platform was then considered in favour of the shallow water platform due to technical and environmental opportunities.

One submission requested further information on the national interest aspects of the proposal. The proponent's response was that there are and will be sufficient reserves close to the Eastern Australian markets to supply them into the next decade. In the longer term Sunrise is one of many potential sources of gas supply, which include PNG and other fields in the Timor Sea. Another aspect of national interest is the perception that a no development decision brought about by Government intervention

could create a global view of instability in the future development of the Timor Sea gas resources.

4.6 Physical and ecological environment

4.6.1 Sampling methods

Additional information was requested on the details and results of the site survey. The Bowman, Bishaw and Gorham (BBG) survey undertaken in April/May 2001 investigated the alternative pipeline routes and the proposed locations for the platforms and FSO. The pipeline route was visually inspected using a remote operated vehicle (ROV). Ten benthic grab samples and five water samples were taken around the project site. Analysis was undertaken for:

- water temperature, conductivity, dissolved oxygen, pH, turbidity, particle size;
- heavy metals, total nitrogen, total phosphorous;
- benthic infaunal composition; and
- phytoplankton and zooplankton.

4.6.2 Physical environment

The climate of the Timor Sea is summarised as follows.

Mean annual rainfall for the Timor Sea region is 1770 mm. Mean temperatures recorded at the Jabiru FPSO, located approximately 420km west of the SGP are of 24.9^0C in July and 29.6 ^{0}C in December (URS, 2002).

Climatic conditions in the Timor Sea are dominated by two periods. The southeast trade winds typified by dry easterly winds of between 5 ms^{-1} to 12 ms^{-1} and the northwest monsoon characterised by moist west-southwest to northwest winds of speeds up to 5 ms^{-1} for periods of between 5 to10 days (Woodside 2001). The southeast trades occur between April to September, the northwest monsoon between October to March with transitional periods between September/October and March/April.

Tropical cyclones may form from November to April with most activity being recorded from January to March. The most severe cyclones likely to effect the region have been recorded from December to April (Woodside 2001).

Information on cyclones has been provided in Section 6.1 and Figure 6.2 of the DEIS. The following information was provided in response to a request for additional information on severe weather, including cyclones. Data from 1970 to 2001 indicates that the expected frequency of cyclones passing within 50km and 100km of the project site is 0.2 storms per year. Woodside has identified that cyclones originating in the region are generally at the developmental stage in the latitudes were the proposal is to be sited. Of the 6 cyclones that passed within 100km of the site between 1970 and 2001, wind strengths experienced at the site would not have exceeded gale force (Woodside, 2002). The frequency of cyclones developing at similar latitudes to the proposal site is 0.07 per year (Woodside, 2002).

The proponent states that the facility will be constructed to withstand a one in 10,000 year storm event.

Currents

At the project site the semi-durnal tidal currents are the predominant influence on the current regime. Other influences on the current regime are wind and regional drift. Current direction, resulting from tides are described in the tides section below.

Wind driven currents are expected to reflect the climatic influences with surface currents in summer to the northeast and westerly in winter. Typical surface current speeds would be 0.2 ms^{-1} to 0.4 ms^{-1}.

Non tidal or non-wind driven currents result from the Pacific Indian Ocean Flowthrough (URS, 2001). Current speeds range form 0.1 ms^{-1} to 0.6 ms^{-1} (Woodside, 2001).

Table 4.1provides a summary of Figures 6.7, 6.8 and 69 in the DEIS showing observed current directions at water depths of 20m, 100m and 260m. The table indicates predominant current direction in an arc between the stated compass points.

Table 4.22: Current Directions at Water Depths of 20m, 100m and 260m

Month	20m	100m	260m
January	west to northeast	west to southwest	Not specific
February	northwest to northeast	northeast to east	west to southwest
March	west to south	north to east	northeast to east
April	east to south	northeast to east west to southwest	west to southwest
May	west to south	west to southwest northeast to east	west to southwest
June	east to southeast	north to east	west to southwest
July	southwest to northwest	southwest to northeast	west to southwest
August	southwest to northwest	west to southwest	northeast to east
September	southwest to west	west to southwest northeast to east	north to east
October	southwest to northwest	west to southwest	northeast
November	southwest to northwest	north to east	northwest to south
December	north to northeast	west to southeast	northwest to southwest

Source: Woodside, 2001

Water Temperature

Section 6.5.5 of the DEIS provides information on water temperature. Annual water temperature variation is expected to range between 26^0C to 30^0C in the vicinity of the project site (Woodside, 2001). The water column is expected to be stratified all year round within the thermocline being at approximately 50m depth in summer and 100m

depth in water (Woodside, 2001). Variation of water temperature within the water column has not been provided.

Tides

Table 6.2 of the DEIS provides the following information on tides at the project site.

Highest Astronomical Tide	3.1m
Mean High Water Spring	2.8m
Mean High Water Neap	1.9m
Mean Sea Level	1.7m
Mean Low Water Neap	1.7m
Mean Low Water Spring	0.4m
Lowest Astronomical Tide	0.0m

(Woodside, 2001)

Ebb and flood of the tides at the project site are expected to flood to the east-northeast and ebb to the west southwest in the upper 100m of the water column. In the lower water column (>100m) flooding is expected to the southeast and ebb to the west–northwest. Tidal currents of $0.6ms^{-1}$ during spring tides and $0.2ms^{-1}$ during neap tides are expected (Woodside, 2001).

Waves

Wave direction corresponds to the wind regime with west to southwesterly surface waves from December to March and easterly surface waves from April to October. Swell direction is predominantly from the southwest to west. One in ten year significant wave height returns are 2.4m to 3.9m for summer and 2.8m and 3.5m in winter (Woodside, 2001).

4.6.3 Ecological environment

Benthic Fauna

The results of the site survey conducted by BBG identified 170 species representing 9 phyla. The phyla listed in Section 6.6 of the DEIS and present species richness are provide below.

Annelida (Bristle worms)	48.2%
Crustacea (Amphipods, crabs, shrimps, copepods, isopods)	27.1%
Echinodermata (Sea cucumbers, brittle stars)	10.6%
Cnidara (Sea pens, zooanthids, corals, hydroids, jellyfish)	3.5%
Mollusca (Bivalves)	3.5%
Porifera (Sponges)	2.4%
Sipuncula (Peanut worms)	2.4%
Nemertea (Ribbon worms)	1.8%
Bryozoa (Lace corals)	0.6%

(Source: Woodside, 2001)

Epibenthic Flora

Dominant epibenthic organisms include sponges, sea pens, hydroids, soft corals and sea gorgonians. The studies identified that benthic substrates ranged from predominantly soft muds to coarse sands along the pipeline routes to sand and shell fragments at the project site (Woodside, 2002). Small numbers of areas with hard substrate (limestone pavement or reef) were observed. Hard substrate areas supported 'moderate densities' of the above organisms (Woodside, 2002). Areas of unconsolidated substrate supported "a very sparse epifauna' (pp 50 Woodside, 2002). The results of the survey indicate that the "uniform nature of the seabed at all sites around the platform location suggest that the habitat type is widespread over similar depth contours" (pp 50 Woodside, 2002). Analysis of water quality parameters identified " the water column is characterised by clear well mixed oligotrophic waters that supported zooplankton assemblages dominated by copepod crustaceans, and sparse phytoplanktonic assemblages. The sediments were uncontaminated and typical of sediments of biogenic origin"(pp 50 Woodside, 2002).

The results of the BBG survey provide evidence that the seabed habitat at the project site is similar to the rest of the Timor Sea, being relatively uniform consisting of unconsolidated sediments with limited areas of hard substrate providing permanent attachment sites for benthic marcophytes. The results are supported by the findings of the investigation conducted by Heyward, Pinceratto and Smith (1997) at Big Bank Shoals. However, this statement is based on the information available from the limited studies of seabed characteristics and species composition in the Timor Sea.

4.6.4 Seismic Activity

The Sunrise Gas Field is on the northern edge of the Australian plate. The Australian plate is moving northward subducting (forced beneath) the Eurasian plate, Pacific plate and Philippine plate. Australian plate subduction rates appear greatest in the east, in the region of the Banda Sea rather than to the west toward Sumbawa (Woodside, 2001). The dipping of the Australian plate beneath the Eurasian plate is expressed as the Timor Trench.

In Section 6.3 of the DEIS the proponent has provided information regarding regional seismic activity associated with movement of the Australian and Eurasian tectonic plates. Limited seismic data from the period 1900 to 1963 is available for the region and is based on "various historical catalogues". Data from the period 1964 to the present is based on information obtained due to improvements in world-wide coverage, including the Timor Sea (Woodside. 2001).

The proposal location is to the immediate south of the Timor Trench. Subduction earthquakes as a consequence of tectonic plate movements are known to occur in the region of the proposed activity. Regional earthquake activity has been noted to be random rather than centred on any specific location (Woodside, 2001).

Studies have been undertaken on behalf of the proponent to define seismic design criteria for project infrastructure. Since 1900 the closest earthquake to the project site was recorded in East Timor at a distance of 138km. Recorded data for the earthquake were intensity 3; peak ground acceleration of 64.48 mm/s^2 and magnitude of 5.2 (Woodside 2001).

4.6.5 Project footprint and sensitive environmental receptors

The original footprint for the project has changed since the site survey conducted by BBG in 2001. A survey of the full project is being conducted for the EIS for Shell's proposed FLNG. The proponent intends to use the results of that survey to establish where sensitive environmental habitats are located within the project footprint. The footprint is the area of seabed directly impacted by subsea infrastructure associated with platforms, pipeline routes and areas smothered by drill cuttings.

Documentation was requested to identify if any sensitive environmental receptors where located in the vicinity of the footprint. This documentation has been provided in Appendix A of the EIS Supplement and in the Addendum.

The studies were conducted using a remote operated vehicle and established that the benthic substrate consisted of "sandy sediments with the remains of shelled organisms and very little attached benthos" (pp 47 Woodside, 2002). The exception was an area identified as 'The Lump' approximately 5.5km south west of the WHP at its closest point. Studies established that 'The Lump' supported a "very diverse and abundant epibenthic community" (pp 47 Woodside, 2001). BBG consider that The Lump is of "local and potential regional significance" (pp 47 Woodside, 2001). The proponent considers that the WHP will not pose any physical impacts to 'The Lump'.

The Lump is a " steeply sloping curved feature", 8km to 9km in length. Water depths range from 120m to 130m (Woodside, 2002a). The proponent identified The Lump as "a unique feature on this part of the continental slope, although there are several other less pronounced features on either side including an unnamed large shoal to the southwest that could represent similar habitat" (pp 12 Woodside, 2002a).

The habitat on the top of The Lump is "coarse sandy flat seabed with a sparse filter feeding assemblage on rocky outcrops dominated by chinroids, seawhips, black corals, gorgonians and vase sponges" (pp 12 Woodside, 2002a). The northern part of The Lump is reported to support the highest diversity and density of marine life. This assemblage consists of those organisms identified above in addition to bryozoans and other species of sponges.

The proponent has identified the following potential impacts of the activity on The Lump.

- elevated water temperature due to discharge of process cooling water;
- exposure to toxins discharged with produced formation water;
- potential smothering and toxicity associated with the discharge of drill cuttings; and
- exposure to hydrocarbon spill due to loss of subsea containment (blowout).

4.6.6 Protected fauna in the project area

Listed protected, threatened and migratory species

Listed below are species that are known to exist in the Timor Sea and potentially in the project area. The species are listed under the provisions of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

EPBC Listed Endangered marine species that occur in the Timor Sea

Loggerhead Turtle	*Caretta caretta*
Pacific Ridley Turtle	*Lepidochelys olivacea*
Abbott's Booby	*Sula abbotti*
Blue Whale	*Balaenoptera musculus*

EPBC Listed Vulnerable species that occur in the Timor Sea

Green Turtle	*Chelonia mydas*
Hawksbill Turtle	*Eretmochelys imbricata*
Leatherback Turtle	*Dermochelys coriacea*
Flatback Turtle	*Natator depressus*
Lesser Noddy	*Anous tenuirostris melanops*
Christmas Island Frigatebird	*Fregata andrewsi*
Humpback Whale	*Megaptera novaeangliae*
Sei Whale	*Balaenoptera borealis*
Fin Whale	*Balaenoptera physalus*
Grey Nurse Shark	*Carcharius taurus*
Great White Shark	*Carcharodon carcharius*

The Grey Nurse Shark has been recorded from the Arafura -Timor Sea region but is 'rare'. There are no records of the Great White Shark (pers comm B Russell, 2003).

Though Environment Australia has listed the distribution as world wide in the Southern Hemisphere the Blue Whale is known to occur between 20^0S and 60^0S to 70^0S (Bannister, Kemper and Warneke, 1996). Blue Whales fed in colder Antarctic waters almost exclusively on krill (Bannister et al, 1996). Other known feeding areas are in southern Western Australia, in the Otway region of Victoria and South Australia and near Eden in New South Wales (Bannister et al, 1996). Calving is in warmer waters of the open ocean (Woodside 2002).

Sei and Fin Whales have not been recorded in Northern Territory waters, however, both are reported to calve in warm tropical waters (Bannister et al, 1996). The Sei Whale breeding grounds are not precisely known (Bannister et al, 1996). The breeding grounds for Fin Whales are in the Southern Ocean. (IFAW, 2001). The Fin Whale feeds on Antarctic krill whilst the Sei Whale feeds mainly on pelagic copepods (Bannister et al, 1996).

The above information indicates that the potential for Blue, Fin or Sei Whales to be in the vicinity of the project area is low (Woodside, 2002). Of these whales, Sei Whale would be the most likely to use the project area for feeding and calving (Woodside, 2002). In the DEIS the proponent has indicated that dolphins are more likely to be encountered at the project site. The proponent acknowledges that uncontrolled large scale spills may impact whale species by resulting in the death or contamination of prey species (Woodside 2002).

The information provided in the Supplement suggests that the Pacific Ridley, Green and Leatherback turtles (though uncommon in northern Australian waters) would be

the most likely of the listed turtles to be encountered at the project area. Research suggests that both the Pacific Ridley and the Green turtles may pass through the project area. Green turtles have been observed feeding in Snake Bay on the northern side of Melville Island, approximately 340km south east of the project area. The Leatherback may use the facility as an opportunity to forage during migration. Bioaccumulation of chemicals entrained in discharge streams from the facility within prey species has the potential to impact Leatherback Turtles. Sessile species attached to the superstructure, which may become prey, should be included in proposed monitoring of biological indicator species Other impacts to turtles may include collision with vessels due to increased shipping and disorientation from lighting at the facility.

The proponent has made a commitment to use chemicals which will "minimise or prevent environmental impacts due to use of chemicals"(pp 53, Woodside 2002).

EPBC Listed Migratory Species found in the Timor Sea

In Australia, migratory species listed under a number of international agreements are protected under the EPBC Act. Migratory species listed that may pass through the permit area or utilise these waters for foraging are:

- Dugongs;
- Saltwater Crocodiles;
- Whale Sharks;
- Numerous species of small cetacea (small dolphins and whales) and;
- Seabirds (Albatross, Petrels).

(URS 2001)

Information was requested to verify that there are no ecological threatened communities in the project area. The proponent has conducted a search of Environment Australia's website http://epbcweb.ea.gov.au/images/index.html and found no listed ecological communities present in the project area (Woodside 2002).

4.6.7 Impacts of Hydrocarbon Spills on Pelagic Species

Information was requested on the impacts of hydrocarbon spills on pelagic species and plankton. The proponent has provided information from Volkman, Miller, Revill and Connell (1994) in relation to the impacts of hydrocarbon spills on plankton.

"There is general agreement in the literature that although laboratory and controlled ecosystem experiments demonstrate oil toxicities to plankton, filed observations from oil spills show minimal or transient effects on marine plankton" (pp 579 Volkman et al, 1994). However, further information is provided indicating that the effects of hydrocarbon spills on tropical plankton communities are not well known (Volkman et al, 1994). Extrapolation from plankton populations in temperate or cold water condition are difficult due to tropical plankton having more stable and different life histories (Volkman et al, 1994). In addition, solubilities and volatilisation of low boiling point components of hydrocarbons are likely to be greater in warmer seawater (Volkman et al, 1994). Zooplankton ingest oil therefore providing the potential for biomagnification via indirect ingestion by predators, however, retention times are short (Volkman et al, 1994).

The known impacts of hydrocarbon spills on marine turtles identified in the DEIS and the Supplement are the potential for eye infections and the ingestion of tar balls.

