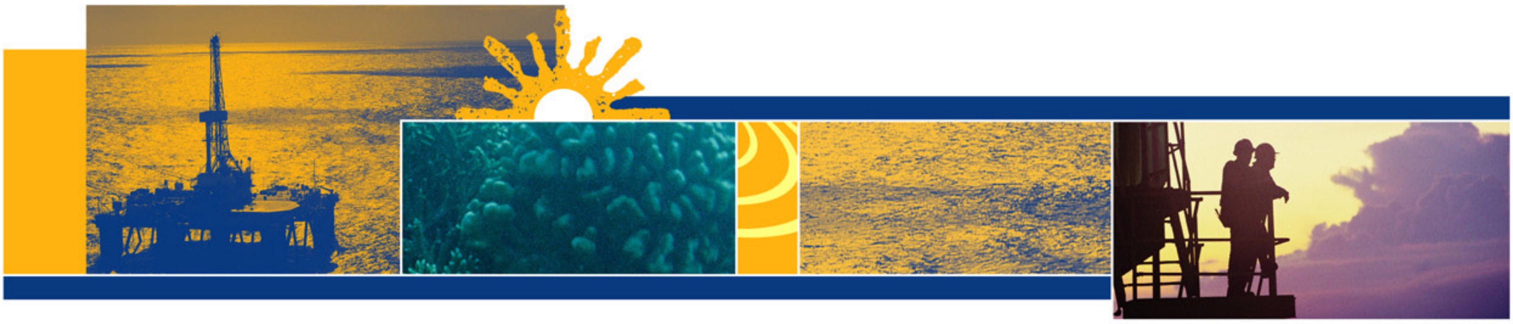
SUNRISE
GAS PROJECT



Draft Environmental Impact Statement

December 2001

WOODSIDE
AUSTRALIAN ENERGY
ABN 63 005 482 986

SINCLAIR KNIGHT MERZ

Draft Environmental Impact Statement

For Woodside Energy Ltd

December 2001

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Sunrise Gas Project
Draft Environmental Impact Statement

PUBLIC COMMENT INVITED

On behalf of the Sunrise Gas Project Joint Venture, Woodside Energy Ltd proposes to develop the Greater Sunrise gas condensate fields located approximately 450 km north west of Darwin in the Timor Sea. As part of the development process an Environmental Impact Statement (EIS) has been prepared and is now available to the general public for comment. The proposal is to install the necessary offshore infrastructure required for gas field development. The key commercial markets for the raw wellstream is likely to be Liquefied Natural Gas (LNG) which will be processed either onshore or offshore.

The environmental assessment of the proposal is being conducted under the Northern Territory *Environmental Assessment Act 1982* and the Commonwealth *Environmental Protection (Impact of Proposals) Act 1974.* Under a cooperative arrangement and in accordance with the provisions of both Acts, the Draft EIS describes the project proposal, and addresses the potential environmental impacts and how these impacts can be mitigated as a result of the Sunrise Gas Field development. This document will be available for review from 15th December 2001 until 9th February 2002 at the following locations:

- ☐ Department of Infrastructure, Planning and Environment (DIPE), Ground Floor, Cavenagh House 38 Cavenagh Street, 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 & 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
- ☐ State Libraries
  - Northern Territory Library, Parliament House, Cnr Bennett & Mitchell Streets, Darwin
  - State Reference Library of Western Australia, Alexander Library Building, Perth Cultural Centre, Northbridge
  - National Library of Australia, Parkes Place, Parkes
  - State Library of NSW, Macquarie Street, Sydney
  - State Library of Queensland, South Bank Building, Cnr Peel & Stanley Streets, South Brisbane
  - State Library of South Australia, North Terrace, Adelaide
  - State Library of Tasmania, 91 Murray Street, Hobart
  - State Library of Victoria, 328 Swanston Street, Melbourne

The report can be examined for the duration of the public review period either on DIPE's Internet site at www.lpe.nt.gov.au/eia or on Woodside's Internet site at www.woodside.com.au. Persons wishing to comment on the EIS are invited to make written submissions by close of business on 9th February 2002 to:

Lisa Banks
Environment and Heritage Division
Department of Infrastructure, Planning and Environment
GPO Box 1680
DARWIN NT 0801
Email: lisa.banks@nt.gov.au
Fax: (08) 8924 4053

Submissions will be treated as public documents unless confidentiality is requested. Copies of all submissions will be forwarded to Woodside Energy Ltd. Written submissions should be typed in black on A4-sized paper.

A version of the draft EIS is available either in hard copy (purchase price $30.00) or CD Rom (Free of charge) from the following location:
Ms Lindy Lock
Sinclair Knight Merz
7th Floor Durack Centre
263 Adelaide Terrace
PO BOX H615
Perth WA 6001
Telephone (08) 9268 4400

Advertised in Classified – Public Notice, in following papers:
Litchfield Times (NT) - 12/12/2001
The Australian – 13/12/2001
Northern Territory News – 13/12/2001

Executive Summary

Introduction

The Sunrise Gas Project Joint Venture, operated by Woodside Energy Ltd (Woodside), proposes to develop the Greater Sunrise gas and condensate field which is located in the Timor Sea approximately 450 km north-west of Darwin and 150 km South of East Timor. Investigations indicate that the Greater Sunrise Gas Field has a 'Scope for Recovery' in the order of 9 trillion cubic feet of gas and 300 million barrels of condensate. **Figure ES1** shows the location of the Sunrise Gas Field and surrounding gas fields.

The Sunrise Gas Project is a joint venture between Woodside (Operator), Phillips STL Pty Ltd, Shell Development (Australia) Pty Ltd and Osaka Gas Australia Pty Ltd. Woodside Energy Ltd is a leading oil and gas company and one of Australia's most successful explorers, developers, and producers of hydrocarbon products. As a participant in, and Operator of, the North West Shelf Joint Venture, Woodside is directly responsible for the management of offshore and onshore assets worth more than $9 billion. On Western Australia's North-West Shelf, Woodside operates the North Rankin A and Goodwyn A offshore production platforms, the Cossack Pioneer Floating Production Storage and Offtake (FPSO) facility and the Onshore Gas Plant (OGP) on the Burrup Peninsula.

For the Sunrise Project this document addresses the environmental issues associated with the proposed offshore facilities, potential pipelines and related plant that have the potential to cause biophysical or social effects, or which are known to be of public interest. The document has been prepared to provide the Northern Territory Government, agencies of the Commonwealth of Australia and the public with the information necessary to enable an informed appraisal of the environmental acceptability of the proposed project.

Contact Details

The designated operator of the Sunrise Gas Project is:

Woodside Energy Ltd
1 Adelaide Terrace
Perth WA 6000

Legislative Framework and Regulatory Authorities and Agencies

As the Sunrise Gas Project requires assessment under both the Northern Territory and the Commonwealth environmental assessment legislation, the two government bodies have agreed to facilitate a joint assessment. As such both the Minister for the Environment (Commonwealth) and the Minister for the Environment (Northern Territory) have set the level of assessment for the project as an Environmental Impact Statement (EIS). Furthermore both governments have agreed that the Environment and Heritage Division of the Northern Territory Department of Infrastructure, Planning and Environment (DIPE) will take the lead role in the assessment process. The final guidelines issued for the project reflect the recommendations of both governments. The final documentation will be assessed by each jurisdiction, with each government making its own decision.

Approximately twenty percent of the Greater Sunrise reserves lie within the Zone of Cooperation, which was initially established in 1991 under treaty between the Australian and Indonesian governments to jointly exploit petroleum resources in adjacent territorial waters and which will be continue with the newly elected government in East Timor by means of the Timor Sea Arrangement

(TSA). However, the production facilities will be located largely within Australian waters and the Northern Territory and Commonwealth governments will comment on the EIS within the process outlined above.

All activities associated with the proposal will comply with the legislative requirements established under a combined Territory and Commonwealth Government framework under which the Project will receive environmental, planning and development approvals and authorisations.

Project Justification

Undeveloped reserves of gas contribute nothing to economic development and community living standards. For the economies and citizens of East Timor, the Northern Territory and the rest of Australia to benefit from the Greater Sunrise gas reserves in the Timor Sea, the fields must be developed and commercial sales made to customers.

Development and production of the gas and condensate will benefit the various economies through:

- The front end engineering and detailed design phases, where Australian and international expertise will apply the latest design concepts and technologies to design world class facilities;
- The construction phase when capital investments to produce, transport and process the gas are made; and
- The operations phase when gas is produced and used by customers.

The design phases will provide opportunities for skill and knowledge transfer essential to maintaining regional capability in the oil and gas sector. The construction phase will involve large expenditures concentrated over a short period on the purchase and installation of capital equipment and construction costs. Local construction and service industries will have the opportunity to support the installation of large capital items leading to a boost in short term jobs in the construction industries and in industries supplying inputs to construction.

Once the project enters its operations phase permanent jobs will be created in running the production facilities. The export of condensate and downstream products will generate income through foreign exchange. This will add to national income and the consumption prospects of the Australian and East Timorese communities.

The extraction of natural gas will add to the Commonwealth government's revenue directly through the Petroleum Resource Rent Tax levied on gas and condensate production and to the East Timor Government's revenue through the Production Sharing Contract provisions of the TSA. It will also add indirectly to both Northern Territory, East Timor and Commonwealth governments' revenue by expanding economic activity, employment, income, expenditure and hence the tax base in the Northern Territory, the rest of Australia and East Timor. This in turn will enhance the capacities of both governments to support desirable social expenditures, including infrastructure development.

The development of the Greater Sunrise gas and condensate fields will secure a long-term source of tax revenue for East Timor. Furthermore, there is the potential for East Timorese involvement in logistics and support operations to the offshore facilities. Direct employment opportunities on the facilities will also emerge for those who acquire the necessary skills through appropriate training.

Natural gas is a fuel which produces approximately half the greenhouse gas emissions of other fossil fuel alternatives on a lifecycle basis. In this respect, the development of natural gas supply for domestic and international markets provides tremendous opportunities for continued economic development in Australia and East Timor. To the extent that gas can be utilised in place of alternative fossil fuels, global emissions will be reduced in line with Australia's National Greenhouse Strategy.

Project Description

The Project scope includes the following major components:

- Construction and operation of offshore production wells production and processing facilities, and subsea infrastructure; and
- Construction and operation of a hydrocarbon pipeline from the Sunrise facilities to the Phillips Bayu-Undan gas export trunkline.

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.

Two main wellstream processing options are under consideration:

- Processing by way of processing, compression, utilities and quarters (PCUQ) facilities – the gas would be exported to Darwin via the main export pipeline to the proposed Darwin Liquefied Natural Gas (LNG) terminal or other potential customers **(Figure ES2a)**; and
- Wellstream exported directly to an offshore Floating LNG (FLNG) facility via a series of flowlines and risers – the LNG and condensate would be exported from the FLNG facility to available markets **(Figure ES2b)**.

The basis of the PCUQ option is a Production Jack-Up facility bridge-linked to the Wellhead Platform (WHP), both platforms being located in a water depth of 140–400 m.

This option provides for full offshore condensate separation, stabilisation and export, requiring the addition of an Floating Storage Offloading (FSO) facility located approximately 2 km from the PCUQ platform. Condensate production will be transferred to the FSO via an 8 inch subsea flowline. Trading tankers will receive condensate from the FSO on a regular basis, and the gas will be exported via pipeline to Darwin.

Figure ES3 shows that the offshore production facilities are designed to deliver two products; natural gas and condensate. There will be two process trains each having a capacity of 50%. The well production from the wellhead platform and the subsea wells will be manifolded on the wellhead platform and routed across the bridge to the PCUQ platform. All risers, subsea flowlines and export stabilised condensate to FSO vessel will be located on the wellhead platform. The facility will produce export gas routed to a gas pipeline, condensate product routed to FSO and produced water.

Under an OLNG scenario both the Sunrise and Bayu-Undan developments will share a section of export gas pipeline comprising approximately 319 km of export pipeline from a Wye piece to Wickham Point for use by potential gas customers. This shared section of pipeline has already been approved under a separate approval process.

Production from the Greater Sunrise field will commence when suitable gas markets have been established and approved by the appropriate regulatory bodies. This may be as early as mid 2006; however, this date is dependent on the establishment of suitable markets.

While it is recognised that the full field life may range from 30 to 75 years, no specific design allowance is made for extended facilities life beyond a nominal 30 years. Instead, the facilities would be managed and maintained to achieve the life required.

The FLNG option provides for full processing of the wellstream on a large moored barge, including the provisions of utilities, support systems and quarters for both the FLNG and Sunrise Upstream facilities, and for storage and export of both LNG and condensate. Both the Onshore LNG (OLNG) and FLNG plants fall outside the scope of approvals currently sought for the development of the Greater Sunrise gas fields and the installation of associated pipelines. FLNG and OLNG will be required to follow separate environmental approval processes.

Alternative Options

A broad range of alternatives have been considered by Woodside including:

- The "no-development" option;
- The location of the development sites and pipeline routes,
- Drilling and platform facilities; and
- Process technologies.

The failure to develop the Sunrise Gas Field may have adverse economic implications for Australia where the petroleum exploration and production industry is important to the national economy as a source of energy, employment and income. Similarly, no development would deny East Timor an opportunity to finance the rebuilding of one of the world's newest and poorest nations. The various economic benefits to both nations are outlined above.

The Sunrise Gas Project was initially a stand-alone project and therefore the early pipeline routes considered were based on a more direct route from Sunrise to landfall at Shoal Bay on the Gunn Peninsula, north-east of Darwin. However, following the agreement to co-operatively develop Timor Sea gas with Phillips (operator of the Bayu-Undan field), a number of pipeline routes were examined that extended from the Sunrise Gas Field to a 'Wye' junction with a pipeline from Bayu-Undan to Wickham Point in Darwin Harbour. The pipeline from the Wye junction to Wickham Point (Darwin) is consistent with the route already approved for Bayu Undan.

Various platform drilling rig options have been investigated to minimise the impact of platform facilities, while optimising the platform drilling capability and minimising capital investment in drilling equipment. Similarly, an assessment of three main production concepts was conducted by Woodside. The choice of the preferred offshore platform was based on geotechnical, environmental and technical criteria.

The Sunrise Gas Project can demonstrate that the best available technologies for reduction of environmental impact of discharges and emissions have been given due consideration. In this regard Woodside produced the report entitled '*Environmental Design Review'* in May 2001. Several available technologies have been considered and benefit-cost analysis performed before recommendations were made. Specific greenhouse gas reduction measures to be considered as part of the Sunrise Gas Project are:

- The development and implementation of a greenhouse strategy to minimise emissions of greenhouse gases;
- Design and operational measures to minimise offshore flaring and venting;
- The reduction of methane emissions to negligible levels through the combustion of regeneration offgas;
- Maximising the use of waste heat from gas turbines; and
- To adopt industry best practice in greenhouse efficient technology and practice wherever practicable.

Existing Environment

Physical Environment

The climate of the Timor Sea comprises two distinct seasons, a dry “winter” from April to September and a wet “summer” from October to March, separated by transition seasons of short duration.

The mean annual rainfall for the Sunrise Gas Field is expected to be in the order of 1,700 mm with the vast majority of the rainfall occurring between November and March. The mean summer and winter air temperatures are likely to approximately 28°C and 27°C, respectively.

Although tropical cyclones form in the area generally south of the equator in the eastern Indian Ocean and the Timor and Arafura Seas, most storms affecting the Sunrise area are tropical lows or developing storms passing well to the south of the Sunrise Gas Field.

The seabed in the vicinity of the Sunrise Gas Field lies at 140 m to more than 700 m below the water surface. The south eastern rim of the gas field lies at the top of the steep shelf break where the depth drops to about 300 m over a distance of 15 km. There are four shallow features adjacent to the southern portion of the Greater Sunrise Gas Field, including the Sunrise Banks. These shoals are covered by minimum water depths of approximately 30 to 40 m.

The preferred subsea pipeline alignment passes through water depths ranging from approximately 140 m to 57 m LAT. The route is aligned to avoid shoals and valleys as much as possible.

The development area is situated on the outer shelf and upper slope of the Sahul Platform off the northern margin of Australia in the Timor Sea. The surficial sediments along the pipeline route vary in thickness between 0.5 and 2.5 m and range from carbonate silty to carbonate clayey sand with gravel.

The Timor Trench lies between the Sunrise Gas Field and the island of Timor. Subduction earthquakes associated with the Timor Trench dominate the earthquakes of the Sunrise Gas Project area. However, the design criteria of the offshore facilities provides for seismic events such as earthquakes, which are of low frequency and an intensity not likely to result in damage.

The sea wave climate at Sunrise Gas Field is closely allied to the prevailing wind regimes, with westerly and south-westerly seas prevailing from December to March, shifting predominantly easterly seas from April to November. Predominant swell direction at Sunrise Gas Field is from south-west to west. In summer the one year return period significant wave height is 2.4 and in winter it is 2.8 m.

Tides in the area are semidiurnal, and are expected to flow east-north-east and ebb west-south –west in the upper 100 m of the water column, whilst flooding south-east and ebbing west-north-west in the lower portion of the water column. Maximum tidal range is about 4 m.

Surface current for the Sunrise Gas field are strongly influenced by the semidiurnal tide and to a lesser extent by the wind-driven and drift currents.

Mean monthly surface water temperatures in the vicinity of the Sunrise Gas Field are expected to vary between about 26°C and 30°C.

Biological Environment

Surveys were conducted at three banks and a deep-water location in the vicinity of the Greater Sunrise Gas Field. The survey found that each of the three banks support extensive areas of benthic communities considered as being both diverse and abundant. The proposed platform location (ie deep water) is generally characterised by a relatively level substrate composed of sand and shell fragments. The area supports sparse epifauna comprised of hydroids, seapens, sea whips and solitary hard corals.

Social Environment

Darwin is the capital city of the Northern Territory and its proximity to major economic growth areas in the Asia Pacific region provides a stable foundation for the Territory to play a major role in the future of the Asia Pacific Region.

Darwin is serviced with a seaport comprising land connections to a major international airport, national highway system, the proposed national rail network and the proposed Bayu-Undan to Darwin natural gas pipeline. Darwin is also equipped with world standard communications systems and has emerging information technology capabilities.

East Timor's proximity to the gas fields is expected to provide opportunity for its local economy. As a landfall, East Timor is 300 km closer to the development area than Darwin. While infrastructure and capability constraints currently prevail, East Timor's capabilities in the area of marine and air support are likely to emerge within the operating life of the project.

Environmental Effects and Management Strategies

A summary of the environmental impacts related to the development of the Greater Sunrise gas and condensate fields is provided in **Table ES1**, which lists:

- Project component;
- The source of the impact;
- The potential or actual environmental impact;
- The predicted effect of the impact (negligible, minor, moderate, significant or serious); and
- The duration of the impact (temporary, short-term, medium-term, long-term or permanent).

In summary, the identified potential and actual environmental impacts associated with the Sunrise Gas Project are:

Atmospheric emissions

- Emission of smoke and particulate from production platform operations, and cargo tank emissions from loading of FSO and shuttle tankers;

Discharges to the Sea

- Smothering effects of accumulated drilling cuttings on marine biota;
- Potential anoxia of sediment due to natural degradation and/or burial by drilling muds;
- Localised reduction in water quality adjacent to off-shore facilities during the construction phase;
- The potential discharge to the marine environment of hydrocarbons resulting from a condensate or diesel spill, or the release of off-specification production formation water resulting in adverse impacts on the receiving waters;
- Potential localised elevation of water temperature affecting marine organisms;
- Contamination of marine environment by anti-fouling agents; and
- Potential temporary localised reduction in water quality due to release of hydrotest water containing biocides, scale and corrosion inhibitors and oxygen scavengers.

Noise, Vibration, Light and Heat

- Potential disturbance to marine species due to noise and vibration created by vessels undertaking project related activities; and

Waste to Shore

- The improper disposal of waste material generated during the drilling, construction and operation phases of the project;

Other Impacts

- Temporary disruption of fisheries during construction and reduced access to fishing grounds due to the establishment of an exclusion zone around the offshore production facilities; and along the pipeline; and
- Disturbance to benthic communities that have established on and adjacent to the facility;
- Disturbance to seabed and potential changes to seabed characteristics from permanent facilities.

The result from the impact identification can be summarised as follows:

- *Drilling and Associated Activities*: Most of the environmental effects are negligible and of short-term or temporary duration.
- *Installation/Construction*: Most of the environmental effects are negligible and of short-term or temporary duration.
- *Commissioning/Operation:* Most of the environmental effects are either negligible, minor or moderate and of short-term duration. A few significant environmental effects have been identified, relating to the potential emission/spill of natural gas and condensate, the duration of this effect deemed long-term.
- *Decommissioning:* Most of the environmental effects were deemed negligible and of short-term duration.