As provided in the Supplement, the National Marine and Fisheries Service (2001) has identified that ingestion of tar balls may impact metabolism or gut function at low levels of ingestion and include the adsorption of toxic by-products (Woodside, 2002).

Volkman et al, 1994 indicates that limited scientific information is available on the assessment of the impacts of hydrocarbon spills on marine mammals. Information provided by the proponent identifies that the impacts of hydrocarbon spills on marine mammals are related to:

- direct surface fouling;
- direct and indirect ingestion associated with bioaccumulation; and
- inhalation of volatilising low boiling point hydrocarbons.
  (Woodside, 2002)

For cetaceans direct contact with hydrocarbons is not considered a serious risk (Volkman et al, 1994). Studies conducted by Geraci (cited in Volkman et al, 1994) indicate "that cetacean skin contains a resistant dermal shield which acts as a barrier to toxic substances in petroleum" (pp 573 Volkman et al, 1994). Field observations record minimal adverse impacts to cetaceans from direct contact with hydrocarbons (Volkman et al, 1994). "Bottlenose dolphins have been recorded swimming through oil slicks with no apparent effects. Humpback, Fin, Right and Minke Whales have been observed swimming, feeding and surfacing through heavy concentrations of oil" (pp 573 Volkman et al, 1994). Baleen plates of feeding Baleen Whales may become fouled with oil (Volkman et al, 1994)

Geraci (cited in Volkman et al, 1994) suggests that inhalation of volatilised hydrocarbons poses greater risk to cetaceans than direct contact (Volkman et al, 1994). The impacts of inhalation are:

- Absorption into the circulatory system; and
- Irritation or permanent damage to sensitive tissues such as eyes, mouth and respiratory tract.
  (Volkman et al, 1994)

Greatest risk from inhalation is proposed to occur within the first days after the spill

The impacts of direct and indirect ingestion of oil provided in Volkman et al, 1994 include:

- "irritation/destruction of intestinal linings;
- organ damage;
- neurological disorders;
- bioaccumulation of hydrocarbon residues and/or other derivatives"; and
- "transfer of hydrocarbon derivatives to young via lactation".
  (pp 574 Volkman et al, 1994)

Limited evidence suggests that there are no 'deleterious effects' of petroleum hydrocarbon bioaccumulation. "Marine organisms appear to have the necessary liver enzymes (mixed function oxidases) to metabolise hydrocarbons and excrete them as polar derivatives" (pp 574 Volkman et al, 1994). Non polar constituents of hydrocarbons may accumulate in lipid layers of the organism tissue (Volkman et al, 1994).

Section 8.6.1.2 of the DEIS provides information on the impacts of hydrocarbons entrained in the water column on fish. Clark 1982 and Jones 1989 (cited in the Woodside 2001) indicates that fish deaths have been attributed to:

- Toxic effects of water or tainted food;
- Ingestion; and
- Clogging of gills.

Atmospheric Emissions

The DEIS identified that atmospheric emissions will be a consequence of the following activities:

- Installation and construction of the WHP;
- Drilling program from WHP and subsea wells;
- Installation and construction of the PCUQ;
- Installation and construction of the subsea pipeline;
- Commissioning and operation of facilities;
- Cargo venting from the FSO and shuttle tankers during offtake; and
- Rupture of the subsea pipeline.
  (Woodside, 2001)

Atmospheric emissions have been divided into non greenhouse and greenhouse gas releases.

4.7.1 Non greenhouse gases

Non greenhouse gas emissions from the installation and construction of the facility and pipeline will primarily be due to burning of diesel, principally for power generation. Atmospheric pollutants resulting from combustion of diesel are primarily nitrogen oxides (NOx), sulphur oxides (SOx), carbon monoxide (CO), volatile organic compounds (VOC) and smoke/particulates. The proponent estimates diesel usage during the installation and construction of the WHP, PCUQ and subsea pipeline to be in the range of 10 tonnes to 30 tonnes of per day. The proponent has stated that the impacts on air quality are not expected to be significant due to the isolation of the project area and distance from sensitive environmental receptors.

Atmospheric emissions for the commissioning and operations will be associated with power generation, compression of export gas and flaring. Within the DEIS it is stated that the contribution of non-greenhouse gas emissions to air quality is expected to be below National Environment Protection Measure (NEPM) air quality criteria for personnel in the immediate vicinity of the emissions. Subsequent to the export pipeline hydrotest, Bayu Undan gas will replace diesel for power generation (Woodside, 2001)

Modelling of atmospheric emissions for the various phases of this project has not been conducted. However, for installation, construction, operation and decommissioning of the WHP and PCUQ, emissions of NOx, SOx, VOC and benzene, toluene, ethyl benzene and xylene (BTEX) have been quantified in Table 3-12 of the EIS Supplement.

The omission of modelling of atmospheric emissions is acceptable considering the location of the project and the distance to sensitive environmental receptors. Health and safety risks associated with atmospheric emissions should be quantified in the Environmental Plan.

Section 3.8.5.7 of the EIS supplement responds to submissions regarding measures to avoid or mitigate atmospheric emissions. Table 3-13 of the EIS supplement identifies the proponent's commitments to avoid, minimise or mitigate non-greenhouse gas emissions. These commitments include:

- Use of associated gas as primary fuel source, instead of imported liquid fuels;
- Use of Australian standard marine diesel which is low in sulphur; and
- Consideration of low NO_x technology where available.

Other commitments related to reducing emissions of non-greenhouse gases provided in Tables 9-1 to 9-5 of the DEIS (See Appendix 5).

4.7.2 Greenhouse Gas Emissions

The DEIS establishes that LNG when used as a fuel will produce less CO_2 per giga joule of energy generated than coal. The EIS guidelines stated that "quantification of annual greenhouse gas emissions (by gas type), including any sinks, over the expected life of the project" should be included in the EIS (pp 16 EA/DLPE, 2000).

Limited information regarding greenhouse gas emissions from the proposed facility is provided in the DEIS. However, in Table 9-5, the proponent does commit to preparing and implementing a greenhouse gas strategy to minimise emissions. In response to several submissions the proponent provided greenhouse gas emissions data in the Supplement. Information was provided regarding:

- Lifecycle emission comparisons with alternative fuel sources;
- Greenhouse Gas Emission Inventory;
- Comparison of Greenhouse efficiency with similar projects;
- Product lifecycle;
- Minimisation and mitigation measures
- Opportunities for offsetting emissions;
- Global greenhouse gas issues; and
- Impacts due to flaring and pipeline rupture.

Greenhouse gas (GHG) emissions for the proposal is expected to be 1% or less of Australia's total annual greenhouse emissions. If gas is processed onshore, emissions from the operation of the WHP and PCUQ are estimated in the order of 800,000 tonnes carbon dioxide equivalent (CO_2 eq) per annum (Woodside, 2002). Most of the

greenhouse emissions are directly associated with compression of gas for transmission down the proposed pipeline to shore (Woodside, 2002).

Flaring contribution to the greenhouse gas emissions is estimated to be "in the order to thousands of tonnes per year" (pp 89 Woodside, 2002). The large contribution of CO_2 eq emissions in comparison to other similar facilities is due to the extensive processing and compression requirements of the SGP (Woodside 2002). The total greenhouse emissions for the SGP from flaring is 'relatively' minor (Woodside, 2002). 'Significant' flaring will only occur during start up or restart operations (after emergency events) or facility blowdown resulting from emergency events and is expected to result in "short term infrequent impact (several days per year)" (pp 89 Woodside, 2002). Flaring requires approval under the P(SL) A.

In relation to the greenhouse gas trade-offs of LNG processing and usage, the proponent has stated the following. "LNG production creates more domestic greenhouse gas emissions (due to GHG generated during processing) than more competitive fuels but has a far greater global benefit with regards to overall GHG reduction during down stream processing" (pp 77 Woodside, 2002).

The Supplement provides comparisons of greenhouse gas emissions for onshore and offshore processing including options which incorporate Shell's FLNG facility. Table 4.2 provides a comparison of estimated GHG emissions between development options. For the purposes of this report FLNG and OLNG greenhouse emission data is provided as a point for comparison between the development options. Greenhouse gas emissions for the FLNG are not within the scope of the SGP EIS and the information provided is the best that is currently available (Woodside, 2002).

Table 4. 2: Comparison of Estimated CO_2 eq Emissions (in tonnes) for each Development Option

Phase	WHP	OLNG	FLNG	PCUQ
Drilling (tonnes per year) [2.]	200,347	0	0	0
Onsite construction /Installation total tonnes	75,299	0	0	65,477
Operations (tonnes per year)	111,337	2,379,104	2,379,104	651,155
Decommissioning (Total tonnes)	75,299	75,299	75,299	65,477
Total tonnes over operational life [1.]	**4,492,443** [1.]	**71,448,419** [1.]	**71,448,419** [1.]	**23,463,270** [1.]

Source: Woodside, 2002

1: for total tonnes assumed 30 years operational life.

2: for total tonnes drilling emissions assumed 5 years duration (see pp 3-5 Woodside, 2001)

Note: Figures for WHP CO_2 eq emissions have only been included once, as WHP is common to all proposals

Table 4.3 provides a comparison with greenhouse emissions from other LNG facilities and averages for other oil and gas production facilities in Australia. It must be noted that all production facilities are not identical and comparisons "should be considered as qualitative or at best a semi-quantitative process" (pp 81 Woodside, 2002).

Table 4.3: Comparative CO_2 eq emissions for LNG and other oil and gas production facilities in Australia

Facility Name	Tonnes of CO_2 eq per tonne of product
Sunrise Gas Development	0.34
FLNG	0.44
Phillips Wickham point	0.46
APPEA average oil and gas production 1999	0.342 (tonnes per unit of product)
APPEA average oil and gas production 2000	0.314 (tonnes per unit of product)

Source: Woodside 2002

In response to a submission requesting comparison with other hydrocarbons, that as petrol is not used to power electricity generation due to the economics the proponent considers it is inappropriate to compare greenhouse emissions of LNG with petrol (Woodside, 2002).

Table 4.4: Comparison of CO_2 eq emissions for fuel sources associated with electrical power generation

Fuel type	Fuel source	Tonnes of CO_2 eq per Megawatt hour	Tonnes of CO_2 eq per tonne of fuel
Coal	Hunter Valley	835	2.549
Oil	Middle East	706	3.753
LNG	North West Shelf	471	3.550
Domgas	North West Shelf	442	2.986
Nuclear	Olympic Dam	-	-

Source: (Woodside, 2002)

In the DEIS the proponent stated that natural gas generates approximately half the quantity of CO_2 eq greenhouse emissions in comparison to coal. In response to a submission requesting explanation of the above claim, the proponent has provided comparison of greenhouse emissions from various fuel sources used for electrical power generation. Table 4.4 is a summary of the information provided in the Supplement in support of this claim.

Calculation methodology

Three respondents to the DEIS including the NT government requested information regarding the greenhouse gas calculation methodology. In response the proponent in the Supplement identified that the DEIS GHG inventory was prepared using methodologies and calculations from '*Methods for estimating atmospheric emissions for E&P operations"* (1994) by the then Exploration and Production (E&P) Forum.

Further information obtained from the proponent indicated that the methodology applied to the estimation of GHG emissions was consistent with the National Greenhouse Gas Inventory methodology (Woodside, 2002a). The proponent also established that the E&P Forum is identified in the National Greenhouse Gas Inventory methodology for the estimation of greenhouse gas emissions from oil and gas exploration and production activities (Woodside, 2002a). The Australian

Greenhouse Office, subsequent to independent verification of Woodside's existing and forecast greenhouse gas emissions, is satisfied with emissions estimation and methodologies utilised for existing and future developments (Woodside, 2002a).

Use of Alternative energy systems

The proponent has considered the use of alternative energy systems to generate the power required to operate the production process systems. Alternative energy systems considered included solar, wind, fuel cells, tidal and hydroelectric. The investigation concluded that the facility was constrained in relation to the amount of space available.

The proponent has not identified if alternative energy systems were considered as part of an integrated power system to further reduce greenhouse emissions. A contrast with investment in renewable energy sources has also not been provided in the Final EIS.

Product Lifecycle

Total greenhouse emissions from combustion of product produced by the facility has been estimated to be approximately 22 million tonnes of CO_2 per annum (Woodside 2002). This figure includes the estimated 320 million barrels of condensate produced during the project life. As identified previously total greenhouse gas emissions resulting from production and processing of the gas and condensate equate 10% (2.2 million tonnes per annum) of the overall potential emissions for the products produced. The remaining 90% (19.8 millions tonnes per annum) of greenhouse gas emissions result from consumer end use of gas and condensate. Consumer use of the products, originating from the SGP is considered to be beyond the control of the proponent.

The above figures do not include the greenhouse gas emissions that will result from processing gas into LNG for export from downstream processing. Processing of gas to LNG is not within the scope of the EIS.

The proponent considers that though demand for energy resources is likely to increase over the project lifetime, LNG produced from gas from the SGP will provide a cleaner alternative in new or existing markets to those energy resources which are currently available (Woodside, 2002).

Pipeline rupture

In the event of a pipeline rupture, gas at high pressure would be released to the marine environment and subsequently into the atmosphere. On reaching the surface gas may begin to mix with the atmosphere, ignite or explode, the later two requiring an ignition source. The proponent has identified that environmental impacts of the release could result in scouring of the benthos in the immediate vicinity of the pipeline. In addition, the inventory (total gas volume) of the pipeline would be released into the marine environment and subsequently the atmosphere.

The impacts of the rupture are dependent on the location of the release. If near sensitive environmental receptors such as reefs and shoals, marine species maybe impacted. A summary of the environmental impacts of natural gas releases into the marine environment is provided below.

- Increased levels of methane in water of 10 to 100 times above background concentration;
- Changes in water chemistry including dissolved oxygen; and
- Disturbance of water fauna resulting in mortality of pelagic and benthic species.

(Patin, 1999)

The proponent has indicated that the likely hood of a pipeline rupture occurring are extremely remote (Woodside, 2002). Pipeline design, construction and operation are subject to various statutory controls.

Greenhouse Management Plan

A greenhouse management plan (GMP) will be prepared for the project. The GMP will be prepared for consistency with the Woodside Flaring and Venting guidelines. The Flaring and Venting guidelines for the SGP will establish that flaring and venting "….of hydrocarbons will be minimised within the design and operational philosophy of the development, using the best available technical and procedural solutions at reasonable cost" (pp 86, Woodside 2002).

To comply with the Flaring and Venting Guidelines the proponent has committed to the following actions:

- Preparing Flaring Management Plans for drilling, commissioning and production activities;
- Development of a greenhouse gas strategy;
- Taking all reasonable measures to reduce the time taken to commission compression facilities and minimise the quantity of gas flared;
- Flaring of gas to be minimised during operations phase. Exceptions to this guideline will only be during periods when compression equipment is not available, for example, during emergency shutdowns; and
- Gas associated with the safety flare system, for safety and operational reasons, will be maintained at a very low rate.

(Woodside, 2002)

The quantity of gas flared will be review for compliance with continuous improvement provisions in Woodside's Environmental policy (Woodside, 2002).

Ozone Depleting substances

In compliance with Woodside's policy, infrastructure incorporating ozone depleting substances will not be installed at any of the temporary or permanent site facilities. Charter vessels associated with the project which carry ozone depleting substances will not be permitted to discharge those substances except on the case of an emergency (Woodside 2002).

Greenhouse Challenge Co-operative Agreement

In 1997 Woodside entered into a Greenhouse Challenge Co-operative Agreement (GCCA) with the Commonwealth Government. (Woodside, 2002). Since the GCCA, Woodside's Environmental Policy has been the impetus for the company to reduce greenhouse gas emissions by incorporating best economically available technology into production system design (Woodside, 2002).

A separate GCCA specifically for the SGP will be developed by the proponent, in which greenhouse gas abatement plans will be agreed with the Commonwealth Government. Agreement on the abatement plans will be finalised before the project is commissioned (Woodside, 2002).

Mitigation Measures

Table 13-3 of the EIS supplement identifies the following mitigation measures for greenhouse emissions:

- Use where practicable of appropriate gas as primary source of fuel;
- Minimise fuel usage by considering type of gas fuel and couple with compatible equipment also incorporate use of waste heat;
- Reduction of requirement to flare through design of operational systems and maintenance schedules to increase reliability; and
- Minimise fugitive emissions by implementing monitoring and safety systems in conjunction with maintenance and equipment selection.
  (Woodside, 2002)

The proponent has identified that currently available equipment designed to reduce nitrogen dioxide (NOx) emissions, impacts efficiencies in power generation equipment (Woodside, 2002). Therefore, the proponent will continue to evaluate progress in development of technologies designed to reduce NOx emissions. NOx technology available at the time will be considered for inclusion in the process during the detailed design stage (Woodside 2002).