Mitigation measures and management strategies have been recommended for implementation, based on the APPEA's 'Code of Environmental Practice', and following consultation with all relevant government and non-government organisations, as well as the public. A summary of mitigation measures to be implemented at various stages of the projects are included in **Table ES2a-b.**

The management strategies proposed will ensure that all impacts on the environment will be minimised during the drilling, commissioning, operation and decommissioning phases of the proposal. An Environmental Management System will be developed and implemented by the Proponent. The majority of the environmental management strategies for the Sunrise Gas Project will be implemented with the following Environment Plans:

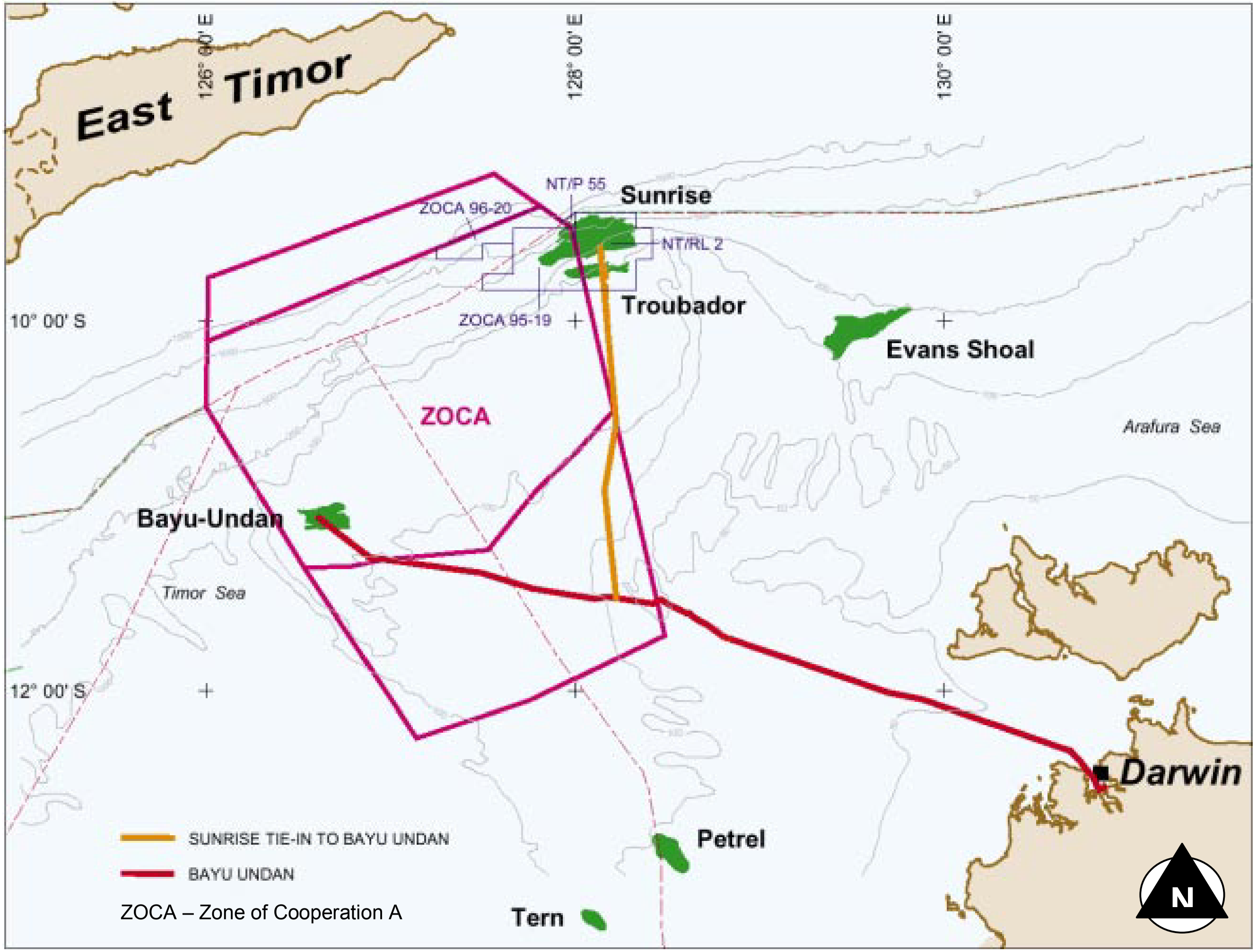
- Drilling Environment Plan: This plan would cover all aspects of drilling of the Wellhead Platform and subsea production wells and the construction and installation of the Wellhead Platform.
- Facility Environment Plan: This plan would cover all aspects of construction/installation, operation and decommissioning of the Sunrise Gas Project. The Facility EP would contain specific plans for decommissioning, waste management, and ballast water management.

In addition to the Environment Plans, project specific plans would also be implemented. These include:

- Oil Spill Contingency Plan.
- Emergency Response Plan.
- Waste Management Plan

Conclusions

The majority of the identified potential and actual environmental impacts associated with the Sunrise Gas Project are assessed as being negligible or minor in nature with temporary or short term effects. As such, this document demonstrates that the project is not expected to pose a significant environmental threat to the East Timor Sea. Woodside is, in any case, committed to achieving a level of environmental management and performance that is consistent with national and international standards and statutory obligations during its pursuit of sound business and financial objectives. To minimise any potential threat to the environment, the most economically effective, environmentally sound technology and procedures will be incorporated into the design of this project. The adoption of such a strategy will ensure optimal management of all emissions, discharges and waste. Furthermore, Woodside is committed to ensuring that the development of the Sunrise Gas Project will be undertaken in a manner that minimises impacts on the surrounding biophysical and social environments.



Source: Woodside

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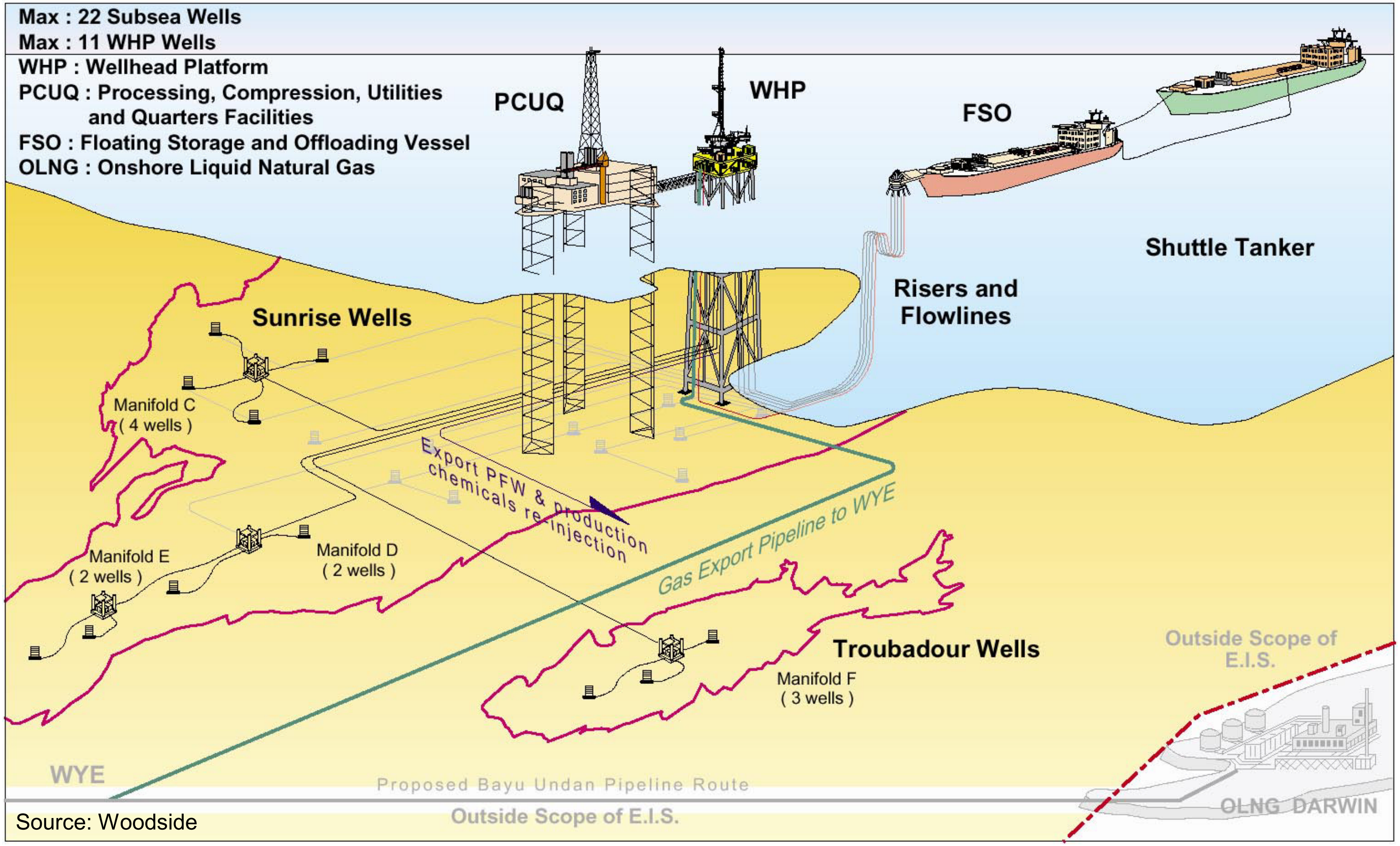
Sunrise Gas Field Location and Surrounding Gas Fields

Figure ES1
Project No.: DE2090.100
Figure prepared by: T.Lee
Date Prepared: 16/10/01



Source: Woodside

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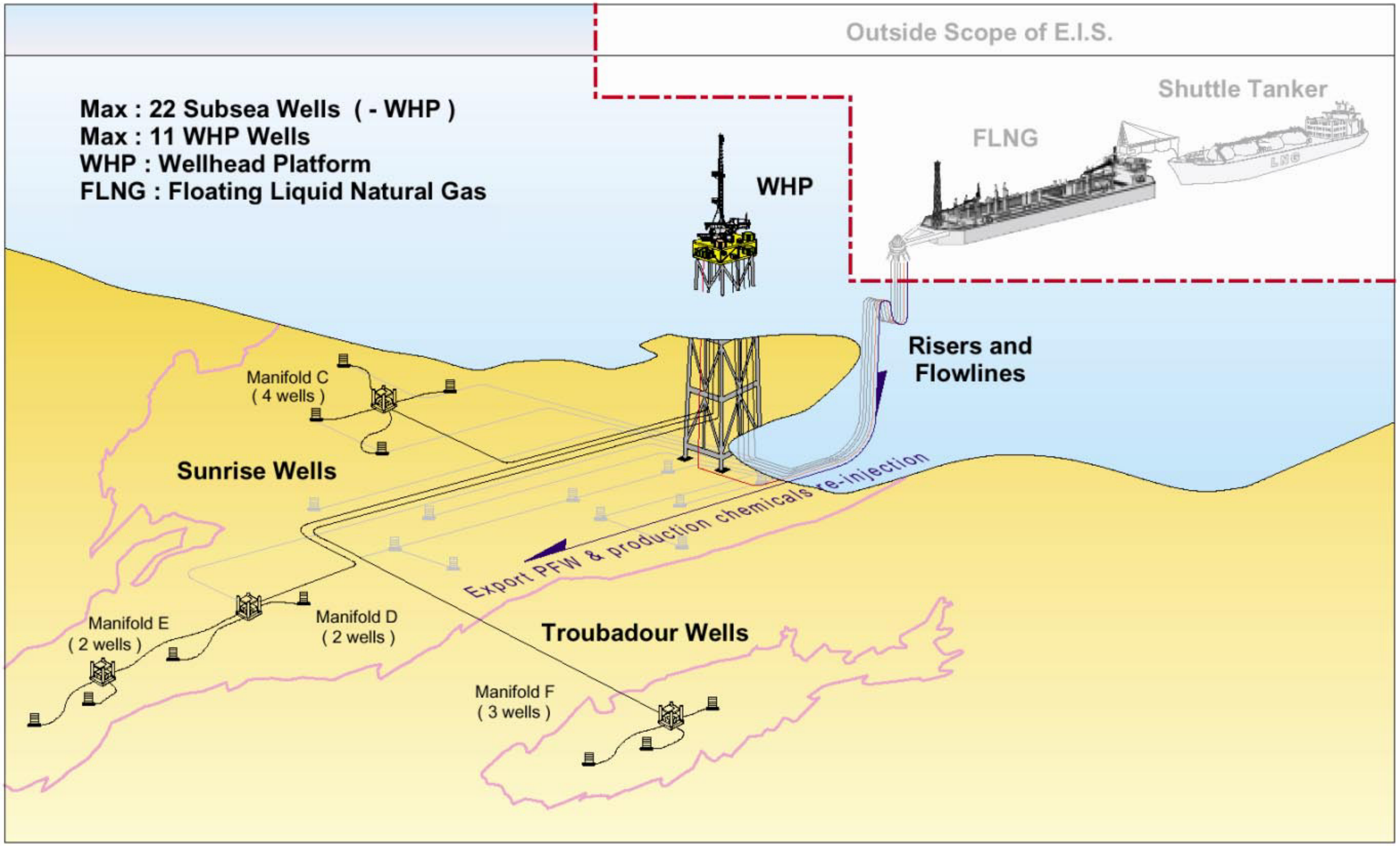
Scope of EIS Scenario 1:OLNG

Figure ES2a
Project No.: DE2090.100
Figure prepared by: T.Lee
Date Prepared: 16/10/01



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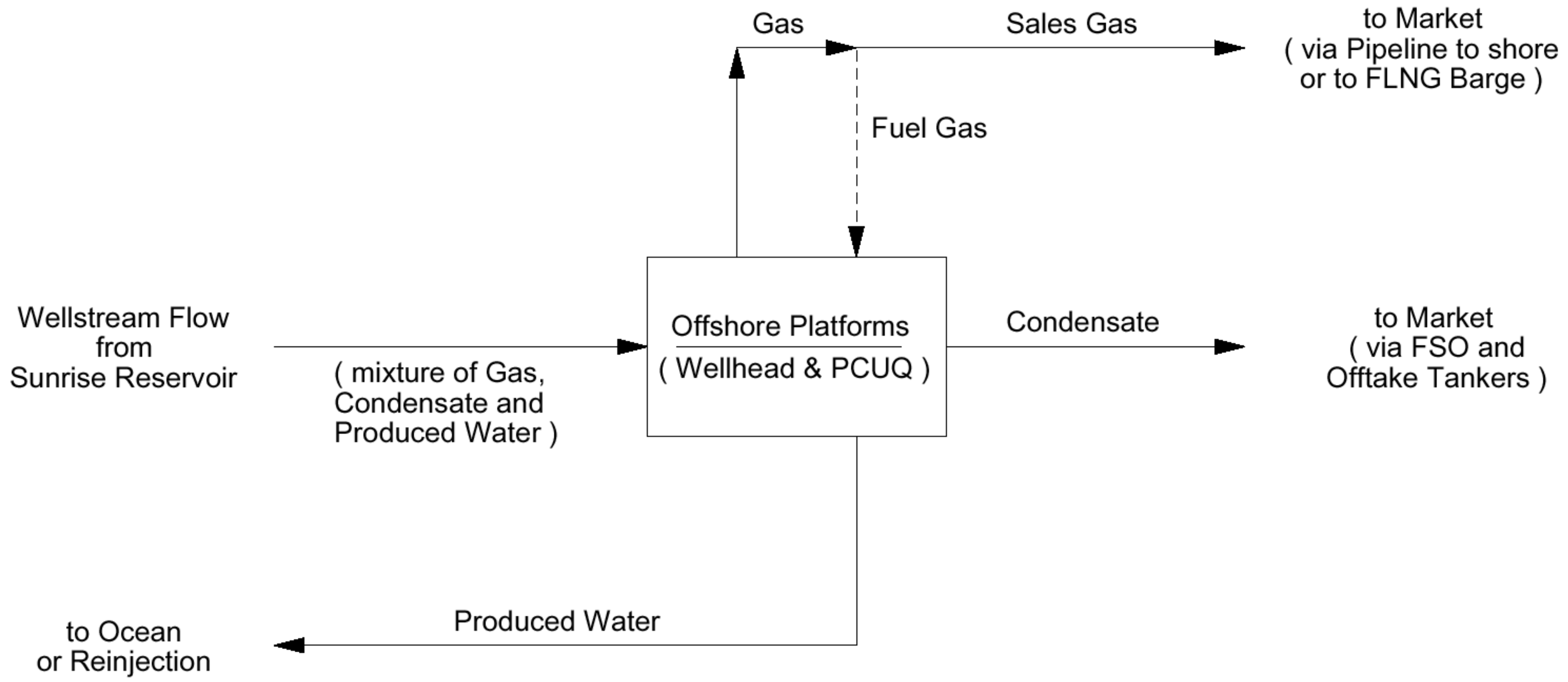
Scope of EIS Scenario 2:FLNG

Figure ES2b
Project No.: DE2090.100
Figure prepared by: T.Lee
Date Prepared: 16/10/01



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Overview of Offshore Process Systems

Figure ES3
Project No.: DE2090.100
Figure prepared by: T.Lee
Date Prepared: 16/10/01

Table ES1a Summary of Potential Environmental Impacts for Drilling and Associated Activities

Project Component	Source of Impact	Potential Environmental Impact	Effect	Duration
Wellhead Platform Installation	a) Physical presence of production and wellhead platforms. b) Power generation during installation c) Lighting. d) Disposal of construction wastes. e) Presence of construction and support vessels. f) Discharge of sewage and greywater. g) Discharge of domestic waste including food scraps.	**Atmospheric Emissions**		
		▪ Greenhouse gases produced by drilling unit power generation (primarily CO_2)	Negligible	Short-term
		▪ Atmospheric pollutants (primarily NO_x, SO_x, VOCs and smoke/particulates);	Negligible	Short-term
		Discharges to the Sea		
		▪ Potential localised reduction in water quality.	Negligible	Short-term
		Noise, Vibration, Light and Heat		
		▪ Potential disturbance to marine biota and birds.	Negligible	Short-term
		▪ Potential attraction of marine organisms to the lights such as turtles	Negligible	Short-term
		Waste to Shore		
		▪ Improper disposal.	Negligible	Temporary
Drilling of Platform and Subsea Wells	a) Anchoring/spudding of drilling unit. b) Cuttings discharge and adherent drilling fluid. c) Use of water based drilling fluids for the initial section of each well or for vertical wells. d) Use of non-water based drilling fluids for deviated sections of wells. e) Activity of support/supply vessels f) Discharge of drilling chemicals and hydrocarbons attached to cuttings only. g) Discharge of sewage and greywater. h) Discharge of domestic waste including food scraps. i) Oily water discharged to the environment during installation and operation of drilling facilities. j) Disposal of domestic waste including paper and plastics etc. k) Power generation. l) Lighting. m) Refuelling at sea.	**Atmospheric Emissions**		
		▪ Greenhouse gases produced by drilling unit power generation (primarily CO_2)	Negligible	Short-term
		▪ Atmospheric pollutants (primarily NO_x, SO_x, VOCs and smoke/particulates);	Negligible	Short-term
		Discharges to the Sea		
		▪ Smothering effects of accumulated drill cuttings on marine biota.	Negligible	Short-term
		▪ Increased turbidity in the area from cuttings discharge	Negligible	Short-term
		▪ Potential accumulation of metal and hydrocarbon concentrations in seabed sediments leading to toxicity.	Negligible	Short-term
		▪ Potential bioaccumulation/ bioconcentration by marine biota of contaminants in non-water based fluids.	Negligible	Short-term
		▪ Potential anoxia of sediment due to natural degradation.	Negligible	Short-term
		▪ Potential reduction in water quality in the area.	Negligible	Short-term
		▪ Potential of a significant fuel spill.	Moderate	Short-term
		Noise, Vibration, Light and Heat		
		▪ Potential disturbance to marine species due to noise and vibration.	Negligible	Temporary
		Waste to Shore		
		▪ Improper disposal.	Negligible	Temporary
		Other Impacts		
		▪ Disturbance to seabed and potential changes to seabed characteristics from drilling unit spud cans.	Negligible	Temporary

Table ES1b Summary of Potential Environmental Impacts for Installation and Construction

Project Component	Source of Impact	Potential Environmental Impact	Effect	Duration
Subsea Facilities (well heads, manifolds, flowlines, risers, etc.)	a) Installation of subsea facilities. b) Anchoring of construction vessel(s) c) Discharge of sewage and greywater. d) Discharge of domestic waste including food scraps. e) Disposal of domestic waste including paper and plastics etc. f) Power generation. g) Refuelling at sea.	**Atmospheric Emissions** ▪ Greenhouse gases produced by vessel power generation (primarily CO_2). ▪ Atmospheric pollutants (primarily NO_x, SO_x, VOCs and smoke/particulates); **Discharges to the Sea** ▪ Potential significant fuel spill. **Noise, Vibration, Light and Heat** ▪ Potential disturbance to marine organisms and birds. **Waste to Shore** ▪ Improper disposal.	Negligible Negligible Minor Negligible Negligible	Short-term Short-term Temporary Temporary Temporary
PCUQ Platform and FSO	a) Transportation of the PCUQ Platform and FSO to site. b) Power generation. c) Installation of the PCUQ Platform and the FSO on site. d) Physical presence of PCUQ Platform and FSO. e) Installation of foundations of the PCUQ platform. f) Lighting. g) Presence of construction and support vessels. h) Installation of mooring for the FSO.	**Atmospheric Emissions** ▪ Greenhouse gases produced by vessel power generation (primarily CO_2) ▪ Atmospheric pollutants (primarily NO_x, SO_x, VOCs and smoke/particulates). **Discharges to the Sea** ▪ Potential reduction in water quality in the area. **Noise, Vibration, Light and Heat** ▪ Potential disturbance to marine species. ▪ Potential attraction of marine species. **Waste to Shore** ▪ Improper disposal.	Negligible Negligible Negligible Negligible Negligible Negligible	Short-term Short-term Short-term Short-term Short-term Temporary
Subsea Pipeline	a) Potential pre-sweep along pipeline route b) Prelay with rock dump. c) Laying of pipeline on seabed. d) Hydrotesting	**Atmospheric Emissions** ▪ Greenhouse gases produced by vessel power generation (primarily CO_2) and vehicles ▪ Atmospheric pollutants (primarily NO_x, SO_x, VOCs & smoke/particulates). **Discharges to the Sea** ▪ Smothering of benthos. **Noise, Vibration, Light and Heat** ▪ Potential disturbance to marine species. **Waste to Shore** ▪ Improper disposal. **Other Impacts** ▪ Disturbance due to repositioning of anchors. ▪ Temporary disruption of commercial fisheries.	Negligible Negligible Negligible Negligible Negligible Negligible Negligible	Short-Term Short-Term Temporary Temporary Temporary Temporary Temporary

Table ES1c Summary of Potential Environmental Impacts for Commissioning and Operation

Project Component	Source of Impact	Potential Environmental Impact	Effect	Duration
Wellhead Platform, Processing, Compression, Utilities and Quarters (PCUQ) and Subsea Facilities	a) Potential blowout of wellhead. b) Hydrotesting of facilities. c) Potential rupture of flowline or riser. d) Potential diesel spill. e) Potential condensate spill. f) Emergency shutdown of facility. g) Discharge of Produced Formation Water (PFW). h) Discharge of cooling water. i) Disposal of waste associated with maintenance of the platforms. j) Disposal of oily water, waste oil, etc. k) Discharge of sewage and greywater. l) Disposal of domestic waste including food scraps. m) Potential collision of shuttle tanker or supply vessels with platforms. n) Operational noise. o) Power generation and compression turbines producing greenhouse gases emission to air. p) Hazardous materials	**Atmospheric Emissions** ▪ Significant emission of greenhouse gases due to export compression. ▪ Significant emission of greenhouse gases due to power generation. ▪ Significant emission of greenhouse gases due to flaring. ▪ Significant emission of smoke and particulates. **Discharges to the Sea** ▪ Potential significant hydrocarbon contamination from condensate spill. ▪ Potential significant hydrocarbon contamination from diesel spill. ▪ Potential significant hydrocarbon from PFW discharge. ▪ Potential reduction in local water quality. ▪ Potential reduction in water quality due to hydrotesting **Noise, Vibration, Light and Heat** ▪ Potential disturbance to marine species. **Waste to Shore** ▪ Improper disposal. **Other Impacts** ▪ Creation of hard substrate that could be colonised by marine pest species. ▪ Recolonisation of a different community to that originally found in the area.	Minor Minor Minor Negligible Moderate Minor Negligible Negligible Negligible Negligible Negligible Negligible Minor	Long-term Long-term Short-term Long-term Temporary Temporary Long-term Short-term Short-term Long-term Long-term Long-term Long-term
FSO and Shuttle Vessels	a) Potential spill during condensate transfer to shuttle tankers. b) Ballast water discharge from offtake tankers once on site. c) TBT and other antifoulant paints on tankers. d) Vessel hulls fouled with exotic marine organisms. e) Cargo tank venting to atmosphere. f) Potential collision with shuttle tankers or supply vessels. g) Power generation emissions. h) Discharge of sewage and greywater. i) Disposal of domestic waste including food scraps.	**Atmospheric Emissions** ▪ Cargo tank emissions from loading of FSO and shuttle tankers. **Discharges to the Sea** ▪ Contamination of marine environment by anti-fouling agents. ▪ Introduction of marine pest species from offtake tanker de-ballasting and hullfouling. ▪ Potential significant hydrocarbon contamination from condensate spill. ▪ Potential significant hydrocarbon contamination from diesel spill. **Other Impacts** ▪ Interference with shipping.	Negligible Negligible Moderate Moderate Minor Negligible	Long-term Long-term Long-term Temporary Temporary Long-term
Subsea Pipeline	a) Potential rupture of pipeline. b) Hydrotesting of pipeline. c) Physical Presence of the pipeline.	**Atmospheric Emissions** ▪ Potential emissions of natural gas in the event of a leak. **Discharges to the Sea** ▪ Potential reduction in local water quality due to release of hydrotest water (biocides, corrosion inhibitors and oxygen scavengers).. **Other** ▪ Physical presence of pipeline.	Significant Negligible Negligible	Long-term Temporary Long-term

Table ES1d Summary of Potential Environmental Impacts for Decommissioning

Project Component	Source of Impact	Potential Environmental Impact	Effect	Duration
Wellhead Platform, Wells and Associated Subsea Facilities	a) Plugging and abandonment of wells. b) Removal of well head. c) Removal of flowlines, manifolds and risers. d) Vessel and rig movements.	**Discharges to the Sea** ▪ Potential discharge of residual hydrocarbons.	Negligible	Short-term
		Noise, Vibration, Light and Heat ▪ Disturbance to noise sensitive marine life.	Negligible	Short-term
		Waste to Shore ▪ Improper disposal.	Negligible	Short-term
		Other ▪ Disruption of benthic communities that have established on and adjacent to the facilities.	Negligible	Permanent
PCUQ Platform and FSO	a) Removal of Wellhead Platform components and equipment. b) Jackup and removal of the PCUQ. c) Disconnection of FSO from flowlines. d) Movement of FSO offsite.	**Discharges to the Sea** ▪ Potential hydrocarbon contamination by oil spillage.	Negligible	Short-term
		Noise, Vibration, Light and Heat ▪ Disturbance to noise sensitive marine life.	Negligible	Short-term
		Waste to Shore ▪ Improper disposal.	Negligible	Short-term
		Other ▪ Disruption of benthic communities that have established on and adjacent to the facility.	Negligible	Permanent
Subsea Pipeline	a) Abandonment of subsea pipeline. b) Removal of subsea pipeline. c) Potential discharge of residual hydrocarbons	**Discharges to the Sea** ▪ Potential hydrocarbon contamination by oil spillage.	Negligible	Short-term
		Noise, Vibration, Light and Heat ▪ Disturbance to noise sensitive marine life and terrestrial fauna.	Negligible	Short-term
		Waste to Shore ▪ Disposal (abandonment of subsea pipeline) ▪ Disposal (removal of subsea pipeline)	Negligible Moderate	Short-term Permanent
		Other ▪ Disruption of benthic communities and habitats that have been established on and adjacent to the pipeline.	Negligible	Medium Term

Table ES2a Summary of Mitigation Measures for Drilling and Associated Activities

Component	Mitigation Measures
Drilling Rig	▪ Ensure the drilling rig has adequate safety systems such as blowout preventers, alarms and automated shutdown devices which meet regulatory and industry standards and for which adequate maintenance and testing programs are in place; ▪ Ensure the drilling rig has safe operating procedures in place which meet regulatory and industry standards including chemicals and waste management aspects, etc; ▪ Ensure the drilling rig has efficient solids control and mud circulation systems which maximise recycling of drilling fluids; ▪ Ensure the drilling rig has adequate comminution, containment, drainage and monitoring systems to prevent overboard discharges of unpermitted effluents (e.g. oil, or chemical contaminated effluents, whole food scraps and sewage, etc.
Drilling Fluids	▪ Where practicable and possible low toxicity water-based drilling fluid formulations will be used; ▪ Where required lubricity or other fluid properties cannot be achieved using a water-based drilling fluid, a synthetic fluid which is of proven low toxicity will be used.
Crew Induction	▪ Regulatory requirements for drilling operations. ▪ Environmental considerations and special procedures to be used for environment protection in the permit area. ▪ Safety procedures with particular regard for appropriate conduct on vessels and safe use of equipment.
Wildlife Protection	▪ Spotting reports of endangered species ▪ Specifying routes and/or operating procedures for supply vessels and helicopters, which minimise impact on wildlife
Spills Prevention	▪ Safety systems including blowout preventers. ▪ Contained oil and chemical, packaging and storage areas. ▪ Containment around oil and chemical use areas and equipment such as the pipe deck, mud tanks, pumps etc. ▪ Efficient oil/water separators in bilges (and ballast tanks where not segregated from containment sources). ▪ Safe fuel transfer procedures from supply vessel to drilling rig eg checking product transfer hoses for leaks, monitoring tank levels etc.
Chemicals and Hazardous Materials	▪ Provision of Material Safety Data Sheets and handling procedures for hazardous chemicals and materials. ▪ Provision of appropriate absorbent material and spill clean-up equipment. ▪ Use of low impact chemicals and materials as far as practicable.
Emergency Response	▪ Oil and chemical spills. ▪ Fire prevention ▪ Diesel or bunker fuel spill.
Waste Management	A project-specific waste management plan will be adopted to address: ▪ Discharges to Sea ▪ Solid and Hazardous Waste The release of contaminants to the sea from deck wash will be minimised by ensuring the following: ▪ Absorbents and containers are available in the rig to clean up small accumulations of oil and grease around work areas and decks. ▪ Accumulations of oil, grease and other contaminants are collected and removed from the deck prior to every washdown. ▪ Oil-contaminated deck drainage is diverted to a settling tank to allow separation of oil from water
Discharges to Sea	▪ No waste will be disposed overboard except for (a) comminuted sewage and food wastes, (b) drilling cuttings and adherent water-based drilling fluids, (c) excess water-based drilling fluids at the completion of a well or if different properties apply and (d) uncontaminated (in as much as is practicable) deck washdown wastes. ▪ The total volume of discharges will be minimised and recirculation of drilling fluids optimised. ▪ Drill cuttings and fluid discharges will be analysed to avoid oil contamination. ▪ Discharges from essential operations such as grouting of the conductor and surface casing strings for eg cement mixture circulation to seabed, surplus cement fluid etc. ▪ To achieve optimal dispersal stage discharges will be implemented eg disposal of excess fluid at the end of well. ▪ Where small amounts of oil additives are added to drilling fluid on a one-off basis, consultation will take place with the Designated Authority on the disposal method – disposal to sea may be considered if concentrations are low, the site environment is suitable and or additional treatment (oil separation) is undertaken.
Air Emissions and Energy Use	▪ Minimise emissions from fired machinery and optimise fuel use efficiency. ▪ Minimise flaring and emissions from production tests. ▪ Optimise flare burner characteristics to ensure maximum burning of all hydrocarbons produced during production test.

Component	Mitigation Measures
Solid and Hazardous Waste	▪ Segregate waste as much as possible and ensure safe storage and labelling of maintenance, chemical packaging, batteries, waste lube oils and other industrial waste for return to shore, recycling and or treatment and disposal in an approved manner. ▪ Collection of all solid domestic waste for return to shore and approved disposal.
Physical Presence of Rig	▪ Advance notification of the presence of the rig to local fishermen and other relevant parties. ▪ Ensure radio watch on shipping traffic and fishing vessels. ▪ Notification of the Australian Maritime Safety Authority of the rig location and anchor distances. ▪ Adequate lighting of the rig.

Table ES2b Summary of Mitigation Measures during Installation and Construction

Component	Mitigation Measures
General Measures	Installation of the platforms will occur over a very short period of time thereby minimising any impacts on the surrounding environment. Mitigation measures will focus on issues such as waste management, air and noise emissions and restriction of the development to the defined project area ▪ Charts of the route and notification will be given to marine users prior to construction/installation. ▪ Navigation and safety lighting will be provided to ensure that any shipping or recreational activities are able to clearly identify the presence of activity. ▪ Woodside will confine activities to the minimum development area required to minimise the area impacted. ▪ Work areas will be kept to a minimum with pipeline laying restricted to at most a 10 km width corridor. Within this corridor pipe laying operations will occur with a 1 km corridor in as much as is possible. Any pre-lay rock armour that may be required will be confined to a much smaller area usually 10 m in width. ▪ Woodside will endeavour to minimise all disturbance to marine life and fisheries. However, as no breeding areas are affected by the development impacts will be kept to a minimum. ▪ Minimise all air emissions and discharges. Efficient planning of vehicle and vessel movements will minimise fuel usage. ▪ All waste will be managed in accordance with a project–specific waste management plan and in accordance with current waste legislation. ▪ Any rock dumping along the pipeline route will be kept to a minimum.
Support Vessels	All marine support activities must comply with maritime laws and implement good environmental working standards. These will include the following: ▪ All support services are conducted in accordance with relevant legislation and the operating companies requirements. ▪ Refuelling and similar operations will be conducted in accordance with port authority requirements and all hoses, fittings and fail-safe devices will be fully operational. ▪ Efficient oil/water separation in bilges and disposal of clean bilge water in offshore areas, where permitted.

Table ES2c Summary of Mitigation Measures for Commissioning, Operation & Decommissioning

Component	Mitigation Measures
Commissioning	Consideration will be given to controlling and minimising where possible the use of biocides and toxic chemicals contained within the hydrotest water. The chemicals used in the pressure testing will be carefully selected with regard to toxicity.
General Operation and Maintenance procedures	▪ Any areas of spillage and leakage will be promptly reported and necessary maintenance works and control measures undertaken immediately. ▪ All monitoring devices and alarms will be operative. ▪ Adequate process surveillance will be undertaken. ▪ Personnel will be adequately informed of procedures. ▪ Oil Spill Prevention. ▪ Navigation and safety lighting will be provided to ensure that any shipping or recreational activities are able to clearly identify the presence of activity
Spills	▪ Hoses for diesel/ oil/ chemical transfer to be fitted with high reliability breakaway self-sealing couplings. ▪ Mooring hawser to be fitted with quick release hook and load monitoring cell. ▪ Consider designing all flowlines for 1 in 10,000 year storms - provided with shutdown valves and HP/LP sensors. ▪ Spill kits available for clean-up of minor spills. ▪ Facilities for disposal of tanker cleaning products during operation and decommissioning should be considered in design. ▪ Process spill and leak detection, alarm, shutdown and isolation devices will be maintained in good operating conditions. ▪ Efficient containment and separation of contaminated run-off decks, machinery areas and oil/chemical storage areas. ▪ An Oil Spill Contingency Plan (OSCP) has been prepared by Woodside for the Timor Sea. If necessary this OSCP will be amended to meet the specific requirements of the field development.
Emergency Response	Woodside will ensure that the ERP are tested and reviewed at regular intervals and the operational personnel are appropriately informed of emergency procedures and trained to effectively implement them.
Hydrocarbon Loading	▪ All regulatory requirements will be observed including standards for design and application of hardware eg flanges, valves, couplings, fittings etc ▪ Marine operating procedures define acceptable ocean conditions for the tanker to be connected to the transfer hose and for the export of condensate to take place ▪ The transfer hose will be flushed with seawater in the tanker prior to disconnecting in the event of rough weather ▪ Pressure sensors will be installed to detect and trigger alarms for stopping the transfer of condensate to the tanker in the event of a high or low pressure trip. ▪ Flowlines and hoses are certified and tested prior to use. ▪ Dry break couplings will be fitted to hoses. ▪ All fittings and hoses will be routinely inspected and maintained. ▪ All spillages, leaks or points of excessive wear will be properly reported and the necessary maintenance work and control measures undertaken without delay. ▪ All monitoring devices and alarm systems will be fully operative
Chemicals and Hazardous Materials Management	▪ Hydrate Inhibitor Chemical Use ▪ Self-Equalising Subsea Shutdown Valve (SSSVs) ▪ Scale Inhibitor Injection ▪ Minimise need to dose demulsifier/anti-foam agent in separator ▪ Minimise need to dose anti-foaming agent in dehydration and stabiliser ▪ Minimise environmental impact of biocide, corrosion inhibitor, chemical scavenger and dye use in hydrotest water ▪ Minimise environmental impact of release of hydraulic fluid from subsea control systems.
Waste Management	▪ A project-specific waste management plan will be adopted to address: ▪ Waste will be labelled appropriately for return to shore where disposal at landfill, or if possible reuse, recycling or recovery will take place. ▪ Discharges to Sea ▪ Solid and Hazardous Waste ▪ As much as possible waste will be segregated into distinct waste streams eg packaging, chemicals, industrial waste, batteries etc and stored in appropriate locations. ▪ Waste will be labelled appropriately for return to shore where disposal at landfill, or if possible reuse, recycling or recovery will take place. ▪ Solid domestic waste will be returned to shore and disposed at an approved landfill.

Component	Mitigation Measures
Discharges to Sea	▪ Discharges will meet oil –in-water standards ▪ Treatment facilities to be of sufficient design capacity to handle PFW, and other oily waters from dirty work areas (deck area drainage, machinery space drainage etc ▪ The effluent discharges from treatment facilities will be monitored by appropriate techniques prior to discharge, and monitoring equipment will undergo periodic checking in accordance with statutory requirements ▪ Cooling water releases will be controlled to avoid thermal effects ▪ As a minimum sewage and food scraps will be comminuted prior to discharge in offshore waters and in accordance with P(SL)A requirements.
Air Emissions/Energy Use	▪ Flaring will be minimised. ▪ Fugitive emission from process equipment will be minimised ▪ Emissions from fired machinery will be minimised and fuel use optimised
Noise, Vibration, Light and Heat	Woodside will attain occupational health standards for noise emissions by installing silencers, cladding and other appropriate noise attenuation controls where practicable. Due to the distance of the facility offshore noise will not be a major issue. Methods for minimising noise, vibration, light and heat impacts are also included.
Marine Support Vessels	All marine support activities must comply with maritime laws and implement good environmental working standards. These will include the following: ▪ Goods and materials are properly package, labelled for transportation and transfer. ▪ Refuelling and similar operations will be conducted in accordance with port authority requirements and all hoses, fittings and fail-safe devices will be fully operational. ▪ Efficient oil/water separation in bilges and disposal of clean bilge water in offshore areas, where permitted. ▪ Comminution of sewage and food waste and disposal in offshore areas only where permitted and containment of sewage and food wastes for onshore disposal when in nearshore waters.
Physical Presence	A 500 m safety exclusion zone will be maintained around the facility and no vessels are allowed to enter or anchor within the zone without the permission. To reduce the risk of collision with vessels using the area, fisheries and shipping are made aware of the presence of facility, flowlines and 500 m exclusion zone. The facility is marked on the Australian navigational charts. Notices issued to shipping and appropriate navigation marker lights are displayed.
Decommissioning	A decommissioning plan will be developed by Woodside in accordance with the guidelines currently being drawn up by the DBIRD. This plan will take into account the concerns and views of other marine users as well as the current and future values of the area. The disposal or reuse/recycling of structures and equipment and the safe decommissioning of wells will also be considered.

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1. Introduction

1.1 Purpose of the EIS

This Draft Environmental Impact Statement (EIS) for the Sunrise Gas Project has been prepared in accordance with Clause 8 of the *Administrative Procedures of the Environmental Impact Assessment Act 1982* of the Northern Territory and paragraph 4.1 of the Administrative Procedures under the *Commonwealth Environment Protection (Impact of Proposals) Act 1974* of the Commonwealth. The document provides information concerning the design, construction and operation, and the potential environmental impacts and associated management of the proposed development of the Greater Sunrise Gas Field.

The purpose of the document is to provide:

- ☐ Sufficient information such that individuals and groups may gain an understanding of the project, the environment that would be affected, the potential impacts and the measures proposed to minimise those impacts;
- ☐ A basis for public consultation; and
- ☐ A framework against which the regulatory authorities can consider the environmental aspects of the proposal, set conditions for approval to ensure environmentally sound development and recommend an environmental management and monitoring programme.

1.2 The Proposal

The Sunrise Gas Project Joint Venture, operated by Woodside Energy Ltd (Woodside), proposes to develop the Greater Sunrise gas and condensate fields (Greater Sunrise) which are located approximately 450 km north west of Darwin in Timor Sea permits NT/P55, NT/RL2, ZOCA96-20 and ZOCA95-19 (**Figure 1-1**). Investigations indicate that Greater Sunrise Field Development has a ‘Scope for Recovery’ in the order of 9 trillion cubic feet of gas and 320 million barrels of condensate. Permit Area NT/RL2 contains approximately 80% of the gas to be extracted.

1.3 Background

Greater Sunrise comprises the Sunrise and Troubadour Gas Fields located within permit areas, NT/RL2 (78.9%), NT/P55 (1%), Z96-20 (0.1%), Z95-19 (20%). Permit areas Z96-20 and Z95-19 fall within the Zone of Corporation A (ZOCA) with the remaining permit areas located in Australian waters.

This gas and condensate resource was initially discovered in 1974 with the successful drilling of the Troubadour-1 well and the Sunrise-1 well in the following year. Then in 1975, Indonesia invaded and annexed the former Portuguese colony of East Timor. After that time, no agreement was reached on maritime boundaries between Australia and Indonesia until 1991 when the Timor Gap Treaty was signed between Australia and Indonesia, creating the Zone of Cooperation (ZOC). ZOC was established between the Governments of Indonesia and Australia to facilitate co-operative development of the areas oil and gas fields. Under this agreement three sectors were designated (A,B,C) comprising 60,000 km^2 of seabed.

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

Further appraisal of the resources began with the Loxton Shoals-1 well, which was drilled in August 1995. Additional wells drilled since then demonstrated that both fields extend into the Zone of Cooperation.

In March 1999, Shell and Woodside announced that the LNG Plant Feasibility Study concluded the LNG project as technically feasible, but commercially the project was immature due to the lack of appropriate LNG market opportunities. This 'lack of market' was fundamentally due to the effects of the Asian economic crisis. In April 1999 Phillips Petroleum Company (Phillips) became a participant in the joint venture when it acquired BHP's interests in several Timor Sea permits, which included the permits for the Sunrise, Troubadour and Loxton Shoals static gas resources.

During the second half of 1999, a joint study of the markets and infrastructure required to bring Timor Sea gas to the Northern Territory and the wider east coast markets was undertaken. As a result of the study, and buoyed by discussions with potential foundation gas consumers, NAGV commenced actively pursuing a development to supply only domestic gas markets in Australia.

In August 1999, the United Nations held a referendum in East Timor to ascertain the population's desire regarding a) continued existence as a province of the Republic of Indonesia, or b) as a separate independent, nation state. The majority of the population voted for independence and since shortly thereafter, East Timor has been administered by the United Nations Transitional Administration in East Timor (UNTAET). An exchange of diplomatic notes and a Memorandum of Understanding (MoU) between Australia and UNTAET, on behalf of East Timor, continued the terms of the Timor Gap Treaty until a new treaty could be negotiated.