Reinjection of CO_2

Reinjection of CO_2 back into the reservoir (geosequestration) has been investigated as a method of reducing greenhouse gas emissions. The proponent has identified that geosequestration is not technically feasible due to the recycling of CO_2 within the reservoir and consequently higher levels of CO_2 in the gas over time. Separation of CO_2 from feed and flue gas, drilling of a dedicated reinjection well, installation of infrastructure to transport CO_2 and ongoing maintenance is considered by the proponent to be uneconomic and "not the best environmental outcome" (pp 87 Woodside, 2002)

Greenhouse Offset Measures

Greenhouse gas emissions offset opportunities identified in the EIS Supplement include:

- "Kyoto Protocol Flexibility mechanisms (Clean development mechanism, Joint Implementation and Emissions Trading);
- Sinks and forestry; and
- Other parallel process such as domestic emissions trading schemes, etc".

(pp 88, Woodside 2002)

Further information was requested following the review of the Supplement, regarding Greenhouse offset strategies. The proponent provided the following information in the Addendum.

Development of new renewable and sustainable energy supplies is integral in reducing global greenhouse gas emissions. The development of new energy sources will take time and is an issue that the proponent is currently investing in through its subsidiary Metasource Pty Ltd (Metasource). Gas is considered by the proponent as a widely available, low cost transitional fuel which will assist in reducing current global greenhouse gas emissions (Woodside, 2002a).

Metasource has investments in the following areas of renewable technologies, carbon sinks and greenhouse gas emissions mitigation:

- Ceramic Fuel Cells;
- Natural gas hydrates;
- Wave energy;
- Plantation developments;
- Geothermal energy; and
- Geological sequestration.

(Woodside 2002a)

The proponent has indicated that in the future Metasource intends to invest in renewable energy companies developing:

- Solar, wind, wave energy, bio-energy and geothermal;
- "Distribution generation, power quality and storage;
- Hydrogen technologies and fuel cells;
- Energy efficiency technologies and services; and
- Carbon efficient technologies."
  (pp 26-27 Woodside, 2002a)

Woodside will consider synergies in renewable energy sources and the company's present activities to reduce greenhouse gas emissions at its facilities.

The Kyoto Protocol

In the DEIS the proponent stated "… the protocol is yet to address how Australia can continue to produce LNG exports without being unduly penalised for emissions incurred in the production process" (pp 5-6 Woodside, 2001). In response, a submission identified that the Kyoto protocol was never intended to resolve this issue. The objective of the Kyoto protocol amongst other mechanisms is to set in place a market for emissions trading.

The proponent responded by further clarifying the statement. In summary, the proponent identifies the Kyoto Protocol's inability to acknowledge the role of countries which export energy that have "lower relative content of embodied energy" incorporating the potential to reduce global greenhouse emissions (pp 88 Woodside, 2002).

There is currently no legislation at a Commonwealth or State/Territory level regulating greenhouse gas emissions.

The NT Government is currently developing a greenhouse strategy to be considered by the Territory cabinet in mid 2003. It is expected that the discussion paper for facilitating input from the public into the proposed greenhouse strategy will be released by the end of 2003.

Recommendation 3:

The proponent shall prepare and implement a strategy aimed at reducing greenhouse gas emissions including aspects such as:

- **regular audits;**
- **reviews of new technologies with a view to achieve international best practice in reducing greenhouse gases; and**
- **opportunities for offsetting greenhouse gas emissions including relevant research.**

In developing its greenhouse strategy, the proponent shall consult with the Australian Greenhouse Office.

Discharges to the marine environment

Discharges to the marine environment expected during normal operations from the activity have been identified as:

- Sewerage and greywater;
- Hydrotest water;
- Cooling water;
- Deck drainage;
- Produced formation water;
- Drilling fluids; and
- Drill cuttings.

4.8.1 Legislation

The *Petroleum (Submerged Lands) Act 1967* (P (SL) Act) and it's associated regulations and directions is the principle legislation governing petroleum activities in the offshore environment under Commonwealth jurisdiction. The Northern Territory administers offshore waters on behalf of the Commonwealth in relation to petroleum activities.

Discharges to the marine environment from normal and abnormal operating conditions are to be justified by the proponent using a risk based approach. Evidence may take the form of a literature search, modelling of discharge dispersion/dilution zones, commitments to conform with legislative discharge thresholds, Australian standards or existing codes of environmental practice. The risk based approach requires the evidence provided by the proponent to be of sufficient detail to satisfy the regulator that the discharge is in accordance with the as low as reasonably practical (ALARP) principle.

4.8.2 Toxicity ranking

There is currently no regulatory requirement in Australia for toxicity testing of drilling fluids, production or hydrotest chemicals discharged to the marine environment. As a consequence testing protocols are not in place. The discharge of these chemicals is presently considered on a case by case basis with the proponent required too justify to regulatory authorities the environmental risk associated with the use and discharge of such chemicals.

However, toxicity testing has been conducted in Australia and other countries to discover what concentrations result in mortality. The impetus behind testing in Australia has come from petroleum operators and petroleum industry chemical suppliers who have endeavoured to demonstrate the toxicity/non toxicity of their products. In addition, Australian regulators have requested that operators conduct toxicity testing on local species (ERM Mitchell McCotter, 1997). However, toxicity testing on species endemic to the Timor Sea has not been conducted.

In contrast, countries which are signatories to the Oslo Paris Convention for the Protection of the Marine Environment of the North East Atlantic (OSPAR) have mandatory toxicity testing of chemicals proposed for discharge to the marine environment. For discharges associated with exploration drilling and production activities limits have been placed on discharge volumes of classified chemicals, based on environmental risk. Australian petroleum operators sometimes use toxicity data provided under the OSPAR system where local information is not available.

In the absence of Australian toxicity test data and for the purpose of identifying environmental risk, the results of toxicity testing under the OSPAR system have been used to screen chemicals proposed for discharge in drilling fluids, hydrotest water and production.

In the UK two systems rank the environmental toxicity of chemicals discharged to the marine environment as a consequence of the offshore exploration, exploitation and processing of hydrocarbons. These are the Offshore Chemical Notification Scheme (OCNS) and the Offshore Chemical Regulations Notified Chemicals Listing (OCRL).

The ONCS has been in operation since 1979 with revisions in 1993, 1996 & 2000. The 2000 revision introduced the "Harmonised Mandatory System for the Use and Reduction of the Discharge of Offshore Chemicals" (OSPAR Decision, 2000/2) (CEFAS, 2002).

'Decision 2000/2' requires that chemicals be ranked according to "Hazard Quotients" (HQ). Primary ranking is done using the "Chemical Hazard Assessment and Risk Management (CHARM) Hazard Assessment Module" employing a banding system to rank chemicals according to HQ (CEFAS, 2002). A key to the banding system is provided in Table 4.5.

Table 4.5 Key to Hazard Quotient Bands

Min Value	Max Value	Category
>0	<1	Gold
>=1	<30	Silver
>=30	<100	White
>=100	<300	Blue
>=300	<1000	Orange
>=1000		Purple

Source: CEFAS, 2001

Environmental risk is considered to be minimal if the product is categorised 'Gold' with risk associated with discharge increasing as HQ becomes larger with environmental risk being highest in the purple band. Listing is categorised into groups of similar function eg, biocides, dispersants or corrosion inhibitors.

The OCNS denoted each ranking by a letter. Each letter indicates the ecological hazard with 'A' being considered to pose the most environmental risk and 'E' the least environmental risk (Wills, 2000). The PLONOR (practically little or no observable risk) category is for those chemicals for which discharge "*does not need to be strongly regulated as, from experience of their discharge, the OSPAR Commission considers that they pose little or no risk to the environment.*" (pp 1 OSPAR Commission, 2002)

Table 4.6 Toxicity thresholds for initial chemical classification under the UK OCNS

OCNS ranking	Aquatic toxicity ppm	Sediment toxicity ranking ppm
A	<1	<10
B	>1-10	>10-100
C	>10-100	>100-1000
D	>100-1000	>1000-10,000
E	>1000	>10,000

Source: (CEFAS, 2000)

Aquatic toxicity refers to toxicity testing *for Skeletonema costatum* (EC_{50} test), *Acartia tonsa* (LC_{50} test) and *Scophthalmus maximyus* (LC_{50} test)

Sediment toxicity refers to toxicity testing for Corophium volutator (LC_{50} test)

4.8.3 Sewerage and greywater

Sewerage will be biologically treated prior to discharge. The proponent has not provided the quantity of sewerage to be discharged during each phase of the development of the SGP. Estimates of volumes of sewerage and greywater discharges from similar facilities with similar levels of staffing varies from 10 m^3 to 25-30 m^3 per day.

The closest environmentally sensitive receptors, which may be impacted by elevated nutrient levels, are 'the Lump' and the Sunrise Banks. Increased availability of nitrogen and phosphorous in the oligotrophic waters surrounding the site will be mitigated by water depth at point of discharge, the expected small volume of the discharge, rapid dispersion/dilution, biodegradability of the material discharged and distance from sensitive environmental receptors. The environmental impacts associated with discharge of sewerage and foodscraps are acceptable.

4.8.4 Hydrotest water

Intrafield pipelines, riser manifolds and the export pipelines will be hydrotested to verify the integrity of the welded joins and associated hardware. Hydrotesting involves the use of water and potential chemical additives pumped into the pipeline with the objective of over pressuring the pipeline in excess of normal design specifications. Hydrotesting is critical to ensure that the pipeline will withstand normal operating pressures, thus reducing the risk of hydrocarbon spills.

If the pipeline is not put in service immediately after installation, chemical additives maybe used to protect the internal surfaces from corrosion and marine fouling. The proponent has not specified the details of the chemicals to be used; however, the chemicals can be grouped generically into corrosion inhibitors, oxygen scavengers and biocides. In the absence of toxicity data the generic groups have been compared to the OCNS used in the UK (see table 4.6). The proponent has stated in the Supplement that at this stage, the exact constituents and concentrations of chemicals entrained in discharged hydrotest water are not available. If the pipeline to the wye piece is to proceed the proponent will provide details on the quantities and the exact chemicals to be used. Similarly, accurate figures for the volume of hydrotest water are not yet available.

After reviewing the DEIS and the Supplement, the NT government requested the proponent provide a review regarding environmental impacts of discharges associated with previous releases of hydrotest water. The objective was to identify the average range of chemical concentrations expected to enter the marine environment resulting from the release of hydrotest water. The following is a summary of the information provided in the Addendum.

Biocide

Biocides are used to control corrosion resulting from the activities of sulphate reducing bacteria (SRB) on the pipeline walls.

Black, Brand, Grynberg, Gwyther, Hammond, Mourtikas, Richardson and Wardrop, 1994, have identified four generic types of biocides used in the offshore oil and gas industry, these being:

- Quaternary amine salts;
- Quaternary amine acetates;
- Aldehydes; and
- Organosulphur compounds.

The above chemicals react in a similar way to antiseptics as they are designed to 'selectively kill' bacteria (Black et al, 1994). " Biocides have acute toxicity to freshwater and marine organisms in the range of about 1 mg/L to 1000 mg/L" (Hugdins, 1991). Hydrotest water biocide concentration for the SGP is expected to be 750 ppm. Tests conducted on degradation rates of biocides in mild steel pipes suggest a rapid reduction in concentration due to adherence to pipeline walls and primary purpose usage (Barton, 1998).

96 hour lethal concentration toxicity tests (96 hour LC_{50}) and 48 hour effect concentration tests (48 hour EC_{50}) for the biocide SurflowB16W which the proponent has previously used on the Laminaria/Corallina project are provided below:

Table 4.7 Toxicity tests for SurflowB16W

Test species	Test	Dose (mg/L)	Assessment
Rainbow trout	96 hour LC_{50}	8	Toxic to fish
Bluegill Sunfish	96 hour LC_{50}	0.65 to 0.9	Toxic to fish
Brown Shrimp	96 hour LC_{50}	44	Harmful to fish
Daphnia	48 hour EC_{50}	0.18 to 0.45	Very toxic to invertebrates

Source: Woodside 2002a

The properties of SurflowB16W are as follows:

- 98% biodegradation in 28 days. If absorbed onto sediments biodegradation rate is expected to be slowed;
- Soluble in water and remains toxic in solution;
- Reduced toxicity on absorption in sediments;
- Predicted that residual products of biodegradation will be completely mineralised;
- Low mobility in sediments when absorbed to anionic exchange sites. Once absorbed to sediments will not revert back to aqueous phase; and
- Low potential for bioaccumulation.
  (Woodside 2002a)

It is noted that SurflowB61W has an OCNS grouping of A (or equivalent) (Woodside, 2002a). It is suggested that the proponent compare the benefits of using other biocides that are "less toxic" to minimise the environmental impacts of hydrotest discharge in accordance with the ALARP principle.

Oxygen Scavenger

Oxygen is a key component in the aerobic corrosion of metal surfaces. Oxygen scavengers are included in hydrotest fluids to reduce the amount of oxygen available within the pipeline. The Laminaria/Corallina project used Ammonium Bisulphate as an oxygen scavenger. Ammonium Bisulphate is listed on the OSPAR list of substances considered to Pose Little or No Risk to the Environment (PLONOR).

The proponent intends to deoxygenate hydrotest water by calculating the quantity of oxygen scavenger required to achieve a no oxygen environment. Some additional chemical in excess of the quantity required will be included to maintain an oxygen deficient equilibrium within the pipeline (Woodside, 2002a). The strategy will ensure that most of the oxygen scavenger will react before discharge to the marine environment. In turn this will reduce chemical oxygen demand within the water column in the vicinity of the discharge point.

Corrosion Inhibitor

Corrosion inhibitors form a film on metallic surfaces preventing "attack" on metal surfaces by corrosive substances (Black et al, 1994). The proponent has identified that it is unlikely to use corrosion inhibitor as part of the chemical suite for hydrotesting. The proponent intends to use duplex or corrosion resistant materials in the intrafield pipelines. Corrosion inhibitor is not expected to be used for the purposes of hydrotesting the export pipeline (Woodside, 2002a).

If carbon steel pipelines are used in the project it is likely that the corrosion inhibitors EC1324A or TROS780 will be used at a concentration of 100ppm. Both have an OCNS grouping of D (Woodside, 2002a).

Dye

Fluoroscein dye at a concentration of 400 ppm will be used during hydrotesting. Fluoroscein is listed as OCNS Grouping E (lowest toxicity).

If the pipeline option is chosen the proponent has committed to:

- undertaking detailed dispersion modelling of the hydrotest water;
- investigate release methods to mitigate environmental impacts including aerial spraying and diffusers; and
- modelling to determine any impacts on sensitive environmental receptors.

(Woodside, 2002)

Recommendation 4

Further investigation is required into choice of biocide. Where practicable discharge concentrations of biocide in hydrotest water should be minimised to fulfil the dual objective of controlling sulphate reducing bacteria and mitigating environmental impacts as a consequence of discharge.

4.8.5 Cooling water

Seawater will be drawn from the ocean and used for cooling of process machinery and stabilising condensate. The proponent has identified that the continuous rate of discharge from the PCUQ will be 10,000 m^3 per hour to the ocean surface. The temperature of discharge will be 45^0C, 18^0C above ambient. Cooling water will not come into contact with hydrocarbons and chemical additives are not anticipated for corrosion or marine fouling management at any stage. The proponent has stated that cooling water discharge "… will have a localised effect on water temperature and restricted to the vicinity of the discharge point" (pp 8-38, Woodside 2001).

In the Supplement the proponent advised that modelling of cooling water discharge will be provided after the completion of studies for cooling water discharge from the proposed FLNG. The NT Government and Environment Australia requested that additional information on impacts of cooling water be provided for this assessment. The proponent has provided the following information in the Addendum.