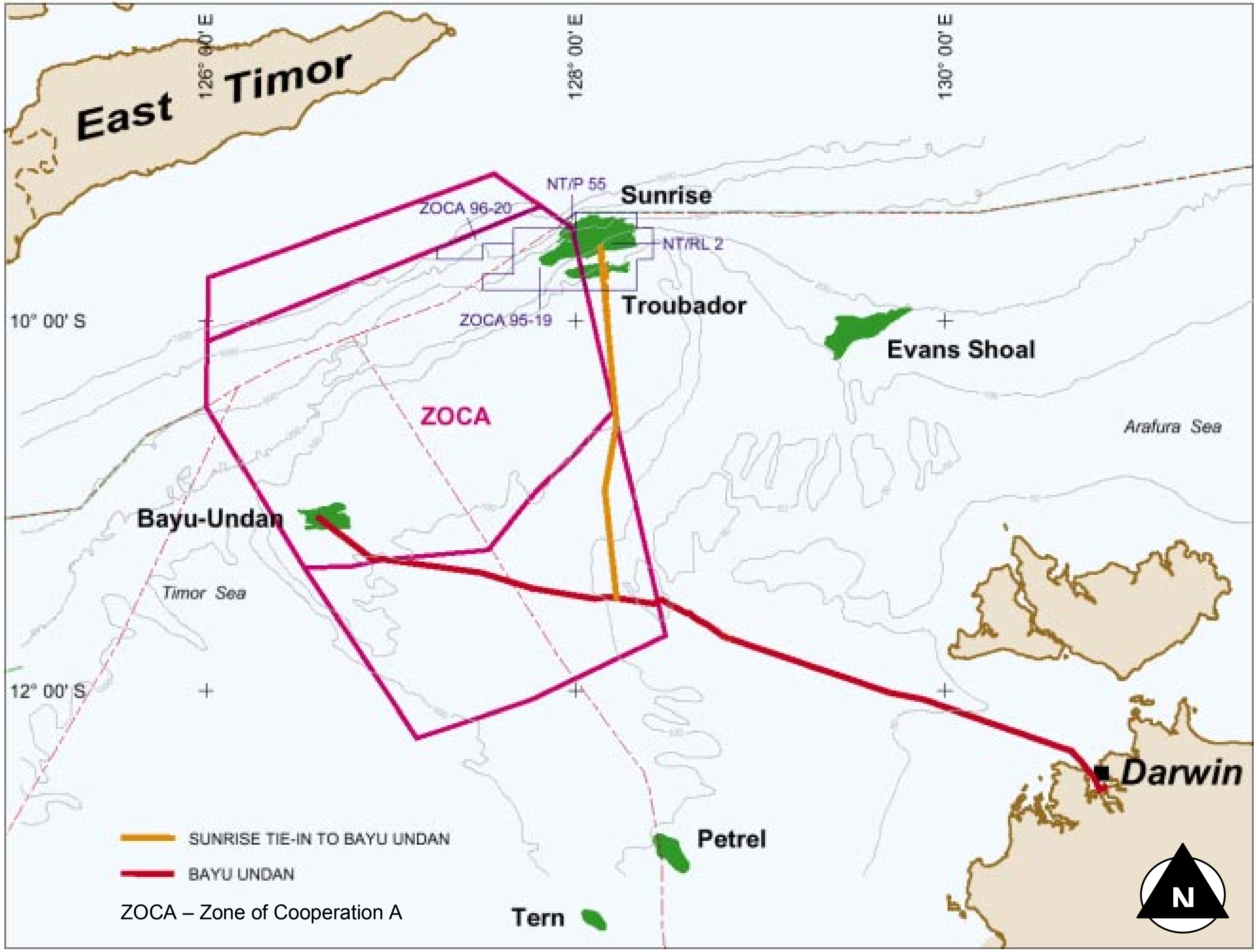
Eastern States opportunities and other domestic gas co-locators in a number of combinations and sizes have been investigated. This included power generation & downstream industries such as ammonia/urea, plastics, and minerals processing in the Northern Territory and elsewhere in Australia. To promote wider east coast gas supply opportunities, a marketing presence was established in Queensland.

Woodside and Phillips announced on 30 November 2000 that they had reached in-principle agreement to pursue cooperative development of their Timor Sea gas resources in the Sunrise and Bayu-Undan projects. The concept was designed to combine the early gas delivery potential of the Bayu-Undan development with the larger reserve base of the Greater Sunrise fields and to optimise investment in infrastructure. The Cooperative Agreement Principles were signed by Phillips, Woodside and Shell in February 2001.

In March 2001 El Paso Global LNG signed a LoI with Phillips, was intended to result in the delivery of 4.8 million tones per annum of LNG from the proposed LNG Plant in Darwin. Deliveries are planned to commence as early as 2005 for about 20 years.

Concept selection and further marketing efforts have continued. Woodside, acting as Operator on behalf of the Joint Venture, has continued to acknowledge the potential importance of domestic customers. However, the lack of a critical market mass in the vicinity of Darwin and the costs associated with supplying more remote customers, has again shifted the focus back to securing an LNG based development.

In September 2001 Shell tabled the Floating LNG (FLNG) concept providing an alternative market to onshore LNG. Under this proposal, a different primary market scenario is addressed, and the scope of the Sunrise Gas Project reduces to field development to supply raw wellstream to the customer FLNG project; rather than supply of either salesgas to Wickham Point with offshore export of tanker specification condensate or two phase gas and condensate to Wickham Point.



Source: Woodside

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Figure 1-1

Sunrise Gas Field Location and Surrounding Gas Fields

Project No.: DE2090.100
Figure prepared by: T.Lee
Date Prepared: 16/10/01

Thus two Sunrise Gas Project development options are therefore under consideration:

- Supply to onshore markets most likely LNG – on either a direct stand-alone basis or indirectly, in co-operation with the Bayu-Undan project; or
- Supply to an offshore Floating LNG project.

The variation in the needs of these customers in terms of gas supply requires that the design and development of Greater Sunrise is able to accommodate gas supply to both markets as they emerge.

1.4 The Proponent

The Sunrise Gas Project is a joint venture between:

Woodside (Operator)	33.44%
Phillips STL Pty Ltd	30.0%
Shell Development (Australia) Pty Ltd	26.56%
Osaka Gas Australia Pty Ltd	10.0%

The designated operator of the Sunrise Gas Project is:
Woodside Energy Ltd
1 Adelaide Terrace
Perth WA 6000

Woodside is responsible for annual production of oil and gas of approximately 146 million barrels of oil equivalent, which has a value of about $4 billion per annum. The majority of this production is exported, with a significant part being shipped to Japan as LNG.

Woodside Energy Ltd is a leading oil and gas company and one of Australia's most successful explorers, developers, and producers of hydrocarbon products. As a participant in, and Operator of, the North West Shelf Joint Venture, Woodside is directly responsible for the management of offshore and onshore assets worth more than $9 billion. On Western Australia's North-West Shelf, Woodside operates the North Rankin A and Goodwyn A offshore production platforms, the Cossack Pioneer Floating Production Storage and Offtake (FPSO) facility and the Onshore Gas Plant (OGP) on the Burrup Peninsula near Karratha as shown in **Figure 1-2.**

Outside the North West Shelf, Woodside is producing from two significant oil fields, Laminaria and Corallina, some 500 km north west of Darwin using the FPSO Northern Endeavour. Woodside is also the Operator of other exploration joint ventures and is actively seeking to increase its exploration portfolio.

Phillips Petroleum Company was founded in 1917 and is headquartered in Bartlesville, Oklahoma, USA. The company has a reputation for developing world-scale projects, pioneering technological efforts including LNG processing and creating value through regional infrastructure cooperation. In

April 1999, Phillips acquired BHP's interest in several Timor Sea permits and is the Operator of the Bayu-Undan field.

Shell is a major participant in the Australian upstream oil and gas industry. The company has been exploring for oil and gas onshore and offshore in and around Australia for nearly sixty years. Shell's extensive involvement in LNG projects worldwide has afforded it the opportunity for steady technical improvement in LNG processing. For example, production train size has increased from one million tonnes in the 1960's to planning today for train sizes of more than four million tonnes capacity per year.

Osaka Gas Australia Pty Ltd, a subsidiary of Osaka Gas Company of Japan, is Japan's second largest gas supplier. Osaka Gas is a foundation customer for LNG from the NWS. The company has two LNG receiving terminals and has plans for a third receiving terminal.

1.5 Description of Project

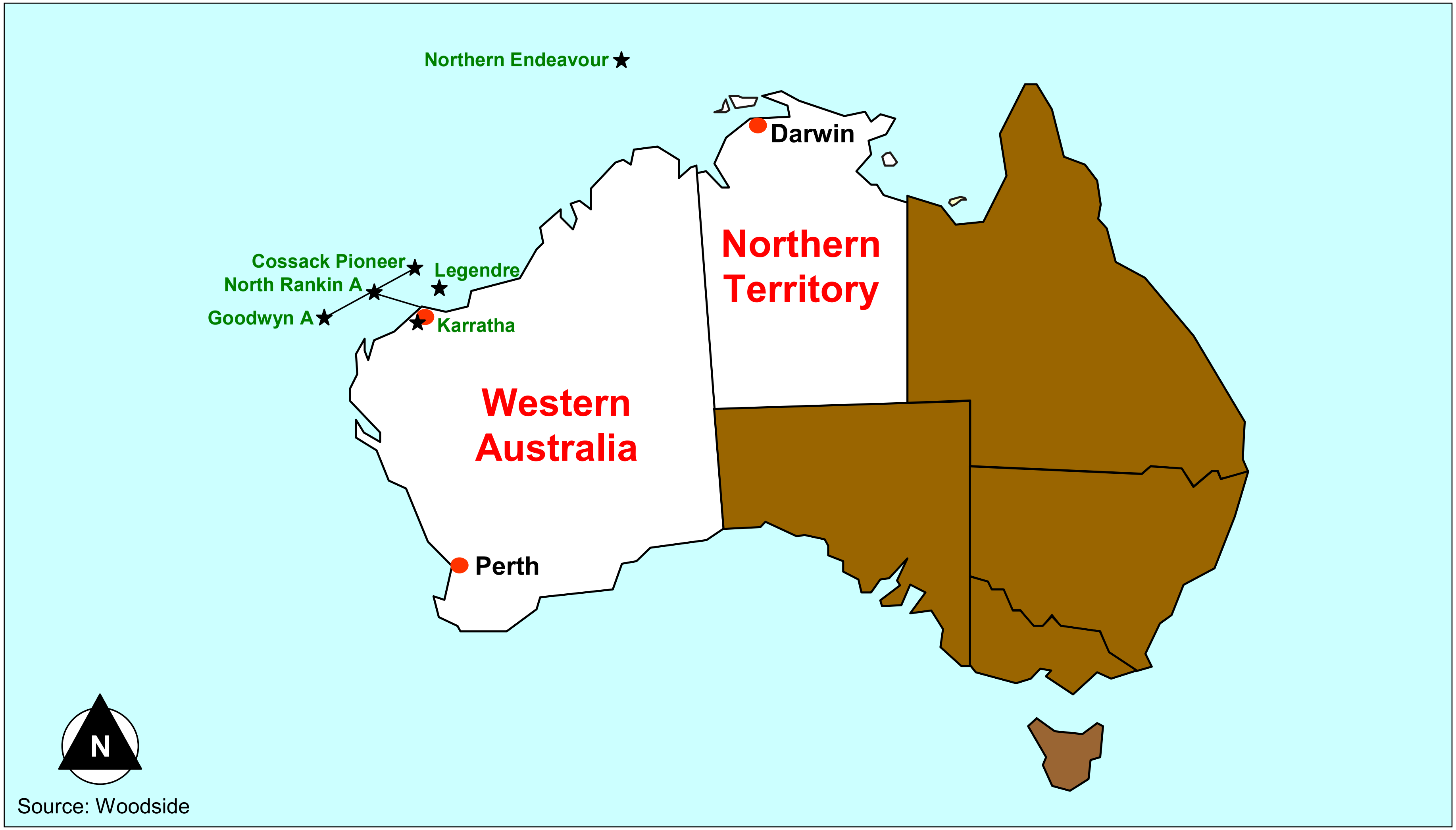
This EIS is focussed on the upstream field development of the gas fields known as Sunrise, which currently have a number of potential downstream customers. The two prime markets for Greater Sunrise gas are Onshore LNG (OLNG) plus other potential domestic customers and Floating LNG (FLNG). The variation in the needs of these customers in terms of gas supply requires that the design and development of the Sunrise Gas Field is able to accommodate gas supply to markets as they emerge. In effect the final design of the upstream field will reflect the downstream customer supply requirements. Therefore this EIS accommodates field development and pipeline infrastructure required to satisfy the markets available to the Sunrise Joint Venture. The final design will be accommodated within the environmental conditions determined in the environmental approvals process.

For clarity it should be recognised that both the OLNG and FLNG plants fall outside the scope of approvals, currently sought for the development of Greater Sunrise and the installation of associated pipelines. FLNG, OLNG and other gas customers will pursue individual environmental and other approval processes as may be appropriate.

To meet the processing and infrastructure requirements of the two prime potential markets, FLNG or onshore customers such as OLNG, the development of Greater Sunrise will entail a broad development with variations in processing and infrastructure requirements depending on which market prevails.

The infrastructure and processing requirements of the Greater Sunrise Gas Field are summarised below. The majority of these processing and infrastructure requirements are included in the scope of this EIS. Those that are not included are the subject of a separate approvals process such as the actual LNG processing plants (OLNG or FLNG).

- Greater Sunrise Field Development comprising:
  - production wells and wellstream gathering infrastructure (flowlines and risers),
  - a produced water re-injection well and infrastructure,
  - reservoir production management and wells control and services functions;
- Production Processing comprising:
  - supply of control and service functions to the Greater Sunrise Field Development,
  - reception and initial separation of the raw Sunrise wellstream into hydrocarbon and produced water streams,
- Infield Processing comprising processing together with appropriate storage and export of the wellstream hydrocarbons into transportable products for example:
  - 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 salesgas (pipeline specification) to Darwin and condensate (tanker specification) to offshore points of sale; or
  - FLNG, comprising condensate (with options for additional products) exported from offshore points of sale.
  - Export pipeline comprising a high pressure subsea hydrocarbons pipeline from the Sunrise infield processing facilities to a Wye point along the proposed Bayu Undan pipeline to Wickham Point.



Source: Woodside

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Woodside's Existing Offshore Assets for Western Australia and Northern Territory

Figure 1-2
Project No.: DE2090.100
Figure prepared by: T.Lee
Date Prepared: 16/10/01

The above processing elements are necessarily supported by utilities, safety and support systems, living quarters and structures.

In the event of an OLNG option being selected, gas processing and metering requirements for Greater Sunrise gas which are not part of this EIS, will take place at an onshore plant such as the LNG Plant proposed by Phillips on Wickham Point Darwin.

The project schedule is presented in **Figure 1-3.** The following is a brief summary of the project schedule, which will be subject to confirmation of design concepts, the identification of suitable markets and agreement on acceptable commercial terms.

The Detailed Design phase of the project may commence in fourth quarter 2002 and will be completed by third quarter 2004. The post-design critical paths in the gas field development are likely to be:

- Fabrication and installation of wellhead platform and associated wells – expected to be completed by second quarter 2006. Drilling will commence more than 12 months before other facilities are installed in the field;
- Installing the Processing, Compression, Utilities and Quarters (PCUQ) substructures (platforms) - expected to be completed by first quarter 2006;
- Installing the PCUQ topsides - expected to be completed by first quarter 2006; and
- Construction of pipeline to connect to Bayu-Undan pipeline or to shore - expected to be completed by first quarter 2006.

By way of example, if current expectations are to be met production from the Greater Sunrise Field Development will commence when suitable gas markets have been established and approved by the appropriate regulatory bodies. This may be as early as Mid-2006, subject to agreement on all outstanding commercial and technical items.

1.6 Legislative Framework and Environmental Approval Process

1.6.1 Introduction

The Environmental Impact Assessment procedure is a formalised process designed to provide information to the regulatory authorities and the public about proposed developments with the potential to impact on the natural and social environment.

The Greater Sunrise Gas Field Development and construction and operation of a subsea pipeline is subject to two separate environmental assessment systems. In Australia all petroleum is the property of the Crown, with the Crown's position expressed in terms of sovereignty and sovereign rights rather than ownership. Offshore exploration and development beyond coastal waters (3 nm) are conducted under the *Petroleum (Submerged Lands) Act 1967*, which for Permit NT/RL2, is jointly administered by the NT and the Commonwealth governments.

The construction and operation of the Sunrise Gas Project therefore requires approval by the Commonwealth Government under the *Commonwealth Environment Protection (Impact of Proposals) Act 1974 (EPIP Act)* and Administrative Procedures. This Act and Procedures are administered by Environment Australia (Environment Protection Group).

As the Sunrise Gas Project, comprising the Greater Sunrise Field Development and associated pipelines, requires assessment under both the Northern Territory and the Commonwealth environmental assessment legislation, the two government bodies have agreed to facilitate a joint assessment. As such both the Minister for the Environment (Commonwealth) and the Minister for the Infrastructure, Planning and Environment (Northern Territory) (NT, DIPE) have set the level of assessment for the project as an EIS. Furthermore, both governments have agreed that the Environment and Heritage Division of the NT DIPE will take the lead role in the assessment process.

The final guidelines issued for the project reflect the recommendations of both governments. The final documentation will be assessed by each jurisdiction, with each government making its own decision.

1.6.2 Northern Territory Environmental Assessment Process

The Northern Territory Minister for Infrastructure Planning and Environment (the Minister) is responsible for administering the *Environmental Assessment Act 1982* and the *Environmental Assessment Act Administrative Procedures 1984,* under which the Act is implemented. A flow chart illustrating the Northern Territory and Commonwealth Government's assessment procedure is presented in **Figure 1-4.**

The Sunrise Gas Project was initially referred to the Minister by Woodside during the second half of 1999. Because the potential environmental impacts associated with the project were viewed as being significant, the level of assessment was set at an Environmental Impact Statement (EIS) and draft guidelines for assessment were issued. Following public review, final guidelines were released on 26 February 1999. The EIS guidelines were amended in August 2000 to reflect the change in project scope at the removal of onshore LNG Processing.

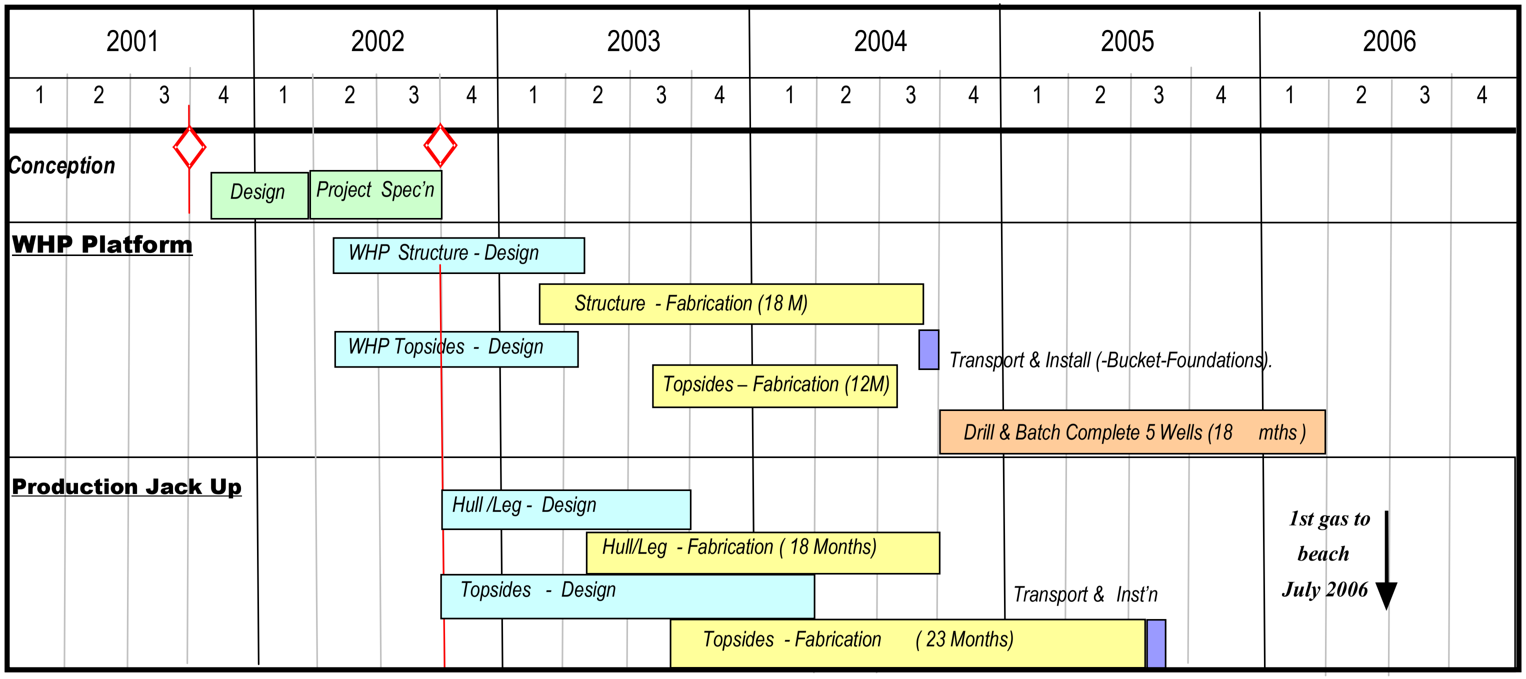
In accordance with the August 2000 guidelines, Woodside as the Proponent has prepared this Draft EIS and associated technical documents, which will be made available for public and government review and comment. In the Northern Territory the period for public review and comment on a draft EIS is a minimum of 28 days. During this period, the draft EIS will be circulated to advisory bodies for comment in relation to their areas of expertise and responsibility.

Following the review period, the Proponent will address the issues raised in submissions from advisory bodies and the public through the preparation of a Supplement to the draft EIS. The two documents, namely the draft EIS and Supplement to the draft EIS, make up the final EIS which is submitted to the Minister for circulation to the various advisory bodies for review and comment prior to decision on approval being made.

1.6.3 Commonwealth of Australia Environmental Assessment Process

The *Commonwealth Environment Protection (Impact of Proposals) Act 1974* (EPIP Act), has been superseded by *the Environment Protection and Biodiversity Conservation* Act *2000* (EPBC Act). However, as the Notice of Intent for the Sunrise Gas Project was submitted prior to the commencement of the EPBC Act on July 16 1999, the EPIP Act is still applicable through the provisions of the *Environmental Reform (Consequential Provisions) Act 1999*. This Act provides for the bridging period between the two Acts. The jurisdiction of the *EPIP Act* will cease if environmental documentation for the Sunrise Gas Project is not submitted by 17 July 2002.

Implementation of the EPIP Act is similar to that for the Northern Territory Government's assessment procedure as the latter was originally modelled on the EPIP Act. As with the Northern Territory *Environmental Assessment Act 1982*, the EPIP process was initiated by the submission of a Notice of Intent, which resulted in the Commonwealth Minister directing the Proponent to prepare a draft EIS to be available for public review for a minimum of 6 weeks. Copies of all public comments will be forwarded to the Proponent, together with comments by Government departments and agencies. As with the Northern Territory process, the final EIS will comprise the draft EIS with a supplement, which responds to the comments received during the public review. Following receipt of the final EIS, Environment Australia will examine the document and prepare an Environmental Assessment Report to the Environment Minister. The Environment Minister will then make comments, suggestions or recommendations to the action Minister (Minister for Industry, Tourism and Resources) on the environmental aspects of the proposal. The action Minister is required to take into account such comments, suggestions or recommendations in making a decision on the proposal.