Modelling of cooling water discharge was based on the following assumptions:

- Discharge volume of 10,000 m^3 per hour;
- Discharge temperature of 47^0C;
- Discharge depth 10-20m below sea level;
- Seawater dosed with sodium hypochlorite of concentration of 0.2mg/L to minimise bio-fouling of cooling system; and
- No other chemicals will be entrained in cooling water.
  (Woodside, 2002a)

The results of the modelling are:

- When discharged, within a few minutes the cooling water will cool rapidly to within 1^0C of ambient;
- Cooling will occur with a radial distance of 33m horizontally and 62m below the outlet at any time of year;
- Chlorine levels of 0.2 ppm at the point of discharge will be within ANZECC GFMWQ of 3 ppb at 70m from the outlet; and
- The impact of cooling water will be localised and not impact any sensitive environmental receptors.
  (Woodside, 2002a)

The environmental impacts of the discharge of cooling water from the PCUQ have been identified as mortality of plankton and potentially fish unable to move out of the zone of influence (Woodside, 2002a). In addition, sessile organisms attached to

platform legs in the proximity of continuous water temperature variations in the vicinity of the discharge caisson may also be impacted (Woodside, 2002a).

Modelling indicates that the nearest sensitive environmental receptors to the cooling water discharge point, 'the Lump' (5km) and the Sunrise Banks (18km) are unlikely to be impacted by localised water temperature variations as a consequence of cooling water discharges for the PCUQ.

4.8.6 Deck Drainage

The DEIS (Section 8.6.1.2) indicates that deck drainage management will involve potentially small quantities of residual chemical, oil and grease being discharged overboard via entry to the open drains system as a consequence of deck washdown. Deck drainage with 'significant' hydrocarbon contamination will be sent to an oil in water separator for treatment, prior to discharge of waste water to the marine environment.

Separate closed and open drainage systems will be incorporated into the design of the facility. The closed drain system will divert water from the deck to an oil in water separator or other treatment system. Waste water is treated until complying with discharge criteria identified in the P (SL) A or other statutory requirements. The open drains system will discharge liquids directly overboard from the facility.

The potential for long term environmental impact associated with the release of hydrocarbons will be limited due to the small quantities likely to be released if any release occurs. The small quantities of discharged hydrocarbons will be rapidly diluted and dispersed on entry to the marine environment.

Produced Formation Water

Produced formation water (PFW) originates from the hydrocarbon reservoir or from injection (usually seawater) into the reservoir to increase pressure and hydrocarbon recovery (Black et al, 1994).

PFW also contains a number of constituents, which may if present in high enough concentrations, result in unacceptable environmental risk when discharged into the marine environment. In addition to hydrocarbons, other constituents may include heavy metals, naturally occurring radioactive materials (NORM), suspended solids and production chemicals (biocides, defoamers, corrosion inhibitors and emulsion inhibitors). PFW may also exhibit physical characteristics, which may be markedly different from those in the receiving environment, such as salinity, temperature and elevated BOD and COD (Black et al, 1994).

Two options are currently proposed for the disposal of PFW from the SGP:

- discharge to the ocean; or
- reinjection into a dedicated shallow well.

In response to a submission requesting the criteria used to determine whether PFW will be reinjected into the formation, the proponent advised that cost and net environmental benefit are the determinants. However the base case as stated in the DEIS remains treatment to the required standards and discharge to the sea.

PFW is removed from the raw well stream and treated to remove any residual hydrocarbons to comply with following legislative discharge requirements:

- an oil in water concentration of 30mg/l averaged over 24 hours ; or
- 50mg/l at any time.

The proponent has indicated that PFW over the 40 year life of the project will be discharged at an average rate of approximately 4000 barrels per day (640m^3 per day) (pp 8-33 Woodside, 2001). Assuming a very light crude oil of API 55^o, the volume of oil discharged into the marine environment per day, if oil in water (OIW) discharge is maintained at 30mg/L is 25 litres. This figure assumes normal operating conditions.

PFW also contains the residual, secondary and tertiary products of production chemicals used to ensure maintenance and flow in hydrocarbon production lines. Chemicals used for this purpose may be grouped into the following categories as identified in Table 4.8.

Table 4.8 Indicative toxicity ranking for gas/oil production chemicals

Product Function	OCNS Grouping Range	Hazard Quotient banding
Oxygen scavengers	C-E	Gold
Corrosion inhibitor	A-E (Z)	Gold-Purple
Biocides	A-E (Z)	Gold-Purple
Demulsifiers	B*–D*	Gold-Orange
De-foamers	Grouping not provided	Gold
Gas treatment	C-E	Gold- Purple

Source: CEFAS 2002a and 2002b
*Temporary ranking

The final EIS does not provide any quantities or concentrations of production chemicals for the proposal.

4.9.1 Discharge to the marine environment

Hydrocarbons

In response to comments, modelling of hydrocarbons in PFW discharge has been conducted. The zone of impact for hydrocarbons entrained in PFW will be concentrated near the surface 3-4m and "should be effectively dispersed within tens to hundreds of metres from the discharge point" (Woodside, 2002). Modelling for the worst case scenario (turn of the tide during neap tides on a calm day) indicates that hydrocarbon concentrations are expected to be less than 0.0001 mg/L below 15m depth and 0.003 mg/L within 15 m of the discharge point.

The nearest sensitive environmental receptors are the Sunrise Banks and 'the Lump' 15km and 5.5km respectively from the proposed development site. The prevailing conditions under which the hydrocarbons entrained in PFW plume will move toward Sunrise Banks are during the southeast monsoon. Modelling indicates that the

concentration of hydrocarbons within 2km of the discharge point under the southeast monsoon are expected to be 0.0001 mg/L (Woodside, 2002). Due to water depth (40 m at Sunrise Banks and 120 m at the Lump), the contribution of environmental parameters to weathering of hydrocarbons and the distance from the point of discharge it is not anticipated that hydrocarbons associated with PFW discharge will impact the Sunrise Banks or the Lump.

Production chemicals

Production chemicals used in PFW identified by the proponent are scale inhibitor (EC6330A Ondeo Nalco), corrosion inhibitor (EC 1324A Ondeo Nalco) and methanol or methyl ethyl glycol.

The results of toxicity testing for North Sea species provided in the Addendum shows that the scale inhibitor has a low toxicity but that the corrosion inhibitor is toxic to algae and moderately toxic to crustaceans and fish.

The results of testing indicate that Scale Inhibitor EC6330A is readily biodegradable and if uptake by a marine organism occurs the potential for bioaccumulation is low. Testing also suggests Imidazoline, a component of EC1324A, will be 'inherently' biodegradable and has a low potential to bioaccumulate. The aromatic solvent is readily biodegradable but has a potential to bioaccumulate.

Methanol is listed as PLONOR by OSPAR Commission, 2002. Methyl ethyl glycol is classified as E under the OCNS.

Modelling conducted for calm conditions and slack water (between turn of the tide) predicted that "within 3.3m of the surface, concentrations were mixed down to 0.01% of initial concentrations within 15m distance from the release site" (pp 10-11 Woodside, 2002a). The results of modelling are also supported by studies undertaken for Nexen's Buffalo FPSO located in the Timor Sea.

In compliance with the requirements of the P (SL)(MOE), the proponent will monitor the PFW discharge, including oil in water, water temperature, salinity and potentially turbidity. Monitoring of the impacts of chemicals entrained in the PFW discharge will be included in the proponent's environmental management measures to conduct ecotoxicological testing of PFW. The results of monitoring will then be used to determine a zone of impact.

Modelling of PFW has indicated that concentrations of chemicals discharged to the marine environment would be diluted by a factor of 1:10,000 within 15m of the point of discharge (Woodside, 2002).

Recommendation 5

Suitable indicator species for bio-marking shall be determined prior to commissioning and operation of the facility.

4.9.2 Naturally Occurring Radioactive Materials

The final EIS does not contain any information with regard to the characteristics and disposal options for naturally occurring radioactive materials (NORM). These materials originate from radioactive elements within the reservoir fluids. Low specific activity (LSA) precipitates are formed as a result of temperature and pressure changes in the produced formation water as it is brought to the surface. Precipitates form on the inside of process equipment, which periodically requires removal and disposal. There are currently no onshore disposal options in the Northern Territory for NORM.

Should there be any disposal requirements the proponent will need to comply with all applicable NT and Commonwealth legislation.

Drilling fluids

Drilling fluids will be used for all production wells and the proposed dedicated reinjection well to be installed for the project. Drilling fluids are essential to rotary drilling and there is no alternative to their use (Hinwood, Poots, Dennis, Carey, Houridis, Bell, Thomson, Boudreau and Ayling 1994).

The drilling fluids proposed for the installation of the directional wells and subsea wells are either:

- water based drilling fluids;
- synthetic based (including ester based) drilling fluids; or
- a combination of water based and ester based drilling fluids.

Oil based drilling fluids may be used to drill a proposed dedicated reinjection well.

During drilling the fluids are reused several times. All attempts are made to separate the fluids from the cuttings using shakers and centrifuges. After completion of drilling and depending on the type of drilling fluid, the options for disposal of drilling fluids are discharge to the marine environment, transport to shore or reinjection.

The environmental impacts of discharging drilling fluids to the marine environment are:

- short term toxicity and morbidity effects on sensitive species and ecosystems;
- bioaccumulation of heavy metals in marine species which may be consumed by humans;
- burial of benthic ecosystems, alteration of benthic characteristics and changes to benthic planktonic larval recruitment; and
- reduction in water quality subsequent to discharge.
  (Neff, 1982)

Under the P (SL) Act water based drilling fluids (WBF) are generally accepted for discharge to the marine environment. Synthetic based drilling fluids (SBF) and oil based drilling fluids (OBF) have been used offshore in the Northern Territory. However, drilling fluid recovery systems have been required as part of the environmental management strategies to ensure that SBF and OBF have not been discharged into the marine environment. Residual SBF and OBF have been discharged to the environment with drill cuttings.

4.10.1 Disposal of non-water based drilling fluids

The proponent in the DEIS provided details on management strategies for the disposal options of non-water based drilling fluids which include transport to shore or reinjection. A feasibility study will be undertaken to establish which option is preferred. Transport to shore will involve returning cuttings and drilling fluids to shore for recycling of drilling fluids or disposal at an appropriate onshore facility. Two options are being considered for cuttings reinjection. One option is to install a dedicated well offshore into a suitable formation where a slurry of drill cuttings and drilling fluids will be pumped into the formation (approximately 1000m below the seabed). Reinjection of drill cuttings and drilling fluids into the sub seabed is based on the premise that a suitable 'sealing' formation is located within an acceptable distance. The other option is to reinject a slurry of drill cuttings and drill fluids "through the annulus between two casings strings of an existing production well"(pp 3-7 Woodside, 2001).

Limited information is provided in the final EIS regarding disposal of OBF or SBF onshore. Discussion is required concerning the treatment options available for safe disposal or recycling of non-water based drilling fluids. Treatment and disposal options should include the capacity of landfill facilities to receive waste of this nature.

Ester based muds will not be discharged to the marine environment at the completion of drilling activities from the WHP. However, the proponent has estimated that approximately 80m^3 of drilling fluids will be lost to the marine environment per individual well. This figure is based on an average 7km directional well generating about 800 m^3 of cuttings. The bulk of EBF or SBF entering the marine environment will be adherent to drill cuttings discharged overboard.

Oil based muds would only be used for drilling part of a dedicated reinjection well. These muds together with the cutting would be reinjected into this well.

4.10.2 Synthetic based muds

Ester based muds are essential for drilling the extended reach platform wells from the WHP, the reason being they improve clay inhibition and provide good lubricity. If released to the marine environment studies indicate that ester based muds result in lesser environmental impacts than oil based muds.

The DEIS provides information on testing by Woodside of biodegradation of two ester based muds, a paraffin based mud and a SBF. The result was that the two ester based muds biodegraded faster and more completely than the other two muds. Baker Hughes have had similar tests conducted with similar results. One ester based mud completely biodegrading after 27 days, the other degrading at a slower rate with 5% remaining after 65 days (Baker Hughes, 2001). Final biodegradation products for both ester based muds were methane and carbon dioxide.

The toxicity of primary and secondary products of biodegradation are not considered to be of concern in an open system due to rapid dilution and limited persistence.

Tests involving the ester based drilling fluid 'Biogreen' have been conducted on the following Western Australian marine species:

- *Isochyrsis sp* - a planktonic alga;
- *Gladioferens imparipes* - a copeopod; and
- *Penaeus monodon* - Crustacean (Tiger prawn).

The results of testing indicated that 'Biogreen' is non-toxic or almost non-toxic to the above marine species. Whole fluid testing for 'Biogreen' was also conducted, however, Hinwood et al, 1994 consider that results are of limited value as exposure to whole fluid is not likely in the natural marine environment.

Interactions between marine species and residual EBF or SBF will be predominantly from direct contact with drill cuttings piles or through indirect exposure in the water column to the by products of biodegradation. The principle mechanism of exposure will be for marine species recolonising benthic areas, which have been smothered by drill cuttings with adherent EBF or SBF.

The results of testing the ester based muds 'Biogreen' and 'Petrofree' included in the Supplement indicate that bioaccumulation and bioconcentration factors for 'Petrofree' are low. 'Biogreen' has some potential for bioaccumulation. Independent testing of other ester base fluids with similar properties to 'Nexes' indicates that there is a large potential for bioaccumulation, however, "If assimilated by exposed aquatic biota it is likely to degrade but not bioaccumulate' (pp 15 National Occupational Health and Safety Commission, 2000)

The benthic zones, which will receive the bulk of any environmental impacts resulting from discharge of EBF adhering to drill cuttings, will be those close to the platform. Degradation of EBF in the marine environment will be dependent on the presence of microbial populations in sufficient numbers and the availability of oxygen.

Studies conducted in the North Sea have concluded that severe disruption to benthic species occurs in the short term with recovery well under way within one year (National Occupational Safety and Health Commission, 2000). In addition, residual EBF biodegrades due to biological processes (National Occupational Health and Safety Commission, 2000).

The drilling program from the WHP will be conducted over a period of 5 years. Re-smothering of benthic zones close to the WHP will occur with potential for coverage being dependent on the time of year. This means that benthic zones in close proximity to the WHP may be impacted more than once during the WHP drilling program. As a consequence, biodegradation of drilling fluids and re-colonisation of impacted areas in the vicinity of the WHP may take longer than expected.

Research indicates that increases in water temperature result in corresponding increased fish metabolism (Patin, 1999). Differences in environmental parameters and physiology may also indicate potential differences in tissue permeability and bioaccumulation in the Timor Sea species compared to those in the North Sea.

A benthic sampling program to establish rates of degradation of residual drilling fluids and benthic species re-colonisation in drill cuttings piles should therefore be

incorporated in the environmental monitoring programme (see Recommendation 8 on page 72).

4.10.3 Disposal of water based drilling fluids

WBF is the most common form of drilling fluid used for drilling operations in the Timor Sea. The constituents of the "common types of water based systems include gel chemical, potassium chloride polymer, saturated salt water fluids and lime fluids" (pp 140 Hinwood et al, 1994).

Water based drilling fluids (WBF) will be used for all subsea wells and the upper sections of wells drilled from the WHP. The proponent has indicated that water based drilling fluids left after the drilling campaign will be discharged to the marine environment. WBF will be the largest volume of drilling muds discharged to the environment during the drilling program. To minimise the quantity of WBF to be discharged at the completion of drilling each well drilling fluid will be recycled.

The results of toxicity testing suggest the environmental risk of discharging WBF into the marine environment is low. This statement must be qualified in that testing was conducted on North Sea test species.

The most commonly used WBF system used in the Timor Sea is Potassium chloride combined with partially hydrolysed polyacrylamide (KCl/PHPA) which together with its components is considered to have low toxicity and to Pose Little or No Risk to the environment (PLONOR).

4.10.4 Environmental impacts associated with discharging WBF

Zone of acute toxic impact

Concentrations of drilling fluids corresponding to those which, result in acute toxic impacts would be encountered in the vicinity of the discharge point. Hinwood et al, 1994 identify that this zone would be within tens of metres in the water column and that concentration resulting in acute toxic impacts would only be experienced for short durations. The most susceptible organisms to the acute toxic effects of discharged drilling fluids are those which could not move out of the plume (URS, 2001).

After completion of a well any remaining WBF will be discharged. On entry to the marine environment fine particulates entrained in the WBF will commence dropping out of suspension and settling out over the benthos. This process will take time due to the depth of water, the strength of regional currents and the weight of particulates.

Reduction in photosynthetic activity

Turbidity resulting from the discharge of drilling fluids will result in reduced photosynthetic activity for organisms entrained in the plume. Only phyto-plankton unable to move out of the plume will be impacted. The proponent has shown in the DEIS that water depths in the vicinity of the project site will preclude the presence of benthic organisms dependant on photosynthesis.

Shallow water environments located to the south and south west of the project site have been incorporated into modelling studies for the project. The results of modelling provided in the DEIS estimate that shallow water environments will receive a maximum cumulative loads of 4 g/m^2 during winter with little or no coverage during summer or transitional period discharges (Woodside 2001).

Heavy metals

Studies in Australia have shown that heavy metal in discharges into the marine environment is mainly from the weighing agent barite. The principle constituent of barite, barium sulphate is insoluble in water. Barite used in a study had high concentrations of lead, arsenic and zinc (Hinwood et al, 1994). Other heavy metals identified in barite include copper, nickel, cadmium, mercury, chromium, vanadium and molybdenum (Hinwood et al, 1994).

Heavy metals may also be derived from the geological formation and from associated pore water (Hinwood et al, 1994). The contribution of the formation to heavy metals concentrations in drill cuttings is therefore dependent on the characteristics of the drilled formation.

In response to a submission requesting clarification regarding the potential for bioaccumulation of heavy metals in marine species, including cadmium and mercury the proponent has provided the n-octanol/water partition coefficient for the ester based drilling fluids 'Petrofree' and 'Biogreen'. As discussed in section 4.10.2 bioaccumulation tests using ester based drilling fluids indicated that the potential for uptake of ester based drilling fluids by marine species is low. Discussions have indicated that use of the n-octanol /water partition coefficient is not appropriate to identify potential for heavy metal bioaccumulation in marine species, unless specific testing has been undertaken. Table 3-6 provided in the Supplement only considers bioaccumulation data for ester based muds and not heavy metals.

The difference in the chemical characteristics of water based and ester based muds should be taken into consideration when identifying bioaccumulation of potential contaminants in marine species.

Recommendation 6

The potential for bioaccumulation of heavy metals entrained in residual ester based muds likely to be used in the SGP shall be addressed in the environment plan for the drilling program.

4.10.5 Oil Based Muds

Oil Based Muds (OBF) is considered to increase environmental risk associated with drilling activities to above acceptable levels. OBF have a hydrocarbon as an "external phase or base carrier" with a water or brine phase (pp 141, Hinwood et al, 1994).

In Section 8.3.2 of the DEIS the proponent has identified the selection criteria for use of oil based drilling fluids. It is recommended that SBF be considered in preference OBF due to reduced environmental risk in comparison to OBF. SBF use non-mineral oil fluids as a base carrier. Bases may consist of vegetable oils or esters. The advantage of non-mineral based fluids is that they display similar characteristics as OBF whilst being aerobically and anaerobically biodegradable in marine environment (Hinwood et al, 1994).

Drilling Cuttings

Drilling cuttings are usually separated from drilling fluids to minimise the use of fluids. Separation is achieved by passing returned drilling fluid/drill cuttings across shale shakers, which incorporate fine screens allowing drilling fluids to be recovered and reused. Depending on the drilling fluid, drill cuttings will be either:

- discharged directly overboard to the marine environment;
- recovered for treatment prior to disposal;
- reinjected into a suitable formation; or
- discharged into the annulus of a production well.

4.11.1 Disposal of drilling cuttings

The average length of a directional well is stated in section 3.2.7 of the DEIS as 7km with an estimated 800m^3 of cuttings. Table3.4 in the DEIS provides details of the estimated volume of drill cuttings for each type of drilling fluid proposed for use.

Modelling has been conducted to predict areas which may be impacted by drill cuttings. The modelling predicted that drilling cuttings will settle on the benthos and depending on the prevalent environmental conditions, different seabed regions would be impacted.

Under winter conditions (influenced by the southeast trades), drill cuttings will principally settle out in a southwesterly direction. Drill cuttings are predicted to settle out over an area of 5245km^2 with a maximum cumulative thickness of 2.93 micrometres (Woodside 2001).

Under summer conditions (the north monsoon), drill cuttings will principally settle out along a north south axis. Drill cuttings are expected to settle out over a smaller area of 3750km^2 with a maximum cumulative thickness of 5.2 micrometres.

In transitional periods between winter and summer conditions the modelling predicts that drill cuttings will principally settle out over an area of 693km^2 with a cumulative thickness of 21.41 micrometres.

Settling patterns of drilling cuttings predicted by modelling have been provided in the Addendum. Large particles with mean size of 707 micrometres are deposited within 1.5km of the point of discharge (Woodside, 2002a). Particles with mean size of 353.6 micrometres are deposited within 3km to 5km (Woodside, 2002a). Finer particles would be deposited at further distance from the point of discharge.

Table 4. 9 Drill Cutting Size Distribution

Mean particle size in micrometres	Percentage
707.1	0.56
353.6	7.45
176.8	17.08
88.4	18.3
44.2	12.18
22.1	44.43

Source: Woodside, 2001

Modelling simulations referred to in the Supplement indicated that cuttings released from the surface could settle out on Sunrise Banks under winter and summer conditions. Cuttings concentrations during winter are expected to be 0.01 g/m^2 – 0.1 g/m^2 corresponding to a sediment thickness of 0.01-0.1 micrometres. Cuttings concentrations during summer are expected to be 1 g/m^2 – 2 g/m^2 corresponding to a sediment thickness of 0.5 -1 micrometres. The proponent has identified that during calm periods sediments due to drill cuttings are predicted to be less than 0.01 microns at Sunrise Bank (Woodside, 2002).

Modelling was conducted in response to a submission requesting predicted sedimentation rates for drill cuttings at 'the Lump'. Two scenarios were considered:

- discharge of 880m^3 of drill cuttings from the WHP under winter conditions; and
- discharge of 717m^3 of drill cuttings from a proposed subsea well to be located approximately 3km west of 'the Lump.

The results of modelling are provided as cumulative loadings.

The modelling predicts that under the WHP scenario sedimentation due to discharge of drill cuttings at 'the Lump' would be highest under winter conditions. Surface currents would deposit cuttings to the southwest of the WHP. Sediment loading was predicted at 164 g/m^2 at an average thickness of 64 micrometres (Woodside, 2002a). Under the subsea well scenario discharge under summer conditions would result in the highest rates of sedimentation from drill cuttings. Sediment loading is predicted at 10 g/m^2. However, the southeast corner of 'the Lump' could experience up to 205 g/m^2 (or 20.5 mg/cm^2 cumulative loading) with an average thickness of 80 micrometres (Woodside, 2002a).

Table 4.10 provides information on recorded sedimentation rates on Australian Coral reefs. The mean sedimentation rates per day at the identified reefs are double the loading that would be deposited at 'the Lump' in the worst case. However, this statement must be qualified by indicating that environmental parameters at the reefs in Table 4.10 would potentially preclude the presence of floral and faunal assemblages present at 'the Lump".

Table 4. 10 Sedimentation rates on Australian Coral reefs

Location	Sedimentation rates (mg/cm/day) mean	Sedimentation rates (mg/cm/day) range
Low Isles	67.9	0.6 – 899.9
Cape Tribulation	110.3	3.1 – 303.5
Magnetic Island	46.2	2.6 – 356.6
Lizard Island	65.0	3.9- 658.3

Source Hinwood et al, 1944

The depositing of drill cuttings has the potential to smother the habitat of filter feeding organisms identified during site surveys at 'the Lump" in addition to, increasing turbidity and reducing photosynthetic potential. The predicted cumulative sediment loading for the modelled scenarios indicate that depth of deposition will be less than 1.0 millimetre. Site surveys indicated that filter feeding organisms at 'the Lump' were observed to stand approximately 0.5m above the benthos (Woodside, 2002a). Due to the water depth of 120m it is unlikely that marine species inhabiting 'the Lump' would not be reliant on light attenuation through the water column for survival.

Submissions in response to the DEIS requested additional information regarding the environmental impacts of discharged drilling fluids and cuttings. The proponent in the EIS Supplement identified that the initial smothering of the benthos in the immediate vicinity of the drill cuttings pile will be major impact on benthic fauna and flora. To this end, the environmental impact will be dependent on the type of drilling fluid attached to the drill cuttings.

4.11.2 Reinjection

One of the options identified in the DEIS for disposal of drill cuttings with adherent non water based drilling fluid was to reinject these either into suitable geological formation via a dedicated reinjection well or into the annulus outside the casing of existing production wells. The proponent has indicated that the depth of the dedicated reinjection well is approximately 1000 metres below the seabed. Section 3.2.7 of the DEIS indicates that the constraints to this option are finding a suitable geological formation in conjunction with a sealing formation capable of retaining cuttings and adherent drilling fluids within the formation.

Some submissions requested more information on the viability of reinjection and the capability of the reservoir to accommodate reinjection. The proponent has advised that further work on reinjection of drill cutting is being undertaken. Information may also become available from the drilling program being undertaken by Phillips Petroleum for the Bayu Undan project, which proposes trialing reinjection of drill cuttings. The Phillips Petroleum drilling program is penetrating similar geological formations that will be encountered at the Sunrise field.

In addition, a submission was received 'urging' the proponent to consider reinjection of drill cuttings as an alternative to disposal to the seabed if there is a net environmental benefit. The proponent has acknowledged this submission and will continue to consider the feasibility of this option.

Cumulative Impacts

The proponent acknowledges that long term impacts may occur at different levels of the marine community structure and agrees with a submission that it is difficult to identify anthropogenic impacts on marine ecosystems.

In relation to the proposal area studies on marine communities have been limited due to its location. To obtain further information on the marine community and environmental parameters the proponent has committed to undertaking a monitoring program. The program will be designed to, where possible, detect anthropogenic impacts on marine communities and add to the body of knowledge in relation to offshore habitats in the Timor Sea.

In response to a submission the proponent indicated that the cumulative impacts of disposal of drill cuttings to the marine environment will be considered in more detail. This information will be provided in the environment plan for the drilling program. The proponent has also indicated that the medium and long-term impacts of the drilling program will be determined by the final drilling option selected.

Section 4.18.2 of this assessment report provides further detail on the monitoring program proposed for the activity.

The proponent has made commitments to undertake a monitoring program designed to obtain baseline data on environmental parameters and marine community structures. Information derived for the field studies will assist the proponent investigate potential environmental impacts when more detailed information is available subsequent to selection of the final field development option and completion of detailed engineering design. The proponent will be in a position at that stage to provide detailed information on the potential cumulative impacts of the proposal.

Information was also requested regarding the cumulative impacts of simultaneous operations of the FLNG and the remaining infrastructure of this project. The proponent has responded by stating that if the FLNG option were to proceed elements of this proposal would no longer be required and the potential for combined cumulative impacts would be “non-existent”.

If the FLNG were to proceed the elements no longer required from this proposal would be the PCUQ, the FSO and pipeline to the wye piece. Wellstream processing previously associated with the PCUQ would be undertaken of the FLNG barge. As a consequence discharges to the marine environment resulting from well stream processing including PFW and cooling water would need to be addressed as part of the environmental impacts associated with the FLNG project. Discharges from the FLNG are not within the scope of this assessment.

Waste Management

In response to submissions Appendix D of the Supplement includes an example of a waste management plan for the facility.

The objectives of the plan are to:

- Ensure that all waste is disposed of in a controlled and appropriate manner;
- Avoid undesirable safety and environmental effects through inappropriate handling, storage, transportation and disposal;
- Comply with all statutory and contractual requirements concerning management of waste; and
- Ensure that appropriate recording and tracking occurs for all wastes generated." (pp 101 Woodside, 2002)

Recycling of waste materials will occur where possible.

The volume of waste expected to be generated during all phases of the proposal has not been provided in the final EIS. In addition, the proponent has not indicated whether they have investigated the capacity of local landfills to continue to accept waste from the facility during all stages of the SGP. Further information was requested from the proponent in relation to the above matters.

In the Addendum the proponent provided the following information.

The PCUQ and WHP will generate wastes similar in composition and quantity to other Woodside facilities in the Northern Territory. Waste arriving onshore will be processed at Darwin Supply Base, Hudson Creek (Woodside, 2002a). Hazardous and other materials found unsuitable for onsite processing will be relinquished to licensed contractors for appropriate disposal (Woodside, 2002a). If wastes are to be transported across state borders, the provisions described in the National Environmental Protection Measure *Movement of Controlled Waste between States and Territories* will be employed (Woodside, 2002a).

A waste management plan (WMP) will be prepared to meet the specific needs of the SGP. The WMP will be in accordance with the *Waste Management and Pollution Control Act 1998* and other applicable NT legislation. The information provided in the WMP will include:

- *waste segregation into recyclables (non hazardous), general (non hazardous) and hazardous wastes;*
- *handling procedures for recyclables and non hazardous wastes;*
- *handling procedures for hazardous waste; and*
- *expected waste types, storage and end use.*
  (pp 28, Woodside, 2002a)

In addition to preparing a WMP, the proponent has committed to conducting waste management audits and other self assessments to establish environmental performance (Woodside, 2002a).

In response to a submission regarding provision of waste receiving services and port related services the proponent acknowledges that:

- Discharges of grey and black water from vessels in port is acceptable to NT Power and Water Corporation sewerage facilities under a bulk waste agreement;

- NT Power and Water Corporation has limited facilities to treat salt water based grey and black water;
- Only liquid wastes complying with a trade waste agreement will be accepted by NT Power and Water Corporation; and
- Current legislation and port procedures require compliance with safety and environmental provisions for handling of product cargoes through the Port of Darwin to and from the site during construction and production phases.

Recommendation 7

A Waste Management Plan is to be prepared for the Sunrise Gas Project to include details of:

- **waste segregation into recyclables (non-hazardous), general (non-hazardous) and hazardous wastes;**
- **handling procedures for recyclables and non-hazardous wastes;**
- **handling procedures for hazardous and chemical wastes;**
- **expected waste types, storage and end use;**
- **identify the facilities available in the Northern Territory capable of receiving hazardous and non-hazardous waste materials expected from the Sunrise Gas Project; and**
- **suitable onshore waste facilities that have the capacity to receive the waste categories and volumes expected over life of the SGP.**

Operational controls

In the DEIS and Supplement the proponent has identified operational controls which will be implemented to provide and maintain plant and systems of work with the objective of conducting the activity in accordance with legislative requirements and reducing environmental, health and safety risk".

4.14.1 Well control

The proponent considers that well control is of primary importance when installing a well. Well control measures will be managed in accordance with the proponents internal management system and in accordance with legislative requirements.

Well control measures such as use of appropriately rated blow out preventers, and ensuring that casing strings are cemented and pressure tested before drilling are primary environmental protection measures. Installation of sub surface safety valves will provide a mechanism to shut production wells below the seabed if any emergency situation arises requiring such action. Section 8.3 of the DEIS 'Mitigation Measures for Drilling and Associated Activities' provides actions to be taken by the proponent to 'minimise or avoid' environmental impacts.

4.14.2 Oil Spill Contingency Plan

An oil spill contingency plan (OSCP) is a component of an emergency response plan and is a statutory requirement for all petroleum activities.

The proponent's current OSCP for operations in the Northern Territory and the Timor Sea (ERP 3220) will be updated to meet the requirements of the Sunrise Gas Project.

Modifications to the OSCP will address the requirements of the final development option. The updated ERP 3220 should include oil spill modelling for spills released from the SGP.

ERP 3220 also provides for regular training of onshore and offshore personnel involved in emergency response activities including oil spill response. In the DEIS the proponent has identified the following measures to minimise the impact of oil spill incidents:

- Transfer hoses fitted with dry break couplings;
- Spill kits to be available for clean up of minor spills;
- Appropriate bunding and containment areas for deck run off, machinery spaces and oil chemical storage areas;
- Mooring hawser incorporating load monitoring cell and quick release hook to ensure appropriate separation distances are maintained between the FSO and tanker during offtake operations;
- Process spill and leak detection systems, alarms and isolation valves to be maintained in good working order; and
- Design of flowlines for 1 in 10,000 year storm conditions and include shutdown valves and high pressure and low pressure sensors.
  (Woodside, 2001)

The proponent has indicated that the SGP joint venturers are committed to minimising the risk of oil spill for all stages of the project and that spill prevention is a high priority. Best practice international technology will be used to meet this objective.

4.14.3 Dangerous goods and chemical management

Section 4.1.4 of the DEIS identifies the types of chemicals which may be used at project site.

Diesel, cementing fluid chemicals (cement, surfactants, defoamers, inorganic salts, bentonite, barite), drilling fluids, helifuels, methyl ethyl glycol, lube oil, methanol and other chemicals to be used for potable water, corrosion and scale inhibitors etc (pp 4-3 Woodside, 2001).