WHP = Wellhead Platform

Source: Woodside

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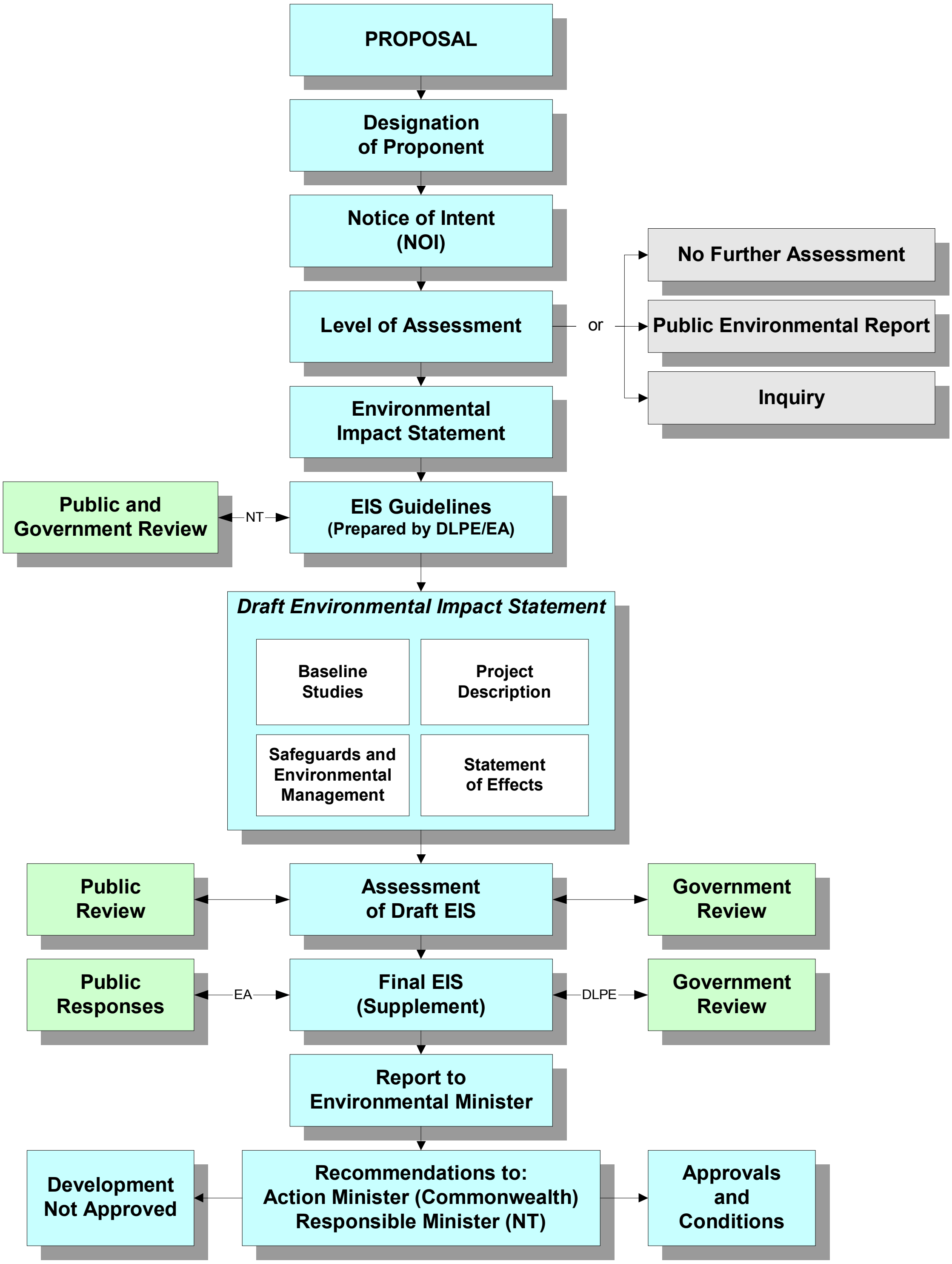
Indicative Project Schedule

Figure 1-3
Project No.: DE2090.100
Figure prepared by: T.Lee
Date Prepared: 16/10/01



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Northern Territory and Commonwealth Assessment Process

Figure 1-4

Project No.: DE2090.100
Figure prepared by: T.Lee
Date Prepared: 16/10/01

1.7 Relevant Legislation

1.7.1 Introduction

All activities associated with the proposal will comply with the legislative requirements established under a combined Territory and Commonwealth Government framework under which the Project will receive environmental, planning and development approvals and authorisations. To obtain a production licence and Foreign Investment Review Board approval, Woodside is required to assess the environmental impact of the proposed project under both Commonwealth and Territory legislation.

Under the Offshore Constitutional Settlement (OCS), Northern Territory coastal waters (within three nautical miles) fall under Territory jurisdiction with petroleum exploration and production activities administered by the NT Government under the *Northern Territory Petroleum (Submerged lands) Act 1982*.

However, the *Commonwealth Petroleum (Submerged Lands) Act 1967* controls exploration and production activities beyond coastal waters (greater than 3 nm) to the outer limit of the Australian Economic Zone (EEZ) at 200 nm. A joint authority formed between the Commonwealth Minister for Resources and Energy and the Territory Minister for Mines and Energy administers this Act. The NT Department of Business, Industries and Resource Development (DBIRD) is the Designated Authority to manage the approvals procedures. The *Petroleum (Submerged Lands) Acts Schedule of Specific Requirements as to Offshore Petroleum Exploration and Production in Waters under Commonwealth Jurisdiction 1997* has been produced by the NT and Commonwealth governments and, therefore both offshore activities are effectively regulated under the same Act, irrespective of whether they are located in NT or Commonwealth waters (Woodside, 2001(d)).

1.7.2 Northern Territory Legislation and Licence Requirements

Table 1-1 lists the known or possible Northern Territory legislative requirements, including licences and permits relevant to the proposed development.

1.7.3 Commonwealth of Australia Legislation and Licence Requirements

All activities conducted during the construction, operation and decommissioning of offshore elements will also be undertaken in accordance with the relevant Commonwealth legislation. Commonwealth legislation and licences that may be applicable to the Sunrise Gas Project are identified in **Table 1-2.**

The following acts were superseded following enactment of the EPBC Act, 1999:
- ☐ Environment Protection (Impact of Proposals) Act 1974.
- ☐ National Parks and Wildlife Conservation Act 1975.
- ☐ World Heritage Properties Conservation Act 1983.
- ☐ Whale Protection Act 1989; and
- ☐ Endangered Species Protection Act 1992.

Although the EPBC Act 1999 has repealed the *EPIP Act 1974*, this project is still designated under the *EPIP Act 1974* by virtue of the *Environmental Reform (Consequential Provisions) Act 1999,* which provides for the bridging period between the two Acts. Although most of the above-mentioned legislation is no longer valid, the EPBC Act 1999 incorporates many relevant aspects of the superseded legislation.

1.7.4 International Treaties and Obligations

One of the principal international agreements governing petroleum operations in both State and Commonwealth waters is the *United Nations Convention on the Law of the Sea, 1982 (UNCLOS)*. UNCLOS outlines a legal framework for marine environment protection. It imposes obligations on parties to prevent, reduce and control marine pollution from various pollution sources, for example, from vessels, land and air. A system for the enforcement of national marine pollution laws was later introduced.

Other international agreements to which Australia is a signatory and which may impact on petroleum activities in both NT and Commonwealth waters, as well as onshore, include:

- *Framework Convention on Climate Change 1992 and Kyoto Protocol 1997* – the aim of which is to stabilise greenhouse gas concentrations to prevent interference with climate.
- *Timor Sea Arrangement*– see below.
- *International Convention on Civil Liability for Oil Pollution Damage 1969.*
- *International Convention on Oil Pollution Preparedness, Response and Cooperation 1990.*
- *International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties 1969.*
- *Protocol to International Convention on the Prevention of Marine Pollution by Dumping of Waste and Other Matter 1972 (London Dumping Convention).*
- *Treaty Establishing an Exclusive Economic Zone Boundary and Certain Seabed Boundaries (1997)* – Signed in march 1997 this treaty covered three areas remaining for the maritime boundary delineation between Australia and Indonesia.
- *International Convention for the Protection of Pollution from Ships and Associated Protocols (MARPOL73/78) as implemented in Commonwealth waters through the Protection of the Sea (Prevention of Pollution from Ships) Act 1983.*
- *Vienna Convention on the Protection of the Ozone Layer and the Montreal Protocol on Substances that Deplete the Ozone Layer.*
- *Agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds and Birds in danger of Extinction and their Environment – (Japan Australia Migratory Bird Agreement or JAMBA).*
- *Agreement between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment (China - Australia Migratory Bird Agreement or CAMBA).*
- *Convention on Biological Diversity 1992.*
- *Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) 1979.*
- *Convention on Wetlands of International Importance (Ramsar Convention) 1971.*

A number of the most pertinent treaties and obligations are summarised below.

Timor Sea Arrangement

At the time of the signing of the Seabed Agreement between Australia and Indonesia in 1972, East Timor was not part of Indonesia. Therefore in the area lying between East Timor and Australia there was a gap in the agreed boundary, which became known as the Timor Gap.

Following Australia's recognition of Indonesia's incorporation of East Timor, negotiations to resolve the Timor Gap boundary commenced. A decade of negotiations was closed with the signing of the Timor Gap Treaty in December 1989. The Treaty came into force in February 1991 and covers about 65,000 square kilometres.

The Treaty, which used the framework provided by the *1982 United Nations Convention on the Law of the Sea (UNCLOS),* allowed for the exploration and exploitation of the petroleum resources of the Gap. Where claims by Australia and Indonesia to the 200 nm exclusive economic zones overlapped, Zones of Cooperation (ZOC) to share the resources were established. The central zone, Area A (formed ZOCA), was jointly controlled by Indonesia and Australia. The southern zone, closer to Australia, was Area B, and controlled by Australia. The northern zone, Area C, is closer to East Timor and was controlled by Indonesia. The Treaty was a provisional agreement entered into for an initial term of 40 years.

Subsequently in July 2001, a Memorandum of Understanding (MoU) incorporating the 'Timor Sea Arrangement' was drawn up between Australia and UNATET, representing East Timor, to take effect upon East Timor's independence due in May 2002. This embodies the arrangements for the exploration and exploitation of the tentatively named 'Joint Petroleum Development Area' (JPDA) (superseding the Zone of Cooperation) pending a final delimitation of the seabed between Australia and East Timor. East Timor and Australia now jointly controls, manages and facilitates the exploration, development and exploitation of the petroleum resources of the JPDA.

Approximately twenty percent of the Greater Sunrise reserves lie within the JPDA, established between Australia and East Timor under the Timor Sea Arrangement. However, the production facilities (ie platforms) will be located within Australian waters and the Joint Authority, the JPDA regulatory authority, will comment on the EIS within the process outlined above.

In accordance with Annex E under Article 9 (b) of this Arrangement, East Timor and Australia agree to unitise the Sunrise and Troubadour deposits on the basis that 20% of the gas field lies within JPDA. The construction and operation of a pipeline within the JPDA for the purposes of exporting petroleum from the JPDA shall be subject to the approval of the Joint Commission.

The Timor Gap is administered by the Joint Authority, representing the Australian and East Timorese interest in the area. The Joint Authority is kept closely informed about the proponent's activities and is advised of progress toward the required environmental approvals.

Framework Convention on Climate Change

Australia's annual National Greenhouse Gas Inventory (NGGI) is supplemented by periodic State and Territory inventories. Each inventory is a database of human-induced greenhouse gas emission sources and sinks categorised into six sectors:

- Energy;
- Land Use Change & Forestry;
- Agriculture;
- Industrial Processes;
- Solvent & Other Product Use, and
- Waste.

The publication of inventories fulfils both an international commitment under the *Framework Convention on Climate Change*, and domestic requirements. The Inventory forms a baseline from which it is possible to identify trends and patterns in sectors and monitor response action.

Table 1-1 Northern Territory Licences and Permits

Licence Required	Legislation	Responsible Agency	Relevance
Possibly	*Northern Territory Petroleum (Submerged Lands) Act 1981*		Authorisation for construction and operation of a pipeline.
	Darwin Port Authority Act 1983		Consent regarding the use of the port and associated activities.
Authority Certificate	*NT Aboriginal Sacred Sites Act 1989.*	NT Aboriginal Areas Protection Authority	Undertake work or use land and manage impacts on Aboriginal sacred sites.
	Northern Territory Building Act 1993		
N/A	*Marine Pollution Act 1999*	DIPE - formerly Department of Transport and Works -Marine Branch	To protect the marine and coastal environment by minimising intentional and negligent discharges of ship sourced pollutants into coastal waters.
Management of Waste	*NT Waste Management and Pollution Control Act 2001*	DIPE	
Store and Possess Dangerous Goods	*NT Dangerous Goods Act 1996 & Regulations*	Work Health Authority	

Licence Required	Legislation	Responsible Agency	Relevance
	(1994)		
Waste disposal, mosquito control	*Public Health Noxious Trades Act 1982, Public Health Sanitation Regulations*	Territory Health Services	Requires refuse disposal to an approved engineered landfill and management of mosquito breeding.
	National Environment Protection Council (Northern Territory) Act 1994 & National Environment Protection (National Pollutant Inventory) Measure.	Environment & Heritage Division (DIPE)	National Pollution Inventory (NPI) - Industrial facilities are required to estimate and report annually their emissions of NPI listed substances.
	Territory Parks and Wildlife Conservation Act 1996		For interference with protected wildlife, parks and reserves.
	Waste Management and Pollution Control Act 1998 and Regulations		Provides legislation to ensure appropriate waste management
Ministerial consent to disturb Heritage Conservation Areas	*NT Heritage Conservation Act 1991*	DIPE	Consent from the Minister required to disturb sites of European, Aboriginal or Macassan occupations
Crown Property Lease or Licence	*NT Crown Lands Act 1992*	DIPE	Activities on land and in certain waters may require a permit of licence issued by Minister of DIPE.
Sea Dumping	*NT Environment Assessment Act 1982, NT Water Act 1992, Darwin Port Authority 1993*	DIPE with Darwin Port Authority	Allows the loading and disposal of specified waste and other material in Territory coastal waters (3 Nm)
Land Use Rezoning	*NT Planning Act 1993*	DIPE	Rezoning of land not appropriately zoned for its end-use.

Table 1-2 Commonwealth Legislation and Licences

Licence Required	**Legislation**	**Responsible Agency**	**Relevance**
Offshore Petroleum Pipeline Licence	*Commonwealth Petroleum (Submerged Lands) Act 1967 (ie. Beyond 3 nm)*	NT Dept of Mines & Energy (Energy Division)	Licence to allow the construction and operation of pipeline for transport of petroleum beyond 3nm
	Environment Protection (Impact of Proposals) Act 1974.		
	Australian Ballast Water Management Guidelines & Australian Quarantine and Inspection Services (AQIS) regulations.		Ballast water discharge into Australian territorial waters.
Environment Plan or HSE Case	*Petroleum (Submerged Lands) (Management of Environment) Regulations 1999;*		
	Petroleum (Submerged Lands) Act 1967; Petroleum (Submerged Lands) Acts Schedules.		Specific Requirements as to Offshore Petroleum Exploration and Production 1995 (regulates both State and Commonwealth activities). P(SL)A Schedule Clause 222 relates to the discharge of sewage/grey water & putrescible galley waste disposal.
Industrial Chemicals	*National Occupational Health & Safety Commission Act 1985*	Worksafe Australia	All industrial chemicals manufactured /imported into Australia must be assessed.
	Protection of the Sea (Prevention of Pollution from Ships) Act 1983 ie. MARPOL.		This Act may not be relevant.
Permit to Disturb or Recover Historic Shipwrecks or Relics	*Commonwealth Historic Shipwrecks Act 1976*	Dept of Communications & the Arts (Heritage Protection Section)	Permit is required for disturbance or recovery of shipwrecks.
Permit to undertake Prohibited Activity in Protected Zones	*Commonwealth Historic Shipwrecks Act 1976*	Dept of Communications & the Arts (Heritage Protection Section)	Permit required to conduct activities within a protected zone – specified radius around wrecks.
Approval & notification required for activities in Naval Waters in Darwin Harbour	*Control of Naval Waters Act 1918*	Dept of Defence	Notification required for activities in naval waters to Commanding Officer, HMAS Coonawarra, Darwin
	Australian Maritime Safety Authority Act 1990		Minimise interference with shipping traffic and recreational vessels
	Aboriginal and Torres Strait Islander Heritage Protection Act 1984		If the proposal is likely to interfere with significant Aboriginal or Torres Strait Islander Areas and any party is disaffected with the Territory legislative process.
Agreement with Traditional Owners	*Aboriginal Land Rights Act 1976*		If the proposal is likely to impact on any extant or claimed native title interests. If the proposed development is likely to encroach on any Aboriginal lands (claimed or awarded).
	Civil Aviation Safety Authority Act		
	Hazardous Waste (Regulation of Exports and Imports) Act 1989		
	Native Title Act 1993		
	Ozone Protection Act 1989		
	Wildlife Protection (Regulation of Exports and Imports) Act 1982		
	Australian Heritage Commission Act 1975		If the proposal is likely to impact on any place entered on the Register of the National Estate.
	Protection of Movable Cultural Heritage Act 1986		
	Air Services Act 1995		

Kyoto Protocol

In 1998, Australia signed the Kyoto Protocol, a set of binding targets for industrialised countries to reduce the emission of greenhouse gases. Australia is yet to ratify the Kyoto Protocol, after which the greenhouse targets become legally binding. If ratified, Australia's target will require limiting the growth of greenhouse gas emissions to 8% above 1990 levels by 2008-12.

JAMBA & CAMBA

In accordance with JAMBA and CAMBA, the governments of Australia, Japan and the People's Republic of China have agreed to protect migratory birds and their important habitats by:

- Preserving and enhancing important habitat used by migratory birds listed in the agreement;
- Encouraging joint research programmes and sharing the information gained;
- Establishing sanctuaries and other facilities for the management and protection of migratory birds and their habitats;
- Preventing damage to migratory birds and their habitats, and encouraging their conservation;
- Meeting regularly to report on progress and develop new initiatives; and
- Generally prohibiting the removal, sale, purchase or exchange of migratory birds and their eggs.

1.8 Land Use Planning

While not part of the scope of this EIS, land use planning is relevant in the context of the provision of gas to shore. The landfall for gas, in accordance with the Phillips proposal for onshore LNG production, is Wickham Point on the Middle Arm Peninsula.

Middle Arm Peninsula lies within the Shire of Litchfield and the primary NT Planning Scheme document of relevance is the "*Proposed Litchfield Planning Concepts and Land Use Objectives, 2001*". This document recognises the Middle Arm Peninsula, with its deep water access and proximity to port and urban infrastructure, as suitable for major industrial development.

The above-mentioned document is currently the subject of the processes of the *Planning Act (NT) 1999* and will form the basis for amendments to the NT Planning Scheme. When approved, this document will become an "incorporated document" and will provide for amended "development provisions" pursuant to the Act.

1.9 EIS Scope and Structure

The EIS is structured on the guidelines issued in response to the Notice of Intent (NOI) submitted by Woodside (as operator of the Sunrise Gas Project) to the NT Government (Department of Infrastructure, Planning and Environment) and the Federal Government (Environment Australia) seeking the determination of the required level of environmental assessment for the Sunrise Gas Project (refer to **Appendix A**). At that time, the scope of the project included the offshore field development, a trunkline from Sunrise to Darwin and the establishment of an LNG facility at Glyde Point. In August 2000, the NOI and EIS guidelines were amended to exclude the onshore LNG plant, but maintained the option of either onshore or offshore gas processing, condensate and LPG removal at Glyde Point. The trunkline route was confirmed as a Shoal Bay landfall with an onshore section to Glyde Point. The scope of the EIS no longer includes facilities at Glyde Point, shore approaches at Shoal Bay or access corridors to Gunn Point. The items which were included in the original NOI and which have now been excluded from the current EIS comprise:

- Construction and operation of a domestic gas processing plant at Glyde Point and supply pipeline from Glyde Point to the existing gas network;
- A jetty for loading of products for export;
- LNG Processing Plant & Storage Tanks;
- Onshore power generation facilities;
- Loading jetty for LNG ships;

- Rock quarry;
- Construction camp;
- Utilities provision; and
- Service corridor for onshore gas pipeline

As discussed, the two potential scenarios are under consideration for the Greater Sunrise Field Development and comprise:

- Option One – a combination of subsea and/or Wellhead Platform (WHP) Wells with gas and condensate processing by way of offshore processing, storage, export, utilities and quarters facilities. Under this option, gas and condensate would be exported to Darwin via an export pipeline to the proposed Darwin LNG facility.
- Option Two - a combination of subsea and WHP wells, with gas and condensate exported to a Floating LNG (FLNG) facility via a series of flowlines and risers. Under this option produced formation water including production chemicals may be transferred from the FLNG back to the field for re-injection.

For clarity it should be recognised that both the OLNG and FLNG plants fall outside the scope of approvals currently sought for the development of the Greater Sunrise gas fields and the installation of associated pipelines. FLNG, OLNG and other gas customers will pursue individual environmental and other approval processes.

The scope of this EIS therefore comprises the following major components:

- Offshore production facilities including production wells, subsea infrastructure and offshore processing, storage, export, utilities and quarters facilities (fixed and/or floating platform structures); and
- Export gas pipeline from the Greater Sunrise Field to a tie in point, known as the Wye, to the Phillips Bayu-Undan pipeline which is proposed to go from the Bayu Undan gas field to Wickham point .

Furthermore, proposals to establish industrial estates at Middle Arm and Glyde Point and service corridors to connect both estates to the gas supply at Wickham Point, are the subject of separate environmental assessments initiated by the NT Government.

The EIS scope for both OLNG and FLNG scenarios are discussed further in **Chapter 3** and illustrated in **Figures 3-1a** and **3-1b**, respectively.

The EIS includes the following main chapters:

Executive Summary

Chapter 1: Introduction

Chapter 1 serves as an introduction to the project providing information on the background to the project, the Proponent, legislation, lead-in studies and planning issues.

Chapter 2: Objectives and Benefits

Chapter 2 discusses the objectives and benefits of the proposal with socio-economic, production and environmental objectives detailed and as such justifies the need for the project.

Chapter 3: Description of Design and Construction Phases

Chapter 3 is concerned with the Project Description of offshore facilities and the associated pipeline. This chapter examines installation and construction procedures where appropriate. It considers the pipeline system and deals with aspects associated with the operation of the pipeline.