The proponent has identified that a hazardous and chemical waste management plan will be prepared. The plan will include:

- Material Safety Data Sheets (MSDS) to be placed in all areas where chemicals and hazardous materials are handled;
- chemical and hazardous spill management materials to be available on the facilities.
- appropriate storage of hazardous and chemical material in bunded or segregated areas; and
- use of low environment impact chemicals and materials where possible.
  (Woodside, 2001)

Information was requested regarding which criteria would be used to ascertain ‘where technically practicable the most environmentally acceptable options will be

preferentially selected". In addition, who/which agency will be responsible to assess whether the chemicals selected where the most environmentally acceptable option.

The proponent responded that the chemicals selected would offer the " best technical cost and environmental performance" (pp 40 Woodside, 2002). Those responsible for chemical selection would be the project engineers in consultation with the proponents Health Safety and Environmental Advisers.

Environment plans prepared for each phase of the project will be required to include information on the chemicals to be used. If spent chemicals are to be discharged to the environment, the volumes and concentrations to be released will need to be established in the environment plan. An assessment of environmental risk shall be provided and shall include:

- demonstrated eco-toxicity of chemicals at expected release concentrations;
- zone of impact;
- alterations in water quality parameters on discharge, for example chemical and biological oxygen demand, temperature, pH, suspended solids or salinity on release to the marine environment;
- potential for bioaccumulation in pelagic, demersal and benthic marine organisms;
- potential for degradation including toxicity and persistence of primary, secondary and tertiary degradation products; and
- persistence in the sediments.

Strategies to minimise the use of chemicals are outlined in Section 8.7.2.5 of the DEIS. In the Supplement the proponent also identified that "international best practice and strict adherence to regulations governing chemical use as specified by the Designated Authority" (pp 41 Woodside 2002).

In response to a submission regarding identification of discharge limits for chemicals to the marine environment and measures to mitigate exceedances, the proponent responded that the Greater Sunrise Joint Ventures will adhere to regulatory requirements governing discharges to the sea. Each environment plan will contain contingency plans to manage exceedance of set discharge criteria.

4.14.4 Maintenance

A submission requested more information on maintenance, specifically whether a four yearly shutdown is an industry standard, do financial considerations make more frequent shutdowns uneconomical and is annual inspection of the offtake hose an industry standard? The submission also required clarification on which authority/agency will be responsible for assessing the adequacy of the above choices.

There is not legislative requirement for planned shutdown of facilities for maintenance purposes. Scheduled maintenance and inspection is determined by analysis of operating risk. Operating risk is determined by agreement with certification/inspection companies on a case by case basis (Woodside, 2002).

The proponent have "a duty to provide and maintain plant and equipment that is safe and without risk to health" and shall comply with Clause 89 of the NT *Petroleum Amendment Act 2000.*

Reporting requirements for discharges and emissions from the facility provides statutory agencies with information regarding the operation of equipment installed as part of the technical barriers minimising environmental risk. Breaches of environmental performance standards will act as a trigger for the proponent and government agencies to investigate the reasons for the breach.

Summaries of maintenance and operational procedures where relevant to environmental management will be included in the environment plans for each phase of the project.

4.14.5 Pipeline

Submissions were received regarding the application of the Det Norske Veritas standard OS F101 "Submarine Pipeline Systems" to construction and operation of the pipeline from the PCUQ to the wye piece.

The proponent has stated that the use of the Det Norske Veritas (DNV) standard is voluntary and it is anticipated that Standards Australia will adopt DNV OS F101 "Submarine Pipeline Systems" within the SGP timescale. In relation to a commitment to use the standard for pipeline construction and operation, the proponent considers that "insufficient development" has been undertaken to make a commitment to use elements of or the entire standard.

The pipeline construction standard adopted shall be acceptable to the appropriate Regulatory Agency.

Risk Assessment and hazard analysis

Section 8.10 of the DEIS considers the principles guiding the proponent's management of safety, hazards and risk during the lifetime of the SGP. A concept Health, safety and Environment Case (HSE Case) for the facility will be developed in compliance with *Petroleum (Submerged Lands) (Management of Safety on Offshore Installations) Regulations 1996.* The principles of the project HSE Case will be:

- "To demonstrate that the design option creates an acceptable major accident and environment risk that is as low as reasonably practicable;
- To demonstrate that the adequacy of the concepts have been considered to achieve the lowest reasonable practicable level of risk for personnel on the installation; and
- To evaluate the projects understanding of the inherent risk in the concept and operation to identify the requirements for controls through the develop and execute phases to ensure operational phase risks are as low as reasonably practicable (ALARP)."

(pp 8-56 Woodside, 2001)

In accordance with the above principles documentation will be prepared by the proponent to demonstrate:

- potential hazards have been identified and managed;
- risk levels have been reduced to ALARP; and

- management strategies that will be implemented in the event of loss of operational control.

(Woodside, 2001)

To assist in the development of the HSE Case, a number of hazard identification (HAZID) or hazard and operability (HAZOP) studies have been conducted or will be conducted in the future.

Submissions requested more information on hazard identification, environmental risk assessment and management commitments. The proponent responded by stating "that risk and hazard are extremely high priorities for all of Woodside's operations, as will be the case with the proposed Sunrise Gas Project" (pp 115 Woodside, 2002). Risk and hazard analysis will be continuously conducted throughout the project to ensure compliance with the ALARP principle.

Appendix C in the Supplement stated that the following quantitative risk assessment (QRA) and Hazard Analysis have been conducted for the SGP:

- Export Gas Pipeline Hazard Review;
- Export Gas Pipeline Preliminary QRA of External Impact Risk;
- FLNG Upstream Facilities Preliminary Risk Assessment; and
- Preliminary Environmental Risk Assessment.

QRA for the offshore processing facilities had not been undertaken for the final EIS. The NT government requested additional information on the QRA for the PCUQ. Woodside provided two documents in the Addendum: "Risk Review of Jack-up Options" and "Preliminary Review of Options Risk". The documents consider preliminary and coarse risk associated with selection of the type of offshore infrastructure to be incorporate into design. Risk is quantified in terms of the potential loss of life. Environmental risk was not considered in the above documents. Calculated risk figures for potential loss of life and individual risk per annum and potential loss of life over 30 years are provided in Table 3-19 of the Supplement

Hazard analysis and QRA was originally undertaken for the operations phase of a pipeline from the Sunrise platform to an onshore plant located at Glyde point. The proponent considers that the findings of the previous study will be appropriate when establishing environmental hazard and risk associated with the current proposed pipeline alignment.

In the Supplement the proponent indicates that only one section (Section 4) of the QRA for the pipeline is relevant to the current proposal. The relevance of hazard and QRA pipeline studies for alternative routes should be reviewed in relation to route specific risk. In addition, as identified in the P (SL)(MOE) risk should established not only for normal operations but also for 'reasonably possible operations being accidental or otherwise' including "construction, corrosion, erosion, burst etc."

4.15.1 Environmental Risk Assessment

A semi qualitative risk assessment has been conducted for environmental risk associated with construction, installation, commissioning and operations and decommissioning activities. Analysis of risk has been undertaken on the assumption

that mitigation measures identified in the DEIS have been implemented. Activities such as PFW dispersion, drilling cuttings dispersion and hydrocarbon spills have been modelled to predict potential for environmental impacts resulting from these discharges.

Modelling of oil spills from subsea wells has not been undertaken. The proponent has indicated that the subsea well drilling program will commence after 2010.

In response to a submission regarding the parameters and assumptions used for modelling and the suitability of these to the project site the proponent has provided the following information. Data used to establish environmental parameters for modelling of the environment has been derived from the Timor Sea. The properties of the oil /condensate used to predict spill characteristics are also from samples taken from the Sunrise field. Parameters for diesel spill modelling are also derived from a reliable data set.

Further data collection will be available from baseline studies including metocean surveys currently being undertaken. Actual on site data will permit the proponent to refine predictive modelling results.

A submission requested more information on the effects of oil spill, specifically in relation to environmental impacts on flora and fauna inhabiting shallow water in the vicinity of Sunrise Banks.

Table 4.11 provides quantitative analysis of the chance of hydrocarbon leakage from the facility (based on information in the Supplement).

Table 4.11 Event probability of hydrocarbon spills from the facility

Source of hydrocarbon discharge	Calculated event frequency per annum
Flowline outside safety zone	0.0036
Flowline within safety zone	0.008
Well blowout platform	0.0019
Well blowout subsea	0.0029
Riser release	0.0049
Pipeline and manifold release at WHP (medium and large)	0.0053

(Source: Woodside, 2002)

The table shows that the probability of an oil spill event is relatively low.

Modelling predicts that in the worst case scenario hydrocarbon releases to the environment are not anticipated to impact shorelines or emergent reefs due to high degradation rates and spill trajectories. However, shallow water environments in an arc from the southeast through to the southwest of the project site have a potential to be impacted by the passage of dissolved aromatic plumes. These sites being Sunrise

Bank and Sunset, Loxton and Martin Shoals in the summer period, Bellona Bank and Echo Shoals during winter and Sunrise Bank during the transitional period. The highest concentration of dissolved aromatic hydrocarbons during any event is predicted as 40 parts per billion at any time of year. Sedimentation of total petroleum hydrocarbons at the above banks or shoals is predicted at less than 0.0001 grams per square meter.

The results of studies provided in the Supplement indicate that coral species from northern Australia and America may survive hydrocarbon concentrations in the range of 5 ppm to 20 ppm. The study by Harrison, Collins, Alexander and Harrison (1990) "*The effects of fuel and dispersant on the tissues of a staghorn coral Acropora formosa*" identified in the Supplement indicates that *Acropora formosa* have survived exposure over a 6 hour period to hydrocarbon concentrations of 5 ppm - 10 ppm (Woodside, 2002). Research conducted by the National Oceanic and Atmospheric Administration of the US Department of Commence (2001) *Toxicity of Oil to Reef Building Corals* also identified in the Supplement, "found that transient concentrations of oil in water below 20 ppm are probably not likely to result in lasting harm to a coral reef" (pp 121, Woodside 2002).

Risk of exposure of 'the Lump' to hydrocarbons was not provide in the DEIS or the Supplement. Modelling of risk for hydrocarbons was provided in the Addendum in response to a request for further information. Two scenarios were considered:

- Blowout at the WHP; and
- Blowout at a subsea well located approximately 3.5km west of 'the Lump'.

The modelling predicted that 'the Lump' may be exposed to hydrocarbons from a WHP blowout. Probabilities of exposure ranged from 62% to 90% for dissolved aromatic hydrocarbons and 46% to 78% for entrained oil (Woodside, 2002a). The highest predicted concentrations of hydrocarbons were identified as 40 ppb to 70 ppb for dissolved aromatic hydrocarbons and 220 ppb to 430 ppb for entrained oil (Woodside, 2002a). A blowout occurring during the transitional months (March/April and September/October) represented the highest risk of exposure.

Total dosages of hydrocarbons experienced by marine organisms inhabiting 'the Lump' have been calculated using the formula mean concentration multiplied by the total duration of exposure. Predicted total dosages for dissolved aromatic hydrocarbons range from 109 ppb to 280 ppb which are equivalent to dosages of 1.1 ppb to 2.9 ppb over a 96 hour period (Woodside, 2002a).

Modelling of a blowout at a subsea well located approximately 3.5km west of 'the Lump predicted that under summer conditions dissolved hydrocarbons may reach the site in 70% of the spill scenarios (Woodside, 2002a). Entrained oil droplets under the same conditions would reach 'the Lump' 34% of the time (Woodside, 2002a).

Marine organisms may be exposed to a total dosage estimated at 160 ppb (1.66 ppb over 96 hours) for dissolved aromatic hydrocarbons and 1650 ppb (17.18 over 96 hours). The highest concentrations of dissolved aromatic hydrocarbons were 130 ppb and 590 ppb for entrained oil (Woodside, 2002a)

The proponent has identified that the ANZECC GFMWQ establish that based on 96 hr LC_{50} tests hydrocarbon, concentrations of 5-6 ppb are applicable as threshold criteria for a lower reliability trigger for total hydrocarbons. Threshold concentrations include dissolved aliphatics and aromatic constituents of hydrocarbons.

Table 4.11 and the risk modelling associated with a blowout from the WHP and a subsea well in close proximity to 'the Lump' indicate that the environmental risk from such an event is low. Total exposure concentrations predicted for blowouts indicated that only entrained oil from a subsea well blowout in close proximity to 'the Lump' would exceed ANZECC GFMWQ for total hydrocarbons. As identified by the proponent in the Addendum total dosage must be considered in conjunction with the duration of the event.

The project is in the preliminary stage and the risk assessment carried out to date is commensurate with the current level of development

Decommissioning

Section 4.4 of the DEIS provides an overview of decommissioning of the project infrastructure. The objective is "to decommission production facilities and abandon operating areas so as to leave them as near as practicable to their original environmental condition" (pp 4-6 Woodside, 2002).

The proponent has identified principles of decommissioning outlined in the Australian Petroleum Production and Exploration Association Code of Environmental Practice 1996. Considerations at the time of decommissioning will include:

- Consultation concerning the requirements of maritime users and current and future resource managers;
- Disposal options for project infrastructure including recycling of structure and equipment;
- Consideration of the current and potential future use; and
- Safe decommissioning of production wells.

The proponent has indicated that the following infrastructure is likely to remain after decommissioning of the facility.

- Wellheads cut approximately 5 metres below the seabed after completion of plugging and abandoning to the satisfaction of DBIRD;
- Manifolds and subsurface location valves;
- Pipelines;
- Platform foundations;
- Platform Jacket cut to a level which does not pose a hazard to shipping;
- Intrafield flowlines;
- Hot water lines to bundles;
- Control and power umbilicals;
- Pipeline end manifolds; and
- FSO foundations.

(Woodside 2002)

It should be noted that details of infrastructure, which will remain after decommissioning is only preliminary. More detailed his information will be available when the final field development concept is selected. Once selected detailed project design will include decommissioning options as a 'key' engineering design consideration. Full removal of site infrastructure will be considered. Figure 1-6 provides a schematic of the infrastructure, which will remain after decommissioning of the current proposal.

In response to a submission the proponent has stated in the Supplement that the decommissioning environment plan will include the option of full removal of intrafield pipelines. Decommissioning of the subsea export pipeline has been discussed in the Supplement. The preferred option is to purge the pipeline of gas and residual contaminants, flood with seawater, disconnect pipeline ends from infrastructure and leave the pipeline in situ.

The proponent has identified in the Supplement an impediment to decommissioning may be that structures cannot physically be removed because they extend beneath the seabed, for example casing strings in subsea-wells and pilings. Other seabed structures such as mooring points for the FSO can be removed. However, justification for removal will be considered in relation to cost and net environmental benefit.

The proponent intends to use evidence from seabed monitoring to support decommissioning strategies selected and outlined in the environment plan. The objective of the decommissioning plan will be to minimise the environmental impacts of the activity. The proponent has committed to conducting baseline monitoring of marine benthic communities prior to the installation and construction phases of the project. Monitoring will continue subsequent to decommissioning of site infrastructure. If monitoring established that the recovery of the benthic marine community sufficient remedial actions would be implemented.

Details on proposed monitoring and baseline studies are presented as Appendix C of the Supplement.

All decommissioning activities will be subject to review and approval by the responsible regulatory agency. Details regarding the infrastructure to be removed will be subject to a consultation and approval process.

Other Issues

4.17.1 Light, noise and vibration

Light, noise and vibration have the potential to impact marine fauna during the installation of the WHP. The use of heavy motors and other construction activity will generate noise and vibration, which may attract marine fauna such as cetaceans. Artificial lighting enabling work to continue during the hours of darkness and serving as warning lights for approaching shipping will also potentially attract marine fauna and avifauna to the facility.

Section 8.2.1.3 of the DEIS provides information on research related to assessing potential environmental impacts of noise, light and vibration on marine species. The

following sections provides information from the DEIS and additional information relevant to this assessment.

Light

Research has established that light spill from facilities located offshore or on the coast may attract turtle hatchlings, nesting turtles (McFarlane1963; Philibosian 1976; Witherington 1992) and seabirds (Woodside, 2002).

The facility is 500km from the nearest known turtle hatchery on Croker Island. Light from the facility is therefore unlikely to affect turtle hatchlings. There is potential for nesting turtles and seabirds attracted by facility lighting to remain in the vicinity during the hours of darkness. Seabirds likely to be impacted will be migratory species protected under international conventions such as the Chinese Australia Migratory Bird Agreement or the Japan Australia Migratory Bird Agreement. Seabirds are likely to continue on their migratory paths after resting at the facility overnight or over a few days. Marine turtles may be disoriented by the lighting at the facility. The proponent has undertaken to investigate lighting controls to minimise this possibility.

Noise and vibration

Noise vibration generated by installation and construction activities has the potential to either disturb behavioural responses of marine fauna or attract marine fauna to the facility. Marine mammals and fish extensively use sound for navigation, social or reproductive behaviour, feeding, predator avoidance or perception of surroundings (McCauley, 1994). Depending on the duration and intensity, noise associated with construction and installation activities has the potential to impact the use of sound by marine fauna. The construction and installation of not only the WHP but all infrastructure associated with the project should be considered with regard to critical lifecycle stages for marine fauna.

Decommissioning

Disturbances during decommissioning would be of short duration. The sources of disturbance would be cutting of infrastructure and vessel movements. If decommissioning of the facility involves removal of the export pipeline, noise will be generated from cutting the pipeline into lengths suitable for transportation. Information on anticipated noise levels or duration of impact has been not been provided. Noise resulting from decommissioning of the pipeline will be limited to acute temporal exposure for territorial marine species.

The proponent has identified that marine species such as cetaceans, fish and turtles potentially impacted by noise associated with decommissioning would be likely to avoid the area (Woodside 2001). Disturbance resulting from noise or vibration is considered to be short term, potential negative impacts of minor consequence (Woodside, 2001).

The environmental monitoring programme should include marine organisms to determine the impacts of noise, vibration and light (see Recommendation 8 on page 72).

4.17.2 Marine pests

The proponent has acknowledged that discharge of ballast water and bio fouling attached to the hulls of vessels may introduce exotic species to the project site. It has also been identified that species translocated from similar marine environments to the project site are considered to have an improved potential for successful colonisation.

Submissions requested more information on frequency of vessel movements, vessel types and ballast water management. Section 8.6.2.2 of the DEIS and Section 3.8.1 of the Supplement provide information on the above issues. The type and number of support and product transport vessels will depend upon the development options, whether gas is processed offshore or onshore. The proponent states that all vessels will be required to meet world and national maritime standards with regard to health, safety and environmental performance.

The proponent has committed to the following in relation to management of ballast water.

- Preparation of a project specific ballast water management plan for incorporation into the commissioning and operation EP.
- Compliance with Australian Quarantine and Inspection Services mandatory requirements for ballast water management; and
- Monitor for introduced pest species on platforms and the FSO.

If introduced marine species are detected during biennial monitoring the proponent has committed to consultation with the following agencies in relation to an eradication program:

- CSIRO's Centre of Research on Introduced Marine Pests;
- DBIRD's Aquatic Pest Management Unit; and
- Environment Australia's Marine Group.

The environmental monitoring programme shall include monitoring to establish over time the presence of marine pests (see Recommendation 8 on page 72).

4.17.3 Socio-ecomonic impacts

The Sunrise and Troubadour gas fields are located outside the Australian Fishing Zone. However, the activities conducted within the project area have the potential to indirectly impact commercial fishing operations.

The DEIS includes information on the Commonwealth, State and Northern Territory managed commercial fishing regions in the vicinity of the project. The fisheries regions are identified below:

- Western Tuna and Billfish Fishery;
- Spanish Mackerel Fishery;
- Northern Territory Timor Reef Fishery; and
- the Northern Prawn Fishery.

(Woodside 2001)

The Timor Reef and Northern Prawn Fisheries are located 75km to the southeast. The proposed pipeline route traverses the western sector of the Timor Box Fishery and encroaches within the northwestern sector of the Northern Prawn Fishery. The pipeline corridor also extends within the central Western Tuna Billfish Fishery and Spanish Mackerel Fishery.

The proposed site for the WHP and PCUQ is in an area identified by the DBIRD's Fisheries Group as having low levels of commercial fishing activity (Woodside, 2002).

The 500m exclusion zone around the processing facility will not impact any commercial fishing activity on Sunrise Banks. The proponent through consultation with the Fisheries Group has indicated that commercial fishing on the continental shelf where the processing facilities will be located is unlikely (Woodside, 2002).

Section 7.10 of the DEIS refers to the Timor Reef Gold Band Snapper Fishery. When the DEIS was prepared the only fishing methods used in this area were droplines. The DEIS indicates that commercial fishers target Goldband Snapper along the sides of shoals and on light rubble substrate. However, since the DEIS was prepared there has been a rapid conversion in fishing methods from droplines to traps which are now used by all but one operator. The result has been that fishing activity has expanded to a much wider area than previously identified. Some operators are regularly targeting fish in the western sector of the fishery in the Margaret Harries Banks area. This appears to be near the area of the proposed pipeline route. It is not stated what distance the exclusion zone will be from the pipeline. It is anticipated that the exclusion zone will be one of the concerns of the fishing industry. (pers comm J Lloyd 2002)

Section 2.3.1 of the DEIS provides information on the protection mechanisms proposed for the pipeline to avoid damage from vessels. The pipeline route will be marked on maritime and navigational charts and an anchoring exclusion zone is proposed during construction of the pipeline (Woodside, 2001).

The proponent also intends to undertake extensive consultation with relevant stakeholders including the NT Seafood Council to identify protection measures for the pipeline in conjunction with minimising impacts on commercial fishing (Woodside 2001). Consultation with commercial fishermen should be undertaken with the objective of establishing if there is limited available habitat for commercial fish species and whether these areas are evenly distributed over the extent of the fishery. Exposed light rubble and the sides of shoals are potentially important to the continued viability of commercial fishing activity in the Timor Reef Goldband Snapper Fishery. To this end, careful consideration should be given to selection of the final pipeline corridor.

The proponent, in section 2.3.1 of the DEIS, has indicated that traditional fishing is likely to occur in the vicinity of the project area given the site is approximately 150km from Timor (Woodside, 2001).

The rights of traditional fishermen have been acknowledged by the Australian Government through the signing of the 1974 Memorandum of Understanding with Indonesia (MOU 1974). The MOU 1974 permits Indonesian traditional fishers using traditional fishing methods to fish within defined areas of the Australian Fishing Zone (Heyward, Pinceratto and Smith 1997). Agreed traditional fishing areas, as identified in Heyward et al, 1997, are located to the immediate south of the proposal site. In this location traditional fishers are likely to be targeting shark (Heyward et al, 1997). Traditional fishing activity is usually conducted between the months of April to December (Apatuah, 1996).

The proponent has identified that the activities of traditional fishers are conducted in 'reef areas' rather than the project area (Woodside, 2002). As a consequence, the proposed exclusion zone of 500m around the project facilities is not expected to affect the activities of traditional fishers

Previous interactions between the proponent and traditional fishers have been occasional approaches to the Northern Endeavour FPSO, located in the Timor Sea. Traditional fishers have sought, amongst other things, medical assistance and fresh water from the FPSO (Woodside 2002).

In response to public submissions, the impact of the project on traditional fishing will be incorporated into a proposed additional study by the Greater Sunrise joint venture. The additional study will consider the potential social and economic impacts of the project on East Timor, the Northern Territory and Australia (Woodside, 2002).

Section 2.3.1 of the DEIS identifies that two shipping lanes are located to the west of the proposal site. The site itself is not anticipated to impact shipping activities in the Timor Sea. However, the proposed pipeline route crosses both shipping lanes (Woodside 2001).

With implementation of the following measures there should be no impact on commercial shipping:

- the facility will be well lit at night;
- a safety zone of 500m will be maintained around the facility; and
- the facility will be marked on maritime charts and warnings will be issued to mariners (Woodside, 2002).

4.17.4 Heritage Impacts

The proponent has identified listed heritage sites in the vicinity of the proposal site, which may be impacted by the installation, construction, commissioning, operations or decommissioning activities.

- The Northern Territory Heritage and sites registers held by Heritage Conservation Services of the Department of Infrastructure Planning and Environment;
- The Register of the National Estate;
- Site register held by the Northern Territory Branch of the National Trust; and
- Northern Territory Shipwreck database.

The investigation identified that heritage sites " have been avoided and no adverse impact is expected" for the proposed action (pp 6-11 Woodside, 2001).

4.17.5 Conservation Reserves and National Marine Parks

In the DEIS the proponent as identified that Ashmore Reef National Nature Reserve is the nearest park being 240km to the southwest of the proposal site. Cartier Marine Reserve is a further 300km to the southwest.

Other marine sites identified are within Indonesian waters, the closet being 1,400km to the northwest (Woodside 2001).

As identified by the proponent and after a review of discharge modelling, it is acknowledged that the distance to the identified marine reserves and national parks, precludes intentional or accidental marine discharges from the proposed development adversely impacting on areas set aside for conservation.

Environmental Management Plan

An integral part of the environmental management of the SGP will be the preparation and implementation of Environment Plans (EP) for each stage of the project. The project stages being construction and installation, drilling, commissioning, operation and decommissioning.

4.18.1 Environment Plans

Section 9.2.1 of the DEIS provides an outline of the proposed contents of environmental plans (EP) to be prepared after the completion of the environmental assessment process and final project concept. The EP's are to be prepared pursuant to the *Petroleum (Submerged Lands) Act 1967* (P (SL) Act) and its associated regulation the *Petroleum (Submerged Lands) (Management of Environment) Regulations 1999* (P (SL)(MOE)).

The EP is an activity specific document that provides details on the proposal such as location, the receiving environment and the environmental effects of identified operations. The EP also establishes the environmental performance objectives, identifies standards to be met and criteria to measure environmental performance. In addition, the EP includes an implementation strategy. The implementation strategy identifies operational systems, roles and responsibilities, practices and procedures to ensure that the environmental effects and risks associated with the activity are reduced to as low as reasonably practicable (ALARP).

Environmental performance objectives, environmental performance standards and measurement criteria provided in the EP are the major mechanism to ensure that the operator is adhering to stated environmental management strategies in accordance with the ALARP principle.

Prior to commencement of each activity the EPs will be reviewed by the DBIRD for compliance with the provisions of the P (SL)(MOE). Each EP will also be reviewed by the Office of Environment and Heritage (OEH).

Overall environmental management commitments for the Sunrise Gas project are provided in Tables 9.1 to 9.5 of the DEIS and Table 3-16 of the Supplement. These tables of commitments are presented as Appendix 5 of this assessment report.

As part of its role, DBIRD will also undertake environmental auditing of the environmental management system implemented to comply with agreed environmental performance objectives identified in any EP for the project. This will be achieved through:

- investigation of incidents;
- review of statutory and arranged reports; and
- on-site auditing.

In response to a submission regarding the absence of a reference to preparation of an EMP, monitoring and reporting commitments in the DEIS, the proponent has respond by stating that a management system for documenting monitoring and reporting requirements will be outlined in the project EPs. Reporting will include the findings of auditing activities, monitoring results and environmental incidents.

Each EP has a statutory timeframe of 5 years before it is reviewed although the Regulating Agency can request a review earlier.

The proponent stated that the environmental management system for the project will be consistent with the following:

- AS/NZ ISO 14001 Environmental management systems – Specification with guidance for use;
- All relevant laws and regulations for the protection of the environment; and
- The Greater Sunrise Joint Venturers HSE management system.

(Woodside, 2002)

In response to submissions, the environmental management system proposed for each activity will include but not be limited to the following:

- Comprehensive training and induction incorporating environmental awareness and management for staff and contractors;
- Roles and responsibilities of staff defined in relation to environmental management;
- Environmental competencies written into job descriptions including legislative requirements;
- Incorporation of regular training drills for emergency response;
- Facilitation for regular internal and external environmental reviews;
- Review procedures to facilitate change management;
- Procedures for maintenance, review, tracking and close out of items on the project hazard register;
- Review of compliance with legislative requirements; and
- Reporting arrangements for environmental incidents.

In response to a submission, reporting environmental incidents to the public is not required under the P (SL)(MOE). If a reportable environmental incident occurs such as an oil spill, the proponent is required to notify DBIRD as the responsible agency.

4.18.2 Monitoring

Submissions have requested further information on emissions and discharges that will be monitored and how the results will be used to improve environmental management.

A preliminary monitoring program is provided as Appendix C, Volume 1 of the Supplement. The final monitoring program will be incorporated into the environment plans submitted for assessment and acceptance by the Designated Authority.

The proponent has indicated that monitoring will be conducted for the following proposed levels of environmental management:

- internal systems and procedures implemented to mitigate environmental risk;
- discharges and emissions which may result in adverse environmental impacts; and
- physical, chemical and biological responses to discharges and emissions.

Baseline monitoring

Baseline monitoring will be conducted prior to the commencement of installation of construction activities. As identified in the Supplement the baseline monitoring program will characterise and provide quantitative biological, physical and chemical data, which will be used to measure environmental performance.

Water quality parameters identified by the proponent may include:

- Water temperature and salinity variation within the first 30 metres of the water column;
- Hydrocarbon concentration at the surface and free phase and dissolved hydrocarbons concentration within the first 5 metres of the water column;
- Heavy metal concentrations of cadmium, copper, chromium lead, nickel and zinc at the surface and within the first 5 metres of the water column; and
- Nutrients (total nitrogen, total phosphorous, orthophosphate, nitrate and nitrite) at the surface and within the first 5 metres of the water column.
  (Woodside, 2002)

Variations of greater than 10% from the baseline data will prompt a management response to investigate the reasons for the discrepancy. (Woodside, 2002)

Components of the baseline survey will be finalised on selection of the final development concept. The baseline study will not include the pipeline routes as these have been previously surveyed. Baseline studies will include selected shoals and areas of benthic habitat similar to that within the footprint of the project area. Other baseline monitoring will include metocean surveys (already ongoing).

The outcomes of baseline monitoring prior to commencement of the activity will assist the proponent in establishing relevant environmental parameters for measurement and appropriate temporal and spatial framework on which to base monitoring schedules.

It is suggested that dissolved oxygen be considered for inclusion in monitored water quality parameters to establish local oxygen concentration and provide information on biological and chemical oxygen demand associated with PFW discharges.

Discharge and emissions monitoring

Monitoring of the following emissions and discharges to the environment will be undertaken:

- Drill cuttings;
- Drilling fluids;
- Hazardous wastes;
- Non hazardous wastes;
- Cooling water;
- Hydrotest water;
- Produced formation water including production chemicals;
- Slops discharges;
- Sewerage and greywater;
- Sub sea control fluids;
- Flaring emissions; and
- Machinery exhausts.

(Woodside, 2002)

Some of the above emissions may not be measured directly, therefore, estimates based on stoichiometry or other methods shall be used.

Under the National Environmental Protection Measure for the National Pollution Inventory the proponent will be required to report to the National Environmental Protection Council if usage or emissions of listed substances trigger reporting thresholds.

The proponent has identified that the following substances may require reporting annually to the National Environmental Protection Council.

- Nitrogen dioxide (NOx)
- Carbon monoxide;
- Sulphur dioxide;
- Particulates; and
- Benzene, ethyl benzene, toluene and xylene.

(Woodside, 2002)

Other monitoring

In response to a submission the proponent has stated that it is not possible to monitor all species that may transit the project area including listed endangered or vulnerable species. Reporting of cetaceans will be conducted on an opportunistic basis and will not be part of a regular scheduled monitoring program. Sightings of whales and other cetaceans will be reported to Environment Australia's marine species section.

Marine pest surveys will also be conducted. See Section 4.17 of this assessment report for further details.

Details of monitoring to be conducted for the decommissioning phase of the project are outlined in section 4.23 of this assessment report.

Section 4.18.1 of this assessment report recommends that discussions be undertaken with the Fisheries Group of DBIRD and the NT Seafood Council regarding the proposed pipeline route. During theses discussions it is also considered appropriate that potential monitoring of the impacts of the pipeline on commercial fishing be discussed and resolved.

A submission requested if monitoring of marine sediments was to include analysis for tributyltin. Two reasons were provided why analysis for tributyltin would not be conducted. Section 8.6.2.2 of the DEIS indicates that international marine laws have been drafted controlling the presence of tributyltin on vessels which is to be phased out by 1 January 2008 with application to current marine vessels ending by 1 January 2003 (Woodside 2001). It should be noted that the "International Convention on the Control of Harmful Anti-fouling Systems for Ships" which incorporates the phasing out of TBT has now been adopted. The proponent has also identified that water depth and currents at the project site will facilitate some aerobic degradation in the water column and dilution of tributyltin.