Chapter 4: Description of Operation and Decommissioning Phases
The operation, maintenance and decommissioning of the offshore facility and export pipeline are described in this chapter.

Chapter 5: Alternatives
In line with EIS requirements, various types of alternatives are discussed in Chapter 5 including alternative pipeline routes, platform locations and the 'Do Nothing Scenario'. The pipeline route selection process is also described, including a summary of the environmental and engineering factors that lead to selection of the final route.

Chapter 6: Existing Environment
Chapter 6 describes the Existing Environment prior to construction, with an outline of the baseline studies conducted. A detailed description of the Physical, Biological, and Cultural environment is provided.

Chapter 7: Socio-Economic Environment
Chapter 7 provides information on the socio-economic environment of the region. Included is information on the transport system, accommodation facilities, demographics etc.

Chapter 8: Environmental Impacts and Mitigation Measures
Chapter 8 discusses the predicted and possible impacts. The chapter also describes the mitigation measures proposed in order to eliminate or reduce impacts resulting during the different phases of the project. A summary of the hazard analysis undertaken to date is provided in this section also.

Chapter 9: Draft Environmental Management Plan
The Draft Environmental Management Plan (EMP) provides a framework for environmental management, as specified in the DIPE Guidelines. Proposed monitoring programmes and reporting arrangements are also outlined. Proponent's obligations are outlined at the end of this Chapter.

Chapter 10: Public Involvement and Consultation
Chapter11 summarises the strategy implemented to ensure the community were given the opportunity to receive detailed information on the project and provide their feedback on any issues or concerns they may have.

Information sources, glossary and appendices providing detailed and technical data are included at the back of the report.

2. Objectives and Benefits of the Proposed Project

2.1 Socio-Economic Objectives and Impacts

The Sunrise Gas Project market vision is:

'to establish a basis for the profitable development of the Sunrise and Troubadour gas fields, within a supportive community environment'.

Undeveloped reserves of gas contribute nothing to economic development and community living standards. For the economies and citizens of East Timor, the Northern Territory and the rest of Australia to benefit from the Greater Sunrise reserves in the Timor Sea, the fields (Sunrise and Troubadour) must be developed and commercial sales made to customers.

Development and production of the gas and condensate under both FLNG and OLNG scenarios for transportation to shore will benefit the various economies through:

- The front-end engineering and design phase, where Australian and international expertise will apply the latest design concepts and technologies to design world class facilities. Ongoing design work is expected to employ 100-150 highly skilled engineers and support staff in Perth;
- The construction phase when skilled labour sourced from Darwin and the rest of Australia will work offshore to assemble and commission modular units of plant that maybe constructed locally or overseas; and
- The operations phase when gas is produced and used by customers. The offshore production facilities will be staffed by skilled personnel on offshore rosters while based predominantly in Darwin. The number of operations personnel is uncertain at this stage. Logistics support is likely to be based in Darwin.

Natural gas, when used as fuel, produces approximately half the greenhouse gas emissions of other fossil fuel alternatives on a lifecycle basis. In this respect, the development of natural gas supply for domestic and international markets provides tremendous opportunities for continued economic development in Australia. To the extent that gas can be utilised in place of alternative fossil fuels, global emissions will be reduced in line with the National Greenhouse Strategy.

2.1.1 Benefits to the Local Workforce & Economy

The Sunrise Gas Project will introduce many benefits to Darwin and Australia in general, and East Timor. The design phase will provide opportunities for skill and knowledge transfer essential to maintaining regional capability in the oil and gas sector. Local construction and service industries will be called on to support the installation of large capital items, leading to a boost in short term jobs in the construction industries and in industries supplying inputs to construction. Capital goods supplying industries will also experience an increase in demand.

Once the project enters its operations phase permanent jobs will be created in running the production facilities and providing the logistics support.

2.1.2 Benefits to Australia

The profitable production and sale of gas and condensate from the Sunrise and Troubadour fields (which lie 80% in Australian waters and 20% in the Joint Petroleum Development Area, JPDA) will result in substantial tax revenues flowing to the Australian and East Timor Governments. 80% of the project will be subject to Petroleum Resource Rent Tax (tax rate of 40% of net revenues after capital cost recovery) and Australian company tax of 30%. 20% of the project will be subject to petroleum and company taxation of up to an effective rate of 65%, predominantly flowing to East Timor. The amount of taxation depends on the development concept chosen, the price of gas negotiated with onshore and/or offshore gas customers, and world oil prices.

The export of condensate and downstream products will generate income through foreign exchange. This will add to national income and the consumption prospects of the Australian community.

The extraction of natural gas will add to Commonwealth government revenue directly through the Petroleum Resource Rent Tax levied on gas and condensate production and company tax paid on profits. It will also add indirectly to both Northern Territory and Commonwealth government revenue by expanding economic activity, employment, income, expenditure and hence the tax base in the Northern Territory and rest of Australia. This in turn will enhance the capacities of both governments to support desirable social expenditures, including infrastructure development.

The taxes paid by the Sunrise Joint Venturers will enable future governments to reduce taxation on other segments of the Australian economy thereby stimulating additional economic activity and job creation. In addition, the local economy is likely to benefit from the construction and operation of processing facilities built by our gas customers. The owners of downstream facilities will pay their own taxes, create additional export earnings (or replace imports) and employ additional staff.

Social benefits from Sunrise development will also be felt, predominantly in the Darwin area. These include:

- Improved job prospects in high technology / high skills industry;
- Influx of tertiary educated staff and families;
- Increased national and international recognition of Darwin as a centre for industry;
- Improved skills in complex industrial and commercial matters within the Northern Territory public service; and
- Sponsorships by Sunrise Joint Venture companies who wish to build a strong and long-term relationship with local communities.

It is in Australia’s strategic interests for all its neighbours to be prosperous and to have a sound economy capable of meeting the aspirations of its citizens. Development of Sunrise will make a substantial contribution to the economy of East Timor, which will decrease East Timor’s reliance on foreign aid including aid from Australia.

2.1.3 Benefits to East Timor

For East Timor, taxation revenues flowing from the development of Sunrise and Troubadour will be a major source of revenue lasting some 20–30 years from the start-up of production.

The development of the Greater Sunrise gas and condensate fields will secure a long term source of tax revenue for East Timor as well as direct revenue from the Production Sharing provisions of the Timor Sea Arrangement. Direct employment opportunities on the facilities will also emerge for those who acquire the necessary skills through education and training programs currently being established. Education, training and employment initiatives associated with the Project will provide both broad capacity development and economic multiplier effects in the East Timorese economy.

Furthermore, there is the potential for East Timorese involvement in logistics and support operations to the offshore facilities should this be commercially viable. A study is being undertaken to determine East Timor’s capacity in this regard.

Already, East Timor’s ability to borrow funds for essential community projects has been enhanced by the prospect of secure taxation flowing from Sunrise. The petroleum sector is likely to dominate the economy of East Timor for many years.

Social benefits to East Timor from the Sunrise development include:

- ❑ Improved education and job prospects in high technology / high skills industry;
- ❑ Improved skills in petroleum and commercial matters within the East Timorese public service;
- ❑ A sense of national pride by being part of a world-class petroleum development; and
- ❑ Sponsorships by Sunrise Joint Venture companies who wish to build a strong and long-term relationship with local East Timor communities.

2.2 Meeting Market Demand

The Greater Sunrise Gas resource is estimated to contain around 9 tcf of recoverable natural gas and 320 million barrels of condensate.

This is a significant volume of gas, which could supply a range of export orientated downstream gas consuming projects (LNG, methanol, chemicals, alumina refining) as well as providing gas for domestic consumption (either via power generation or gas transmission/distribution systems) in the Northern Territory and possibly beyond. Australia's current and proposed pipeline systems are illustrated in **Figure 2-1.**

2.3 Impacts on Local Economic Activities

2.3.1 Commercial Fisheries

The Sunrise Gas Field lies entirely to the north of the Australian Provisional Fisheries Surveillance and Enforcement Line, yet is within the Agreed Seabed Boundary between Australia and Indonesia. This means that pelagic fish stocks are under the jurisdiction of Indonesia and East Timor; however, demersal fish stocks fall under the jurisdiction of the Australian Government.

Fisheries under Indonesian and East Timorese jurisdiction in the Sunrise Gas Field area are not actively managed. Over time, East Timorese management of its fisheries will emerge. Woodside will work closely with the East Timorese authorities to ensure co-existence. Discussions with officers from the Australian Fisheries Management Authority (AFMA), and findings from previous investigations undertaken on behalf of Woodside by Sinclair Knight Merz (1993), indicate that in terms of commercial fisheries the region is only lightly exploited by longline fishermen. Sharks are the main target species, with fishing concentrated in the deeper waters.

There are currently no major Australian fishing interests or activities in the Sunrise Gas Field area. AFMA catch and effort returns indicate that only one Australian vessel has fished in the Sunrise Gas Field area in the past few years. The closest Australian commercial fishery to the Sunrise Gas Field is the Timor Reef Fishery, which is located in the ‘Timor Box’ area, approximately 75 km south east of the gas field (**Figure 2-2**).

It should be noted also that some traditional fishing is likely in the vicinity of Sunrise Gas Project area given the proximity (150 km) of the Sunrise Gas Field to Timor.

A safety zone of 500 m around the platforms and FSO will be maintained during operation. A further exclusion zone will be sought from the authorities and marked on navigation charts. The presence of the facility and its anchors means that fishing boats will need to avoid the area to prevent fouling anchor chains or other accidents. This exclusion is not likely to have any significant impact on fishing activities.

The pipeline route will have a suitable level of protection to guard against potential vessel damage and will be clearly marked on all maritime and navigation charts. During construction there will be an anchoring exclusion zone along the pipeline corridor. Extensive consultation with all harbour users, including fishermen and the Seafood Council will take place to establish agreement on the best way forward to protect the pipeline with minimum if any disturbance to the fishing community, and this would be done as part of the detailed studies.

2.3.2 Commercial Shipping

Two shipping lanes run to the west of the Sunrise Gas Field, and the Sunrise to Wye pipeline would cross these lanes.

The types of vessels using shipping lanes in the Timor Sea area include rig tenders, navy ships, tankers, livestock, bulk cargo and car carriers, container and general cargo vessels, barges and passenger vessels.

The number of vessels recorded by the Darwin Port Corporation visiting Darwin Port between September 1999 and September 2000 was 2059. Rig tenders (497), livestock carriers (413), navy vessels (392) and container ships (216) make up 73 per cent of the total number of vessels. Pearling vessels, yachts, ferries, fishing and pleasure boats make up a very small proportion of the total.

Several cruise ships enter Darwin Port each year. From September 2001 to November 2002, 22 cruise ships are expected to arrive and depart Darwin Port. Of the 22 cruise ships arriving in Darwin, 6 are expected to travel from Bali, one from Palau and one from Timor/Indonesia. Four ships are bound for Cairns, one for Timor/Indonesia, one for Brisbane and one for Bali.

The offshore facility will be well lit at night and during times of poor visibility, and its presence is unlikely to affect local shipping. A safety zone of 500 m will be maintained around the platforms and FSO. The presence of the facility and anchors means that shipping will need to avoid the area to prevent fouling anchor chains or other accidents. This exclusion is not likely to have any significant impact on shipping activities.

2.3.3 Other Activities

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

2.4 Local, Regional and Global Environmental Objectives

2.4.1 Environmental Policy Objectives

As operator of the Sunrise Gas Project, the policies and standards of Woodside will be applied to the design and operation of the facilities.

Woodside recognises that operations are carried out in environmentally sensitive areas, and shares the desire of the community to develop natural resources in a way, which protects people and the environment. All activities will be planned and performed so that adverse effects on the environment are either avoided or kept to an acceptable level while meeting all statutory requirements.

Woodside has a corporate environmental policy that provides a public statement of the corporate commitment to protecting the environment as well as a number of individual policies aimed at managing specific environmental issues such as:

- Waste Minimisation and Disposal Policy - Woodside will ensure that all waste management practises are undertaken in an environmentally acceptable manner;
- Flaring and Venting Policy; and
- Ozone Depleting Substance (ODS) Policy.

Woodside's Environmental Policy is contained in **Appendix B.**

At a later stage of the project Woodside will possibly develop project-specific policies, customised to the requirements and processes of the Sunrise Gas Development.

2.4.2 Occupational Health and Safety Objectives

Woodside employs a structured approach to the management of Health, Safety and Environment (HSE) issues via a formal and documented HSE management system (HSE-MS). The HSE-MS ensures that impacts from Woodside's operations are either avoided or kept "as low as reasonably practicable" (ALARP), and it also drives continuous improvement in the company's environmental performance. The HSE-MS assists in providing confidence to regulators, stakeholders and the community that Woodside is responsibly fulfilling its environmental responsibilities.

Woodside believes that all injuries are preventable and that striving continuously to improve the health and safety of all employees, contractors and third parties who are impacted by Woodside activities is fundamental. Woodside's Health and Safety Policy is included in **Appendix B**.

2.4.3 National Greenhouse Strategy Implications

The National Greenhouse Strategy (NGS), released in November 1998, was developed by the Commonwealth and State and Territory Governments, with input from the Australian Local Government Association, industry and the community. It maintains a comprehensive approach to tackling greenhouse issues, and details both existing and additional measures aimed at improving our awareness and understanding of greenhouse issues, limiting the growth of emissions and enhancing greenhouse sink capacity, and developing adaptation responses.

The NGS provides the strategic framework for an effective greenhouse response and for meeting current and future international commitments. It provides an impetus for action by governments, stakeholder groups and the community and leaves Australia in good stead to meet the Kyoto Protocol targets.

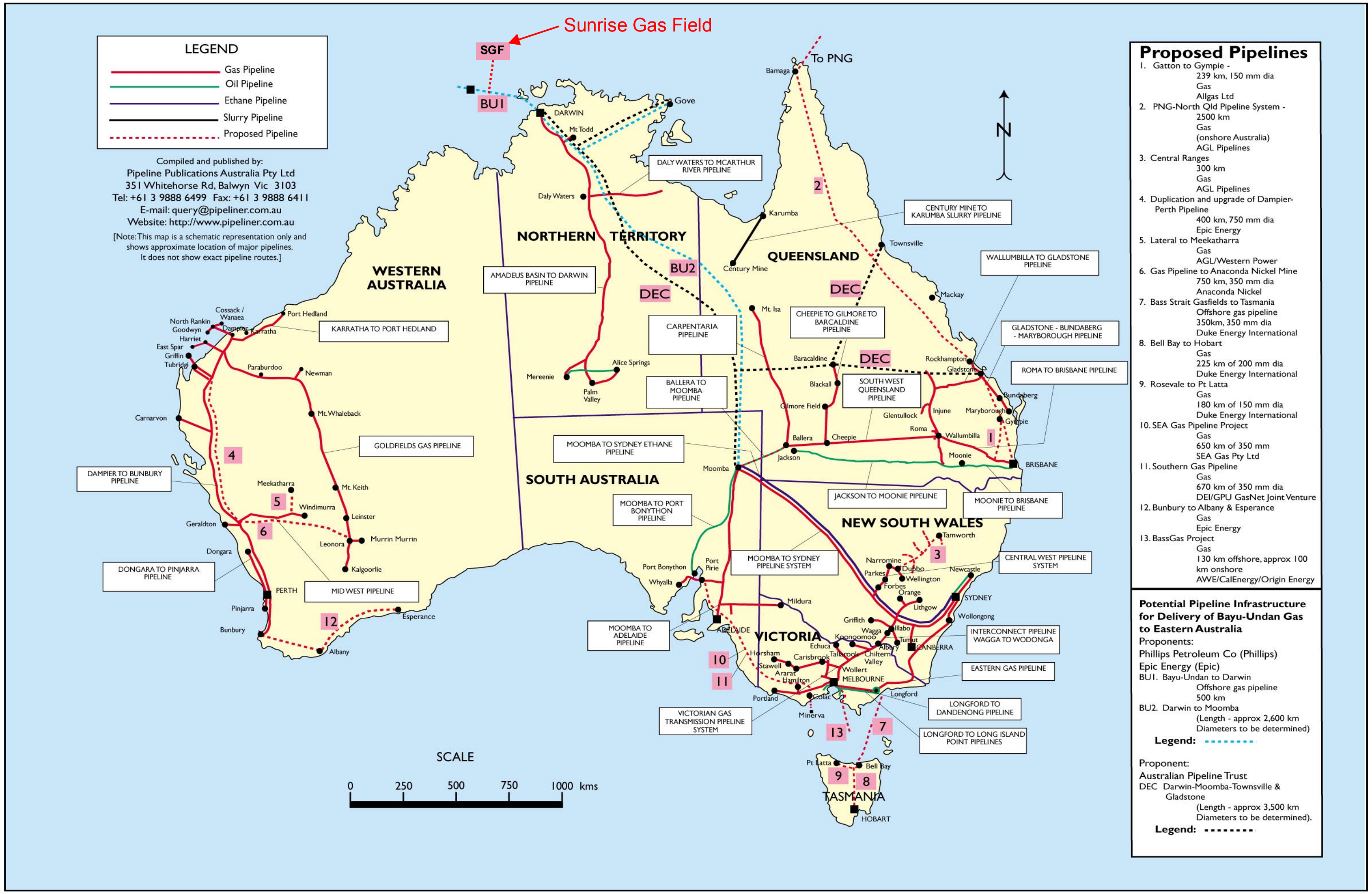
Continued energy market reform is a key element of Australia's greenhouse response and of the NGS. Progressive restructuring of the electricity and gas industries over the last decade has led to greater competition amongst generators, supply efficiency improvements, and innovative promotion of renewable energy.

Further reforms outlined in the NGS include the delivery of consistent and compatible national frameworks for gas and electricity by 2002, and removal of barriers for grid connection of small scale generation, such as from co-generation and renewable sources.

Governments are working with industry to pursue strategies for energy industries to abate greenhouse gas emissions. Furthermore, electricity retailers and other large electricity buyers will be legally required to purchase 2 per cent of their electricity from renewable or specified waste-product energy sources by 2010.

The Northern Territory's response to the Greenhouse Strategy was in the form of several objectives, one of which stipulates that operators of onshore and offshore oil and gas facilities must reduce greenhouse gas emissions to as low as reasonably practicable. The end result was the promulgation of environmental regulations under the *Petroleum (Submerged Lands) Act*, which requires all oil and gas producing companies to submit environmental management plans incorporating emissions reporting (http://ngs.greenhouse.gov.au/action_plans/module7/measure7.1/nt.html).

Woodside is making concerted efforts to reduce Greenhouse emissions, as a voluntary participant in the Commonwealth Government's Greenhouse Challenge launched in 1995. The Greenhouse Challenge is a joint voluntary initiative between the national Government and industry to abate greenhouse gas emissions. Participating organisations sign agreements with the Government that provide a framework for undertaking and reporting on actions to abate emissions. The Greenhouse Challenge has been highly effective in achieving greenhouse gas emissions abatement, and in building the capacity of both Government and industry to identify, monitor, manage and report greenhouse gas emissions.



LEGEND

- Gas Pipeline
- Oil Pipeline
- Ethane Pipeline
- Slurry Pipeline
- Proposed Pipeline

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[Note: This map is a schematic representation only and shows approximate location of major pipelines. It does not show exact pipeline routes.]

Proposed Pipelines

1. Gatton to Gympie -
   239 km, 150 mm dia
   Gas
   Allgas Ltd
2. PNG-North Qld Pipeline System -
   2500 km
   Gas
   (onshore Australia)
   AGL Pipelines
3. Central Ranges
   300 km
   Gas
   AGL Pipelines
4. Duplication and upgrade of Dampier-Perth Pipeline
   400 km, 750 mm dia
   Epic Energy
5. Lateral to Meekatharra
   Gas
   AGL/Western Power
6. Gas Pipeline to Anaconda Nickel Mine
   750 km, 350 mm dia
   Anaconda Nickel
7. Bass Strait Gasfields to Tasmania
   Offshore gas pipeline
   350km, 350 mm dia
   Duke Energy International
8. Bell Bay to Hobart
   Gas
   225 km of 200 mm dia
   Duke Energy International
9. Rosevale to Pt Latta
   Gas
   180 km of 150 mm dia
   Duke Energy International
10. SEA Gas Pipeline Project
   Gas
   650 km of 350 mm
   SEA Gas Pty Ltd
11. Southern Gas Pipeline
   Gas
   670 km of 350 mm dia
   DEI/GPU GasNet Joint Venture
12. Bunbury to Albany & Esperance
   Gas
   Epic Energy
13. BassGas Project
   Gas
   130 km offshore, approx 100 km onshore
   AWE/CalEnergy/Origin Energy

Potential Pipeline Infrastructure for Delivery of Bayu-Undan Gas to Eastern Australia

Proponents:
Phillips Petroleum Co (Phillips)
Epic Energy (Epic)

BU1. Bayu-Undan to Darwin
Offshore gas pipeline
500 km

BU2. Darwin to Moomba
(Length - approx 2,600 km
Diameters to be determined)

Legend: - - - - - - - -

Proponent:
Australian Pipeline Trust

DEC Darwin-Moomba-Townsville & Gladstone
(Length - approx 3,500 km
Diameters to be determined).