Recommendation 8

The environmental monitoring program shall, in addition to the relevant commitments include:

- **Sampling of benthic species to establish rates of degradation of residual drilling fluids and recolonisation of drilling cuttings piles;**
- **Monitoring for marine pests;**
- **Monitoring of marine organisms to determine impacts of light, noise and vibration; and**
- **Dissolved oxygen should be considered for inclusion in the water quality monitoring.**

5 CONCLUSION

It is considered that the environmental issues associated with the project have been adequately identified. Some of the issues have been resolved through this assessment process, while the remainder will be addressed through the environmental plans required for the installation, construction, commissioning, operational and decommissioning phases of the SGP. Acceptance of environment plans will be subject to review by DBIRD in consultation with other relevant Northern Territory and Commonwealth Government agencies.

Initially, the EIS and recommendations detailed in this Assessment Report will form the basis for Woodside Energy's management and monitoring commitments. The environmental plans prepared in compliance with the *Petroleum (Submerged Lands) (Management of Environment) Regulations 1999* (P (SL)(MOE)) will be working documents for each phase of facility development.

Based on the review of the draft Environmental Impact Statement and the Supplement and Addendum in which the proponent responds to issues raised by relevant NT Government agencies and the public it is considered that the Sunrise Gas Project can proceed. The Project can be developed and managed in a manner that avoids unacceptable environmental impacts provided the commitments and safeguards made by the proponent are implemented, the recommendations and suggestions in this Assessment Report are adopted and regular reviews and reporting are undertaken.

A summary of the potential environmental impacts

Discharges to the marine environment

Drill cuttings

Studies conducted in the North Sea have indicated that benthic areas impacted by drill cuttings with residual ester based muds have been recolonised within 12 months. Benthic organisms impacted by smothering of the benthos with drill cuttings discharged from the WHP are excepted to recolonise covered areas in the short term. However, site specific data on re-colonisation after re-smothering should be included in short and long term monitoring commitments. Monitoring should also include cumulative environmental impacts of discharges to the marine environment to verify statements provided in the final EIS.

Water based and residual ester based drilling fluids

Toxicity data on the constituents of water based and ester based drilling fluids which indicates that environmental risk associated with discharge of water based drilling fluids and residual ester based mud adherent to drill cutting at the project site is acceptable. This statement must be qualified by identifying that some of the toxicity data provided in this report is derived from testing conducted on non-Australian marine species and under different environmental parameters than those experienced in the Timor Sea. Therefore, the results of toxicity testing on non-Australian species should be taken as indicative only. Studies have identified that change in water

temperature and oxygen availability may alter metabolic rates and potential chemical of concern uptake rates in fish.

Hydrocarbons and production chemicals entrained in produced formation water

In the worst case scenario, that being calm conditions during slack water (turn of the tide), modelling of production chemicals entrained in produced formation water (PFW) indicates that impacts associated with chemical toxicity would not be experienced further than a radial distance of 15 metres and at a depth of 3.3 metres below the point of PFW discharge. Marine organisms unable to move out of the zone of impact may be effected and severity would depend on residence time and dosage.

Hydrotest water

Toxicity testing conducted on hydrotest chemicals indicate that the discharge criteria proposed by the proponent need further justification. Risk-based criteria will be used for the assessment of impacts associated with the discharge of hydrotest water. Investigations into the concentration of biocide expected to be released into the environment at the time of discharge should be undertaken.

Sewerage, greywater and foodscraps

Nutrient loading resulting from sewerage and foodscraps is not expected to result in localised or regional environmental impacts. Increased availability of nitrogen and phosphorous in the oligotrophic waters surrounding the proposal site will be mitigated by water depth at point of discharge, the expected small volume of the discharge, rapid dispersion/dilution, biodegradability of the material discharged and distance from sensitive environmental receptors.

Cooling water

The environmental impacts of the discharge of cooling water from the PCUQ have been identified as mortality of plankton and potentially fish unable to move out of the zone of influence. Sessile organisms attached to platform legs in the proximity of continuous water temperature variations in the vicinity of the discharge caisson may also be impacted.

Modelling indicates that the nearest sensitive environmental receptors to the cooling water discharge point, ‘the Lump’ (5km) and the Sunrise Banks (18km) are unlikely to be impacted by localised water temperature variations as a consequence of cooling water discharges.

Loss of containment of hydrocarbons

Hydrocarbon releases to the environment are not anticipated to impact shorelines or emergent reefs due to high degradation rates and spill trajectories. However, shallow water environments in an arc from the southeast through to the southwest of the project site may be impacted by the passage of dissolved aromatic plumes. These sites being Sunrise Bank and Sunset, Loxton and Martin Shoals in the summer period, Bellona Bank and Echo Shoals during winter and Sunrise Bank during the transitional

period. The highest concentration of dissolved aromatic hydrocarbons during any event is predicted as 40 parts per billion at any time of year. Sedimentation of total petroleum hydrocarbons at the above banks or shoals is predicted at less than 0.0001 grams per square meter.

Oil spill contingency plans in conjunction with emergency response plans will be prepared for all stages of the project.

Discharges to the atmosphere

Section 4.7 of this assessment report provides quantification of atmospheric emissions including carbon dioxide, other greenhouse gases and non-greenhouse gas emissions. In response to submissions on the subject of greenhouse gas emissions, issues considered in the report include lifecycle comparisons with alternative fuel sources, greenhouse gas emission inventory, comparison of greenhouse efficiency with similar projects, product lifecycle, minimisation and mitigation measures, opportunities for offsetting emissions, global greenhouse gas issues and impacts due to flaring and pipeline rupture.

The report recommends that regular greenhouse audits, a review of new technologies to identify opportunities to reduce emissions with a view to achieving international best practice in terms of carbon dioxide equivalent emissions per unit of production be conducted. Opportunities for offsetting greenhouse gas emissions, including support for relevant research should also be considered.

Waste disposal

Waste management will be dependent on the final development concept for the SGP. If FLNG is the market for Sunrise Gas waste generated by the remaining components of this proposal, those being the well head platform and the subsea infrastructure, will be taken to the FLNG for disposal onshore. If gas to shore proceeds waste will be transported to shore for processing at Hudson Creek Supply Base. A waste management plan will be prepared for the project, which will include details on waste segregation, handling procedures for non hazardous and hazardous wastes and expected waste types, storage and end use. The proponent will need to conduct further consultation with the owners/operators of suitable waste facilities to ensure the future receiving capacity is sufficient for the categories and volumes of waste expected over the lifetime of the project.

Subsequent to characterisation of naturally occurring radioactive materials from the field, disposal options (if any) will require discussion with relevant Northern Territory government agencies.

Vessel movements

The proponent has acknowledged that discharge of ballast water and bio fouling attached to the hulls of vessels may introduce exotic species to the project site. Monitoring of facility infrastructure will be conducted and management strategies compliant with Australian Quarantine and Inspection Service mandatory ballast water exchange requirements included in environment plans for each phase of the project.

Infrastructure siting

The impacts of the proposed pipeline corridor on fishing activity depend on the location of the pipeline in relation to the habitat of commercial species. Studies have indicated that within the Timor Sea region there is limited available habitat for commercial fish species and that these are not evenly distributed over the areal extent of the fishery. Exposed light rubble and the sides of shoals are therefore important to the continued viability of commercial fishing activity in the Timor Reef fishery. To this end, careful consideration should be given to selection of the final pipeline corridor. When finalising the pipeline alignment, the proponent shall consult with the Fisheries group of the Department of Business, Industry and Resource Development and the NT Seafood Council.

The 500m exclusion zone around the processing facility will not impact any commercial fishing activity on Sunrise Banks.

Hazard analysis and environmental risk assessment conducted for the EIS have been preliminary due to the uncertainty regarding the final development concept. The results of assessment to date have concluded that environmental risk associated with the project is low and therefore acceptable subject to implementation of mitigation strategies. On selection of a final development concept further detailed analysis of environmental risk should be conducted for the preparation of environment plans for each phase of the activity.

Due to limited baseline data for the project site additional information on the biological and physical environment is required to refine modelling parameters and quantify statements regarding environmental risk. Baseline studies should be commenced well in advance of the installation and construction phase to permit the proponent to identify spatial and temporal scales for monitoring of marine species for environmental impacts. Detailed information on the physical and biological environment will be required for inclusion in environment plans. It is acknowledged that the proponent has already conducted some metocean studies for the project site.

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Woodside (2002a) *Sunrise Gas Project Draft Environmental Impact Statement Addendum to Supplement*. Prepared by Sinclair Knight Merz Pty Ltd, October 2002, Perth, Western Australia.

APPENDIX 1 List of respondents to the DEIS

Submission No	Name	Organisation	Territory
1	Tim Pritchard	Environmental Defenders Office (NT) Inc	NT
2	Margaret Clinch	Planning Action Network	NT
3	Mark Wakeham & Kirsten Blair	The Environment Centre NT Inc	NT
4	Linda Cuttriss	WWF Australia World Wide Fund for Nature	NT
5	Greg Chapman & Diana Rickard	Private submission	NT
6	Justin Tutty	The Australian Greens	NT
7		Northern Territory Government	NT
8		Environment Australia	Commomwealth

APPENDIX 2 Issues raised in Submissions

Issue	1#	2	3	4	5	6	7	8	Total
Environmental Assessment Process									
Designation under *Commonwealth Environmental Protection (Impact of Proposals) Act 1974* rather than *Environment Protection and Biodiversity Conservation Act 1999*	*								1
Final decision on conditions set by Northern Territory or Commonwealth	*								1
Limitations of assessment under the *Environmental Assessment Act* and Northern Territory Government involvement given changes in project scope.	*								1
EIS guidelines (requirement to amend and subsequent confusion in proposal scope)	*								1
Scope of the EIS (final scope unknown)	*		*	*					3
Structure of the EIS (improvement to establish what is proposed)	*								1
Discussion of options (offshore development, no development and alternatives)		*	*				*		3
Assessment process including identification of responsible agencies for approval /acceptances.						*	*		2
Inclusion of studies supporting the draft Environmental Impact Statement (DEIS)							*		1
Public participation and community consultation (including public review period)	*	*	*	*		*			5
Identify environmental criteria/parameters used for preferred site selection and other favoured options.							*		1
Availability of EIS					*		*		2
Environmental Impacts									
Greenhouse gas emissions (greenhouse agreement/strategy, comparative emissions with other similar projects, quantification and offset measures including CO_2 sequestration vegetation sinks and renewable technologies and use as customer selection criteria)	*		*	*	*	*	*	*	7
Non-greenhouse gas emissions							*		1
Modelling assumptions and requirement for representative environmental parameters for enhanced ecological risk assessment							*		1
Inadequate discussion of impacts	*			*					2
Drilling cuttings (including not all impacts identified)	*			*			*		3
Drilling fluids (including environmental significance, biodegradation, toxicity, modelled discharges from WHP not conducted for subsea wells)	*			*			*		2
Well control/well testing (further explanation)							*		1
Reinjection of drill cuttings and drilling muds				*			*	*	3
Rock armour (environmental assessment of material sources)	*								1
Decommissioning (infrastructure to remain, current international practice, environmental impacts of residual liquids)	*			*			*	*	4
Severe weather data (including impacts of global warming)			*			*	*		3
Establish zone of influence regarding direct environmental impacts resulting from installation, construction, operation and decommissioning.							*		1
Biological environment additional information required			*				*	*	3
Loss of habitat			*		*				2
Threatened species (migration paths)			*				*		2

Issue	1#	2	3	4	5	6	7	8	Total
Accidents			*						1
Dilution of pollutants	*		*						2
Long term impacts (including benthic bioaccumulation)	*		*			*	*	*	5
Impacts of discharges to sea (including discharge limits and plumes)				*	*		*	*	4
Ballast water and introduced marine pests				*			*	*	3
Produced formation water (selection criteria for reinjection options, monitoring, naturally occurring radioactive materials (NORM))			*	*			*	*	4
Antifouling paints on tankers and other vessels			*	*					2
Sewerage, greywater/blackwater and food scraps				*					1
Noise, vibration and light impacts			*	*			*		3
Impacts of hydrocarbon spills			*	*			*	*	4
Waste management (including reuse, minimisation and recycling)				*			*		2
Environmental hazard/risk assessment (event probabilities and mitigation measures and risk to population of Darwin)		*					*	*	3
Cumulative Impacts (including combined contribution of upstream and downstream processing)	*		*	*			*	*	5
Cooling water (impacts of increase in temperature on chemical metabolism in marine organisms)			*				*	*	3
Pipelines (including scouring, decommissioning, route selection and Det Norske Veritas pipeline guidelines)							*	*	2
Hydro-test water (chemical constituents, toxicity, bioaccumulation, persistence and pipeline drying)	*						*	*	3
Mitigation measures									
Use of renewable energy sources as option							*		1
Selection criteria of use and effect of greenhouse emissions abatement options								*	1
Training and competency (emergency safety and best practice implementation, regular refresher training to be conducted as part of environmental management system)				*		*	*		3
Environmental monitoring, auditing , reporting and hazard /safety review (transparency and availability of results, quantification and changes recorded for determination against performance criteria)				*			*		2
Environmental impacts and mitigation measures (Implementation in EMPs)				*			*		2
Spill prevention (including revision of oil spill contingency plans and mitigation of product transport impacts)				*			*		2
Preferential use of low toxicity chemical for project.							*		1
Need for further research (identification of environmental management strategies, lack of information for decision makers)				*			*	*	3
Baseline studies to be undertaken before installation commences							*		1
Socio-economic									
Rush to develop resource does not consider future domestic requirements and undervalues the resource						*			1
Development of gas resources should not be undertaken on premise of the East Timorese requirement for funds.						*			1
Use of gas for domestic purposes						*			1
Traditional fishers (more research on impacts of proposal)			*						1
Commercial fishing (interference and monitoring of impacts)							*		1
Commercial shipping (interference with vessel movements)							*		1
Self regulation, self monitoring and accountability				*					1

Issue	1#	2	3	4	5	6	7	8	Total
Environmental Management plans (EMP) (description of function)							*		1
Commitments to be formalised in EMPs in accordance with final EIS and assessment report.							*		1
Applicable NT legislation and land use planning							*		1
Socio-economic benefits of Darwin harbour including loss of visual amenity and beneficial use.		*							1
Request to comment on future expansion in relation to the project including EIS on use of fuel						*	*		2
Commitments regarding discovery of heritage sites							*		1
General									
Accuracy of information provided in the DEIS							*		1
Rational for maintenance scheduling							*		1
Revision of quantification of reserves							*		1
Trade waste and bulk waste agreements							*		1

 # Respondent number (refer to Appendix 1)

APPENDIX 3 Locations where Draft EIS was on public review

- DIPE Ground Floor, Cavenagh House, Darwin, NT;
- Darwin Public Library, Civic Centre , Harry Chan Avenue, Darwin, NT;
- Casuarina Public Library, Bradshaw Terrace, Casuarina, NT;
- Palmerston Public Library, Civic Plaza, Cnr University Avenue and Chung Wah Terrace, Palmerston, NT;
- Litchfield Shire Offices,, 7 Bees Creek Road, Bees Creek, NT;
- Environment Centre 3/98 Woods Street, Darwin, NT;
- Environmental Defenders Office, 8 Manton Street, Darwin, NT;
- Environment Australia Library, John Gorton Building, King Edward Terrace, Parkes, ACT;
- Northern Territory Library, Parliament House, Cnr Bennet and Mitchell Streets, Darwin, NT;
- State Reference Library of Western Australia, Alexander Library Building, Perth Cultural Centre, Northbridge, WA;
- National Library of Australia, Parkes Place, Parkes, ACT;
- State Library of New South Wales, Macquarie Street, Sydney, NSW;
- State Library of Queensland, South Bank Building, Cnr Peel and Stanley Streets, South Brisbane, Qld;
- State library of South Australia, North Terrace, Adelaide, SA;
- State Library of Tasmania, 92 Murray Street, Hobart, Tas; and
- State Library of Victoria, 328 Swanston Street, Melbourne, Vic.

Electronic copies of the EIS were also available at the following websites:
www.lpe.nt.gov.au/eia
www.woodside.com.au

APPENDIX 4 SUMMARY OF ENVIRONMENT MANAGEMENT PLANS AND COMMITMENTS IN FINAL EIS

(Where not stated, tables sourced from Woodside, 2001)