Legend: - - - - - - - -

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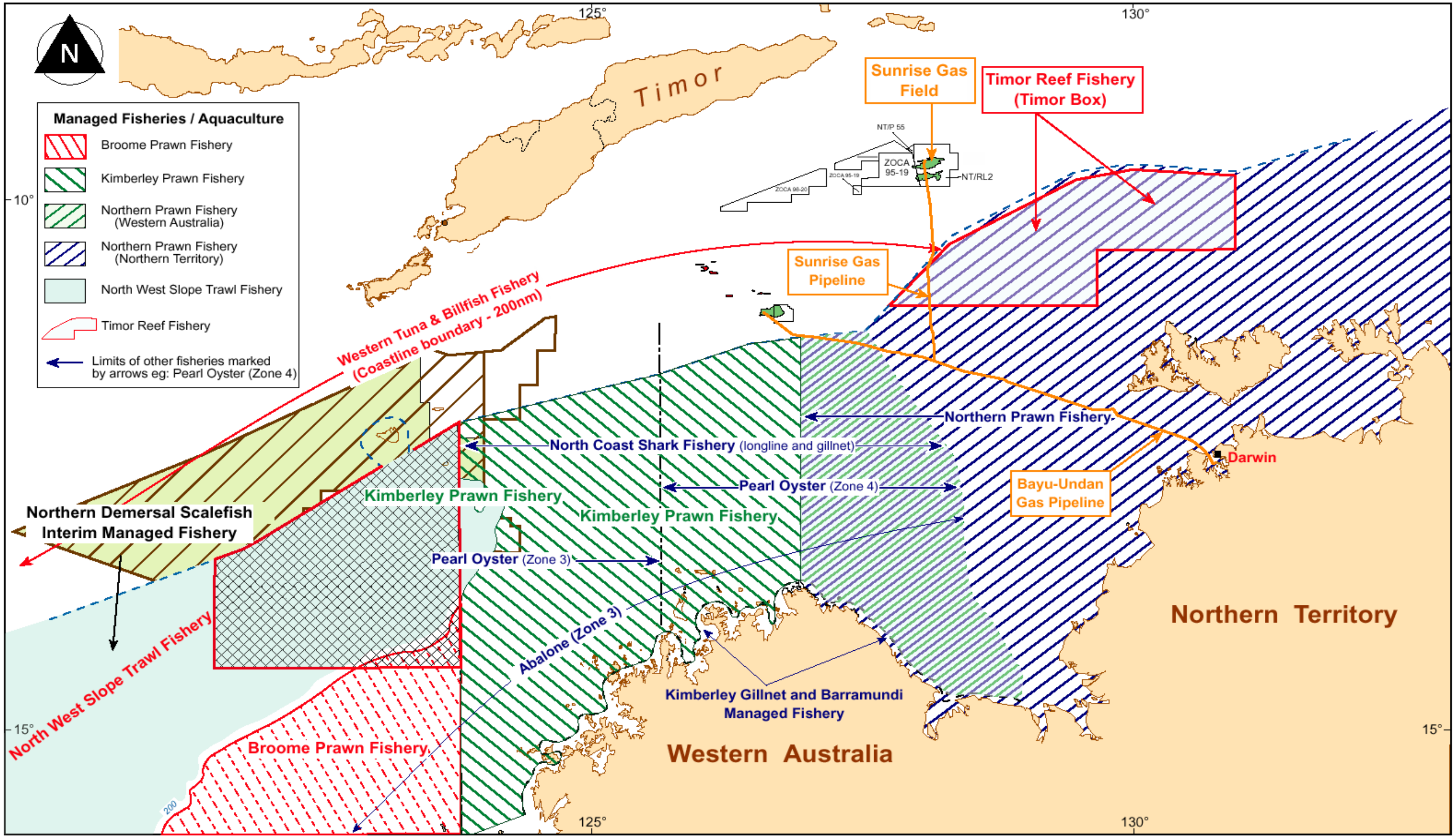
Australia's Major Pipeline Systems

Figure 2-1

Project No.: DE2090.100
Figure prepared by: T.Lee
Date Prepared: 16/10/01



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Northern Australia Permits/Managed Fisheries

Figure 2-2
Project No.: DE2090.100
Figure prepared by: T.Lee
Date Prepared: 16/10/01

3. Description of Design & Construction Phases

3.1 Overview

The Sunrise gas field development is flexible to allow for the adoption of two market scenarios, namely Onshore LNG (OLNG) and Floating LNG (FLNG) and, as such, this EIS assesses the environmental impacts of the following main elements of the upstream development:

- ❑ Wells (subsea and platform), subsurface, intrafield pipelines, flowlines, and risers from the gas field back to the PCUQ platform/FLNG or wellhead platform;
- ❑ Offshore facilities including PCUQ platform, wellhead platform, condensate export system and Floating Storage and Offloading (FSO) Vessel; and
- ❑ Gas export pipeline up to the inlet flange on the 'Wye' piece i.e. junction of the Sunrise and Bayu-Undan gas pipeline. This EIS does not address environmental issues associated with the export pipeline from the "Wye" to shore as this section of pipeline has already been assessed and approved under a separate approvals process.

It should be recognised that both the OLNG and FLNG plants fall outside the scope of approvals currently sought for the development of the Greater Sunrise gas field. FLNG and OLNG will be required to follow separate approvals environmental approvals processes.

The key elements pertaining to the Sunrise Project are summarised in **Table 3-1.**

In summary, the basis of the offshore facility is a PCUQ (Jack-Up) facility with a separate bridge-linked Wellhead Platform (WHP). A combination of subsea and/or WHP wells will be required, with gas and condensate processing by way of PCUQ and FSO facilities. Any subsea wells will be linked to the production platform by intra-field pipelines and export/import risers. Gas and condensate would be exported to Darwin via the main export pipeline and Bayu-Undan pipeline to the proposed Darwin LNG terminal. The two platforms, located in a water depth of 140–400 metres would be as follows:

- ❑ Wellhead Platform (WHP); and
- ❑ Production, Compression, Utilities and Quarters (PCUQ) Platform – with utilities and living quarters located on deck.

Drilling will commence 18 months prior to the installation of the field facilities. Initially, up to 11 wells are proposed from the WHP. A further 11–22 subsea wells will be drilled over the life of the project. **Figure 3-1a** illustrates the field development for an OLNG scenario and **Figure 3-1b** illustrates the field development under a FLNG scenario.

Table 3-1 Key Characteristics of the Sunrise Gas Project

Project Element	Characteristics
Production Wells (both FLNG & OLNG)	A combination of subsea and/or WHP wells linked to PCUQ Up to 16 platform wells (up to 10 km step-out) and up to 32 subsea wells linked to a PCUQ platform via flowlines and risers. Possible drill cuttings/produced water reinjection wells.
Wellhead Platform (WHP) (either OLNG or FLNG)	140 m to 400 m water depth. 24 x40 m platform. Steel Jacket with Bucket Foundation or Tension Leg Wellhead Platform Up to 16 platform wells with maximum 8–10 km reach. Tender Assisted Drilling using a semi-submersible vessel. Risers for export pipeline and subsea flowlines.
PCUQ Platform Offshore Production, Compression, Utilities & Quarters (PCUQ) Platform	140 m water depth. 60–100 m bridge link to wellhead platform. Production Jack-Up. Process/accommodation/utilities on deck. 100 x 80 m. 3 legs on bucket foundations – 40 m diameter and 7.5m skirt with 18 m main leg spacing. Accommodation for 80 workers, heli deck. Separation, cooling, pre-compression, de-hydration, dewpointing and export compression. 2 x 50% train basis; gas export compression units initially 5 x 25 %.

Project Element	Characteristics
	Condensate separation & stabilisation with offgas re-compression.
Condensate Export System Via Floating Storage & Offloading Vessel	8 inch, 2 km long export line to Floating Storage and Offloading Vessel (FSO). Turret moored FSO (gravity system or pile foundations). Every 17 days offloaded condensate product from FSO to tanker via floating hose. Additional heli-ops. FSO crew – 10–20 (approx.)
Main Gas Export Pipeline	Gas export pipeline for the export of gas/condensate to the Bayu-Undan Wye piece 36 inch 218 km to the Bayu-Undan Wye piece, carbon steel X-65. Pre-lay rock dump may be required Concrete coating Anti-corrosion coating: 5 mm asphalt enamel & sacrificial anodes.
Flowlines and Risers	Export and import risers to the process facilities including WHP, PCUQ and FLNG
Intra-field Pipelines	16 inch–24 inch carbon steel clad (corrosion resistant alloy and insulated) Length varies from 2 –18 km

3.2 Gas Field Development Facilities

3.2.1 Location

The Greater Sunrise Gas Fields (Sunrise and Troubadour) are located approximately 450 km north-west of Darwin and 150 km from Timor, within Timor Sea permits NT/RL2, NT/P55, ZOCA 96-20 and ZOCA 95-19. Approximately 80% of the gas field lies within NT/RL2, where both the WHP and PCUQ platforms will be positioned. **Figure 3-2** illustrates the general reservoir layout and location.

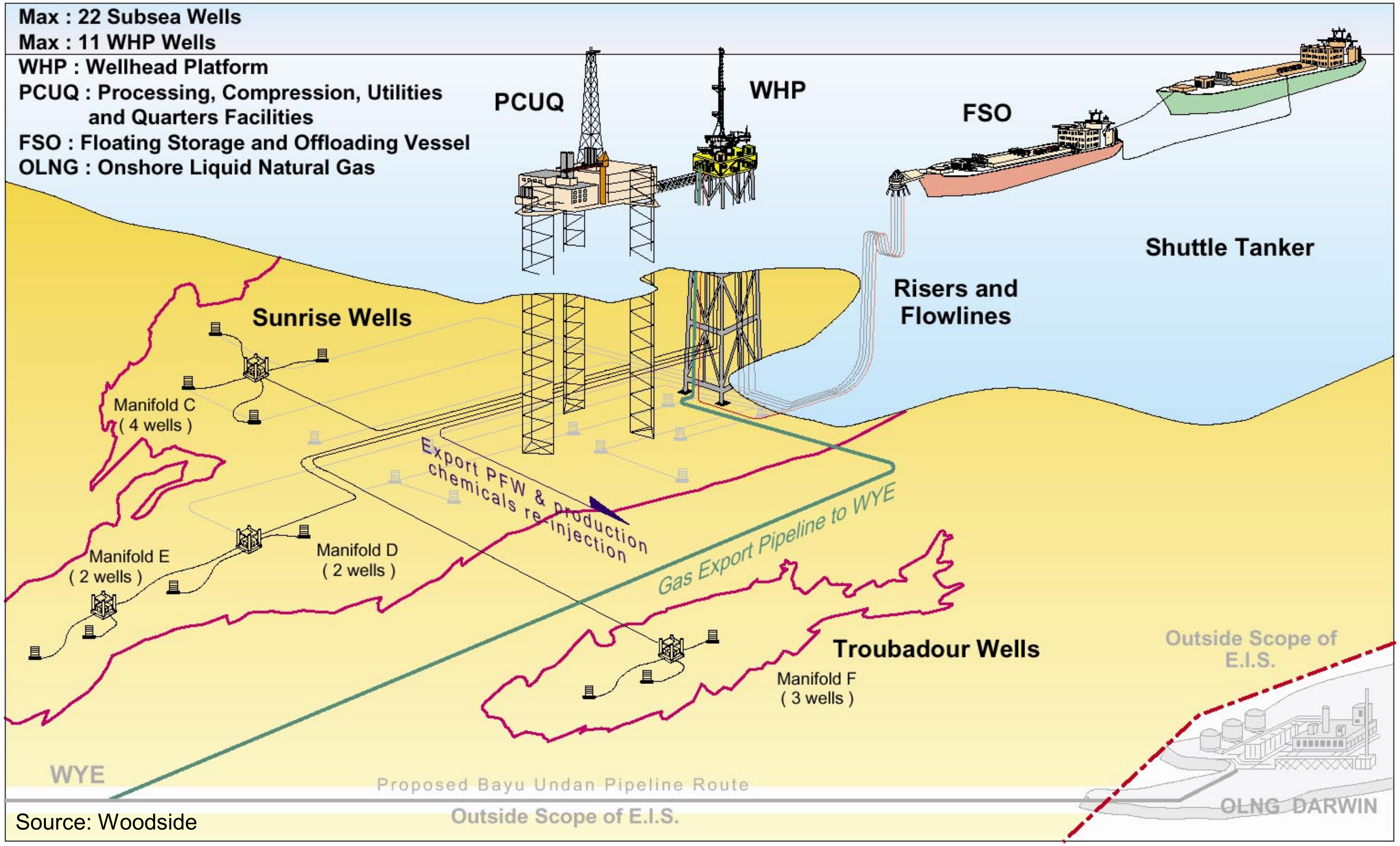
Both platforms are planned to be installed in 140–400 m water depth on the shelf break in the south-east section of the field. The 140 m deep location is at a latitude of 9^{o}36’13” S and longitude of 128^{o}08’02 E.

3.2.2 Site Selection Criteria

In selecting the general location for the platforms several factors have been considered. Generally, shallow waters are preferred for the location of the platforms and deep-water locations for the wells, hence, a compromise has made between these two conflicting factors. Furthermore, it is important that the seabed is composed of a firm material to ensure stability.

The approach to the offshore facility is a significant consideration. Pipeline/flowline route selection in the area of the approach to fixed or floating offshore facilities, or subsea manifolds considers the following:

- To facilitate the anchoring of vessels for support and future construction activities at the offshore facility, pipelines close to offshore facilities are as far as possible arranged in corridors. Initiation and layout typically requires a straight route section;
- Risers are protected from the main activity around the offshore facility and located away from the living quarters;
- Location of the risers, fixed platform overhangs, flare boom;
- Anchoring of moored vessels at subsea drilling centres and liquid loading facilities;
- Orientation of manifold and location of flowline tie-in points;
- Location of the pipeline route corridor;
- Area for expansion loops;
- Pipeline initiation and termination laydown method;
- Designated anchoring areas and no-anchoring areas;
- Provision for future pipelines;
- Avoidance of areas where localised scour may occur;
- Avoidance of vessel anchor cables crossing the pipeline during construction;
- Minimisation of risk due to dropped objects and the consequent requirement for additional pipeline protection devices; and
- Avoidance of areas of shallow gas.



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Scope of EIS Scenario 1:OLNG

Figure 3-1a
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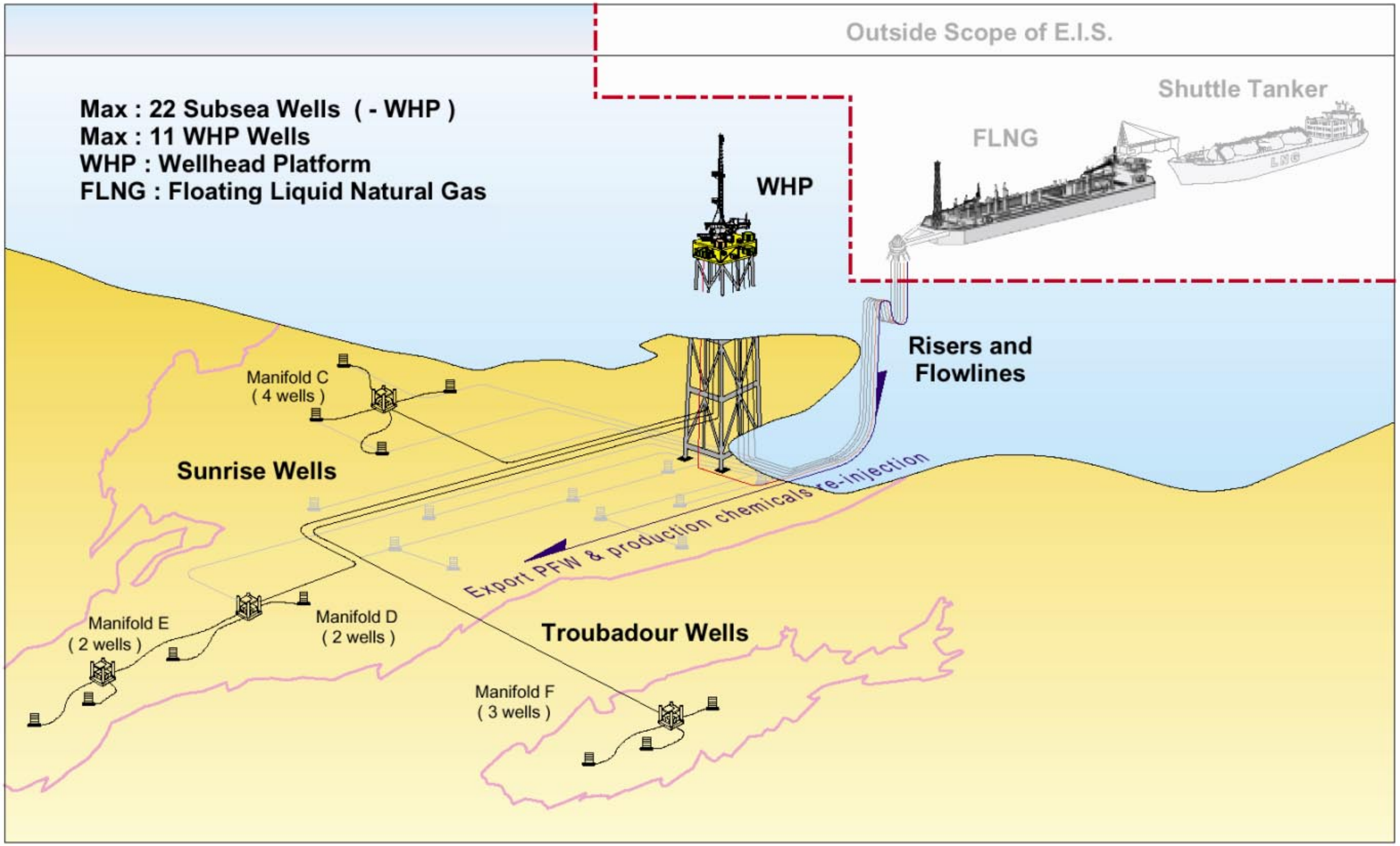
Figure prepared by: T.Lee
Date Prepared: 16/10/01



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Scope of EIS Scenario 2:FLNG

Figure 3-1b

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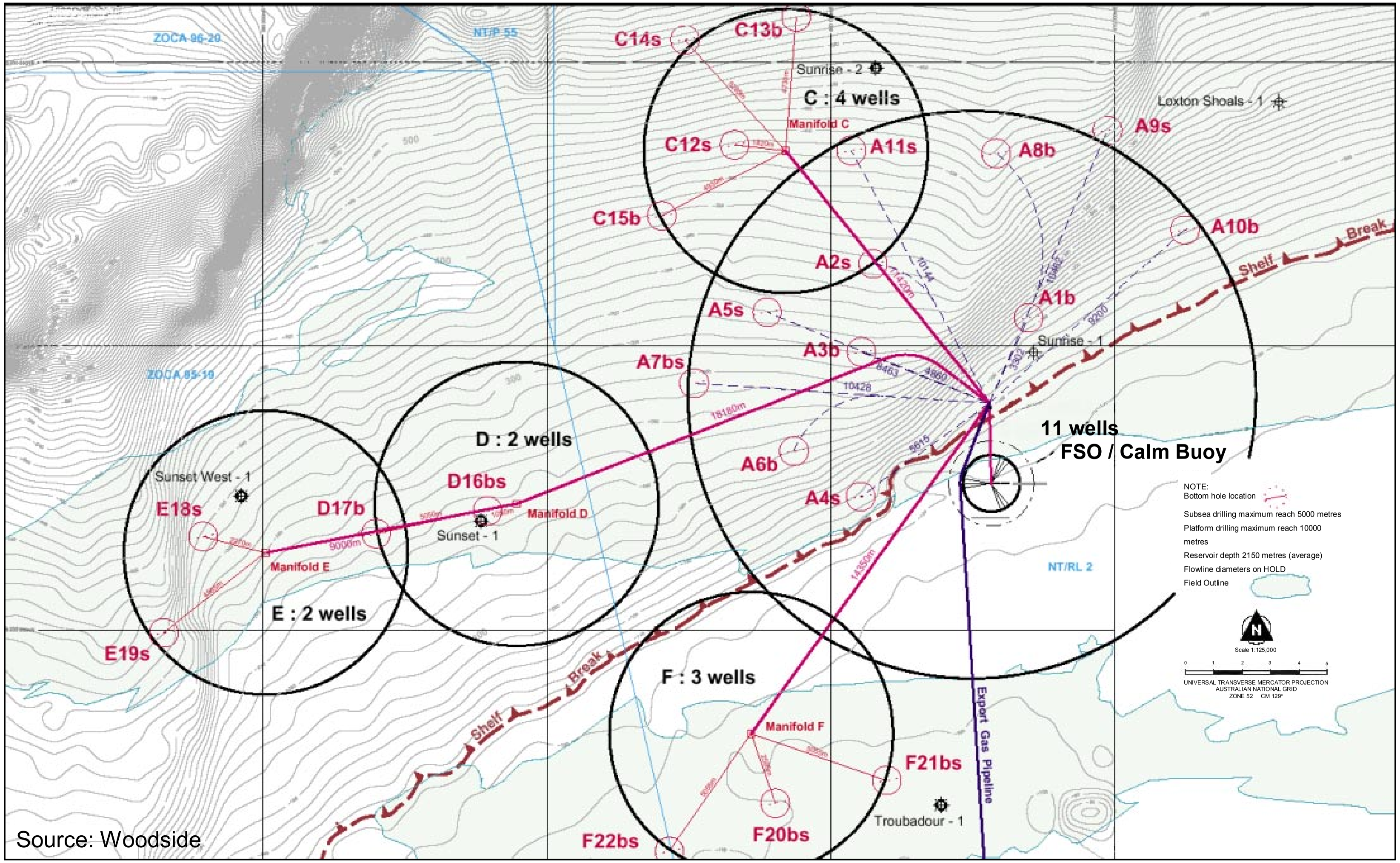
Figure prepared by: T.Lee
Date Prepared: 16/10/01



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General Gas Field Layout

Figure 3-2

Project No.: DE2090.100
Figure prepared by: T.Lee
Date Prepared: 16/10/01

The main routing considerations for the approach to the offshore facility were identified as follows:

- The offshore facility is located in approximately 140 m depth of water;
- The platform is located towards the eastern end of the Sunrise Gas Field; and
- The final location of the risers will be influenced predominantly by the location of the drilling facilities, FSO, flare, living quarters, process facilities and support vessel offloading areas.

Subsea wells are planned to be tied into the proposed offshore facility. Because the subsea wells will be located to the west of the offshore facility the most likely location for the import risers is on the western side of the facility. The final location will be influenced as for the export riser above. Typically, all risers will be located adjacent to one another to simplify deck layout.

The main routing considerations for the flow lines are as follows:

- The edge of the Sahul Platform is predominantly silty/sandy and may be subject to local scour. The orientation of the flowlines and pipelines has a significant influence on scour, as it is driven by the magnitude and direction of the currents;
- Pockmarks are present over a wide area, particularly at the edge of the shelf. However, it is not believed that the pockmarks will present a serious risk to the integrity of the pipeline, due to their small size and depth. Appropriate strategies will be developed to deal with spans, caused by formation and migration of pockmarks, during operation of the pipeline; and
- Scour features (possible contourites) and gullies have been identified. The scour features are believed to have been formed recently, in a geological timeframe but may be inactive in terms of pipeline operating life. Ripples are present in some areas, which suggest high seabed currents and supports the supposition that the scour features are active. Flowlines and pipelines will be deviated to avoid any gullies. A span analysis will be performed to assess the requirement for seabed preparation and may result in a recommendation for deviation of the route.

3.2.3 Seabed Envelope & Sea Area Usage

The development area is large covering 40 km by 20 km. A 500 m diameter Safety Zone will be maintained around the facility restricting vessel movement in the area, in accordance with DNV OS-F101 (2000).

The nearest commercial fishery (Timor Reef Box) to the Sunrise Gas Field lies 75 km to the south-east, as described in **Sections 2.3.1 and 7.10.** For information relevant to the subsea pipeline, from the Sunrise Gas Field to the Wye piece, these sections should be referred to.

3.2.4 Design Standards and Limitations

Water depth over the reservoir area varies from 50 m to 700 m (Sunrise BOD 2001) and the platforms are located in approximately 140–400 m of water. However, the environmental conditions in the field are relatively benign.

The key relevant basis of design parameters can be summarised as follows:

❑ Water Depth	50–700 m
❑ Environment (100 year return):	
- Maximum Wave Height	H_{max} 11.3 m
- Wind Speed	U_g 35.7 m/s
- Surface Current	V_o 1.38 m/s
❑ Soil Conditions:	Based on exploration wells, seismic etc.
❑ Reservoir Temperature:	100–170^{o}C
❑ Final Flowing Tubing Head Pressure:	17 bara
❑ Design Life:	30 years minimum.

The estimated tidal levels for the Sunrise and Troubadour fields are included in **Table 3-2**.

Table 3-2 Estimated Tidal Levels

Location: Platform A		Tide Level (m)
Highest Astronomical Tide	HAT	2.96
Mean High Water Spring	MHWS	2.65
Mean High Water Neap	MHWN	1.83
Mean Sea Level	MSL	1.60
Mean Low Water Neap	MLWN	1.51
Mean Low Water Spring	MLWS	0.34
Lowest Astronomical Tide	LAT	0.0

Work to date has confirmed the integrity of the proposed Production Jackup substructures to survive 10,000 year storm events. The FSO moorings will also be designed to 10,000 year storm conditions.

3.2.5 Construction Location & Materials

The Production Jackup would be fabricated in modules in main construction yards in either Korea or Singapore. The bucket foundations will be constructed in South East Asia and transported on a barge to site. The Production Jack Up allows the possibility of topside modules construction in the same or another yard to the substructure.

There will be parallel construction of the hull, process and utility modules and accommodation. The construction methodology is based on modular approach with the production/utility/accommodation modules skidded onto the completed hull at the fabrication yard prior to loading onto barge for transport to site **(Figure 3-3),** which will take an estimated 30 days. Very little construction will be required on site. A summary of the construction material requirements is provided in **Table 3.3.**

Table 3-3 Construction Material, Types, Sources and Quantities

Description	Factored Dry Weight (Modular) Tonnes
Topsides: Process Structural Steel	 9,800 5,700
Topsides Total	**15,500**
LQ/heli Jacking Hull	1,000 3,800 6,600
Total Elevated Weight	**26,900**
Total Modelled Weight	**29,000**
Hull Legs Foundation	6,600 6,500 600
Grand Total	**39,400**

3.2.6 Wellhead Platform

The wellhead platform is a fixed steel platform located on the shelf break in 140–400 m of water on the southern boundary of the Sunrise Gas Field. The platform would be installed by Heavy Lift Vessel in time for the scheduled initial drilling and main export pipeline pre-commissioning activities. It will stand-alone with the drilling tender for this initial period. The main production platform will be installed nearby and connected by a 60–100 m bridge link.

The wellhead platform will support up to 16 conductors for gas production, a boat landing and a main crane deck.

Source: Woodside

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Transport of Jack Up on Barge

Figure 3-3

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Figure prepared by: T.Lee
Date Prepared: 16/10/01

The wellhead platform topsides accommodate the Derrick Equipment Set (DES) as provided by the Semisubmersible Self-Erecting Tender Rig (SSETR). It will incorporate the wells, venturi flow-metering, production manifolding, pipeline and subsea flowline termination facilities, ie well controls, Emergency Shutdown Valve (ESDV) and Subsea Isolation Valve (SSIV) facilities, risers, J-tubes for umbilicals and pigging facilities, as well as cranage and emergency facilities. Risers will be provided for export pipeline and subsea flowlines.

The substructure comprises a four leg launched jacket secured to the seabed by bucket foundation. The estimated weight of the structure is 8,000 t. Following completion, the jacket will be towed to site and launch-installed with the assistance of a 500/600 class launch barge and 2,000 t capacity construction vessel.

The first phase of drilling is planned to be from the wellhead platform. It is proposed to drill these wells with a SSETR. Up to 16 wells are planned to access the reservoir in a semicircular pattern from the platform. Preliminary studies have confirmed that the rig can drill extended reach wells of up to 10 km step-out from the platform. The typical lithology of a well is illustrated in **Figure 3-4.**

The SSETR delivers and erects a DES to the drilling platform using its own heavy lift motion compensated crane. The derrick, draw-works, drill floor, solids control tanks and supporting substructure are all installed on the platform. In addition the DES is supplied with emergency power, high pressure mud pump and circulating tanks to ensure that well control can be maintained in the unlikely event that the SSETR tender has to pull away from the platform. All drilling services, storage and accommodation is provided by the SSETR tender, connected to the DES / platform via a telescoping bridge, flowlines, power and instrument cabling.

The Tender Assist Rig will be in place while the initial wells are being drilled from the wellhead platform, which will take about 3–5 years. Accommodation will be provided on board the Tender Assist Rig, which can accommodate approximately 100 crew. Shift changes will occur every 2 or 3 weeks.

3.2.7 Drilling Programme

Wells

Two different well types are being considered for development of the Sunrise Gas Project. These are:

- Platform Wells using Extended Reach Drilling (ERD) –from the wellhead platform; and
- Subsea Wells – drilled using a mobile offshore drilling unit (MODU).

Three options are being considered by Woodside with respect to the drilling programme and specifically the type/combination of wells that will be drilled:

- **Option 1:** Eleven platform wells up to 11 km in horizontal reach and eleven subsea wells with a requirement for both a wellhead and PCUQ platform;
- **Option 2**: Ten wellhead platform wells up to 8 km in length and twelve subsea wells requiring both a wellhead and a PCUQ platform; and
- **Option 3**: Twenty-two subsea wells, averaging 2 km vertical reach and 1 km horizontal reach, requiring a PCUQ platform but eliminating the need for a wellhead platform.

Options 1 and 2 will involve platform wells being drilled initially, taking up to 5 years to install, followed by the development of subsea wells. Alternatively, Option 3 will entail the installation of the following two types of subsea wells:

- Eleven wells using the daisy-chain system with flowlines back to the PCUQ platform. These subsea wells are laid out in a circular shape around the PCUQ platform and would replace the eleven wellhead platform wells; and

- Eleven wells using the manifold system with flowlines tied back to the PCUQ platform, i.e. Manifolds C, D, E, F, lying generally to the south and south west of the PCUQ platform.

The proposed wellhead platform wells range in length from 3–11 km with an average length of 7 km. The characteristics of a typical 7 km well is provided in **Table 3-4**. The cuttings volume for a 7 km well is expected to be about 800 m^3 and the cuttings mass 2,000 t. Drill cuttings are the crushed rock generated by the drill bit as it penetrates the seafloor. A large proportion of cuttings is retrieved from the wellbore, passed through a shale shaker to separate the cuttings from the drilling fluid and discharged overboard from the drill rig (URS, 2001). The subsea wells, being considerably shorter, will generate a much smaller quantity of cuttings. Re-injection of cuttings differs for platform and subsea wells, as described below and illustrated in **Figure 3.5.**

Drilling Fluids

All wells will be drilled using drilling fluids, frequently referred to as ‘muds’. In this EIS the term ‘mud’ is used for drilling fluids, although both terms are used interchangeably in the industry. This avoids confusion with the ‘base fluid’ (ie oil, paraffin or synthetic), one of the main constituents of the OBM or SBM (Craddock, 1999).

The drilling mud is circulated down the inside of the drill pipe to the rotary drill bit and flows up the annulus between the drill pipe and the wall of the hole (or cased hole) that has been drilled. The drilling mud carries the rock (formation) cuttings from the bit to the surface, where a variety of solids control equipment remove most of the fluids from the cuttings. Drill cuttings are usually disposed to the seabed below the installation (Craddock, 1999).

There are a number of different drilling muds used in the oil and gas industry, namely:
- Water-Based Muds (WBMs);
- Oil-Based Muds (OBMs); and
- Synthetic-Based Muds (SBMs) including Ester-based Muds (EBMs).

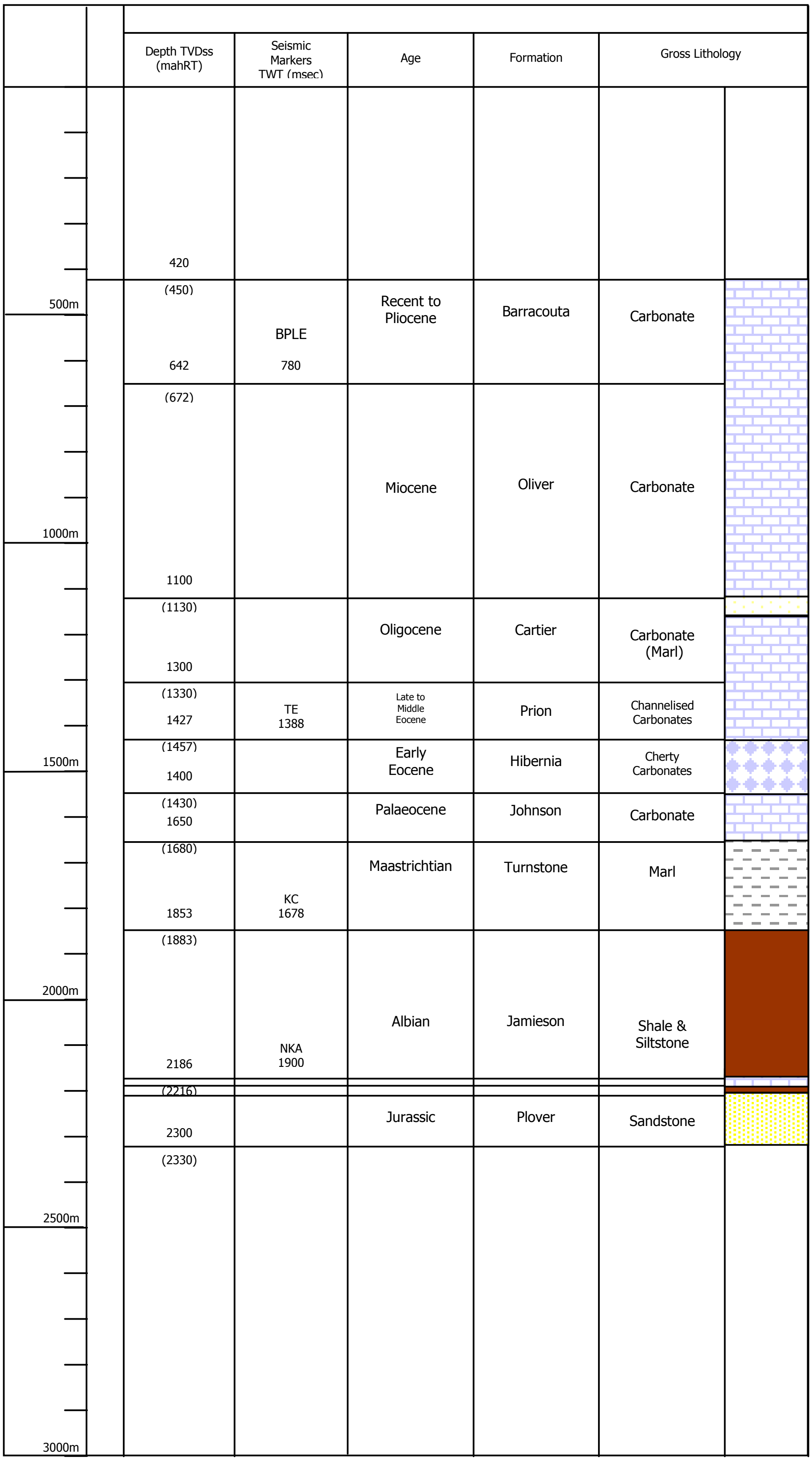
Both Water-Based and Synthetic-Based (including Ester-Based) Muds will be employed depending on the type of well, depths proposed and other well characteristics. Oil-Based Muds (OBMs) are not proposed for use in the drilling of either the subsea or platform wells, however, they may be suitable for the drilling of a closed-in fully contained system, eg re-injection well, should one be installed. The environmental impacts associated with the use of water-based, synthetic/ester and oil based muds are discussed below.

Drilling muds are used for the following (Macro-Environmental, 2001):

- Carrying cuttings to the surface;
- Supplying power to the drill bit;
- Cooling and cleaning the drill bit;
- Forming a filter cake on permeable formations and seal openings in formations drilled;
- Exerting a hydrostatic head to help prevent caving or sloughing of the formation, and to prevent flow of formation fluids into the borehole, or blowouts; and
- Suspension of cuttings and weight material such as barite when circulation is interrupted as when adding a new joint of drill-pipe.

Oil-based-fluid cuttings (Wellhead Platform ERD wells)

A wellhead platform would include from 6–11 extended reach wells, therefore generating a large amount of cuttings at a single location. Surface hole sections would be drilled using water based drilling muds, and deeper hole sections are likely to use Ester/Synthetic based (EBM, SBM) Muds.



Depth TVDss (mahRT)	Seismic Markers TWT (msec)	Age	Formation	Gross Lithology
420				
(450) 642	BPLE 780	Recent to Pliocene	Barracouta	Carbonate
(672) 1100		Miocene	Oliver	Carbonate
(1130) 1300		Oligocene	Cartier	Carbonate (Marl)
(1330) 1427	TE 1388	Late to Middle Eocene	Prion	Channelised Carbonates
(1457) 1400		Early Eocene	Hibernia	Cherty Carbonates
(1430) 1650		Palaeocene	Johnson	Carbonate
(1680) 1853	KC 1678	Maastrichtian	Turnstone	Marl
(1883) 2186	NKA 1900	Albian	Jamieson	Shale & Siltstone
(2216)				
2300		Jurassic	Plover	Sandstone
(2330)				

Source: Woodside

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Sunrise Generic Lithology vs Depth Plot

Figure 3-4
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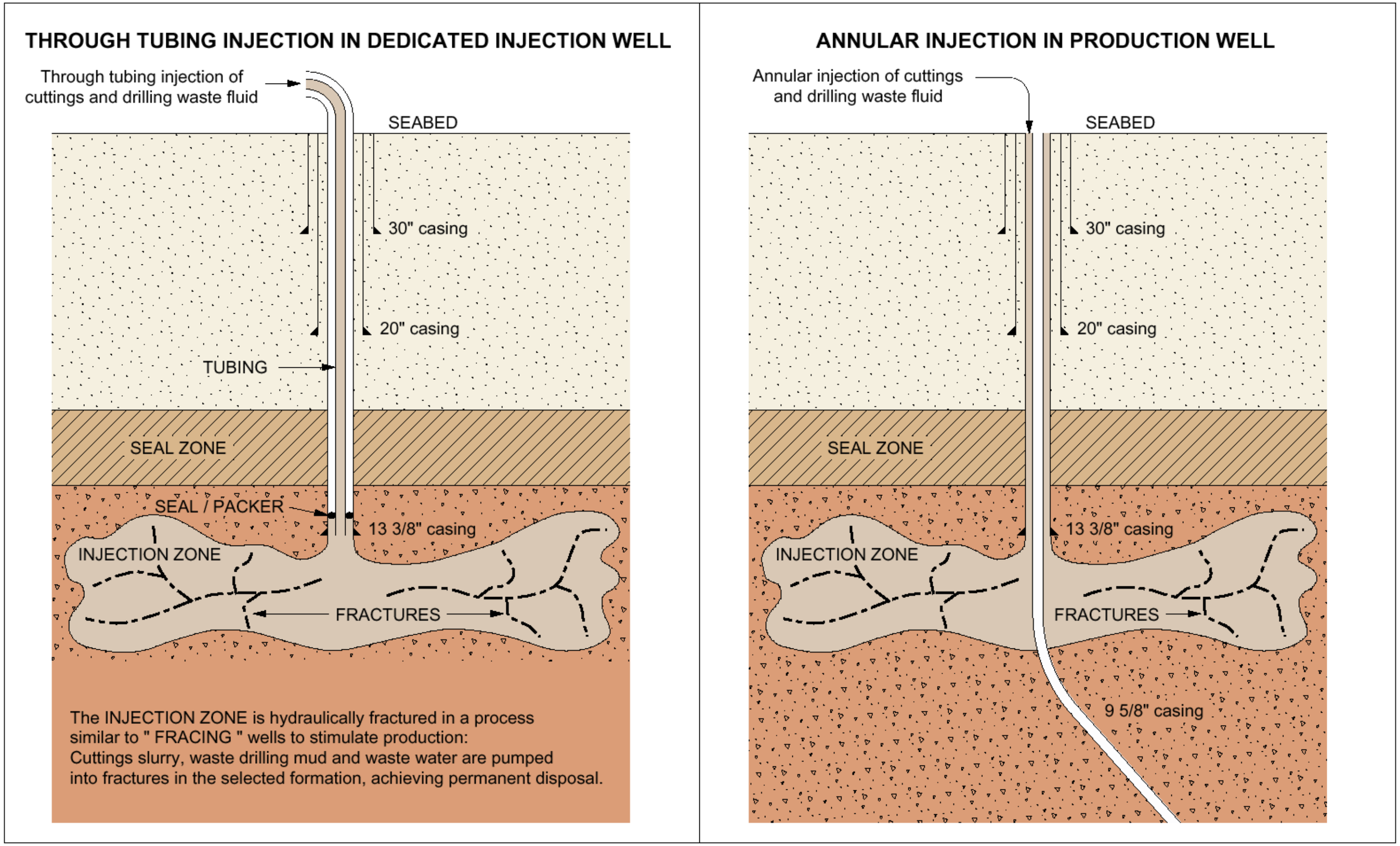
Figure prepared by: T.Lee
Date Prepared: 16/10/01



THROUGH TUBING INJECTION IN DEDICATED INJECTION WELL

ANNULAR INJECTION IN PRODUCTION WELL

The INJECTION ZONE is hydraulically fractured in a process similar to " FRACING " wells to stimulate production: Cuttings slurry, waste drilling mud and waste water are pumped into fractures in the selected formation, achieving permanent disposal.

Source: Woodside

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Schematic of Cuttings & Fluids Re-Injection

Figure 3-5
Project No.: DE2090.100
Figure prepared by: T.Lee
Date Prepared: 16/10/01

Disposal methods for non-water based fluids and cuttings generated using these drilling muds will depend on the results of feasibility work to establish the optimal system for the Sunrise Gas Field. Options include , transportation to shore ('skip and ship') and cuttings re-injection. Skip and ship involves the transportation of cuttings to a shore-based recycling or disposal facility. In a cuttings re-injection operation, waste muds and cuttings slurries are pumped (ie. injected) into a suitable formation approximately 1000m below the seabed.

Two options exist for cuttings re-injection (**Figure 3.5**). Injecting cuttings through tubing into a dedicated injection well and injection through the annulus between two casing strings on an existing production well. For cuttings re-injection to be viable, a suitable geological formation must be available for injection of the cuttings, together with a sealing formation to contain the cuttings and muds within the required zone. A detailed analysis would be undertaken in order to confirm whether a suitable injection zone exists in the Sunrise Gas field. A strategy has been developed for cuttings re-injection operations, should a wellhead style development be selected.

Water-based-fluid cuttings

Subsea wells will be drilled singly, at selected sites throughout the field. Cuttings re-injection would not be viable due to the lack of a nearby injection well. These wells are likely to be drilled using Water Based Mud systems due to their limited measured depth and relative ease of construction. The surface hole sections of wellhead platform wells would also be drilled with water based drilling fluids. Water based cuttings would normally be discharged to the seafloor, however in environmentally sensitive locations, it may be possible to implement a skip and ship operation as a back-up alternative.

Table 3-4 Typical Profile of a Seven Kilometre Wellhead Platform Well

Hole Diameter (Inches)	Bit Type	Lithology	Fluid Type	Fluid Wt (SG) [1]	Length (m)	Bulk Volume (m^3)	Porosity	Cuttings Volume (m^3)	Density (SG)
26.00	Milled Tooth	Barracouta	Seawater	1.00	350	120	20	96	2.40
17.50	Milled Tooth	Barracouta/ Oliver/ Cartier.	WBM [1]	1.10	3,200	497	15	422	2.50
12.25	PDC [1]	Prion/ Hibernia/ Johnstone/ Turnstone/ Jamieson/ Darwin.	EBM [1]	1.35	3,500	266	10	240	2.60
8.50	PDC	Plover	EBM	1.20	1,200	44	15	37	2.65
		Totals			**8,250**	**927**		**795**	

Note[1]: SG–Specific Gravity, PDC–Poly Diamond Crystalite, WBM-Water Based Mud, EBM–Ester Based Mud

3.2.8 Production Compression Utilities Quarters Platform (PCUQ)

The PCUQ platform will be a production jack-up structure, with all facilities located on the topsides, connected by 60 to 100 m bridge link to the wellhead platform.

The construction methodology for the topsides is based on a modular approach with the production, utility, and accommodation quarters skidded onto the completed hull at the fabrication yard. After mechanical completion and pre-commissioning in the yard, the platform will be towed to a sheltered shallow location for fitting the foundations. The bucket foundations (**Figure 3-6**) will be offloaded at the shallow location and set in position on the seabed. The Jack-up legs will be temporarily jacked down and connected to the bucket foundation and welded in place. The tow to Sunrise field site will then be completed.

Installation at site is to be carried out by jacking down the three legs and locking them into position. Following PCUQ platform installation near the wellhead platform, the interconnecting bridge will be lift-installed by crane.

3.2.9 FSO

The FSO will most likely be built in Korea and towed to site. It is estimated that it will take 56 days to tow and install the FSO, on site 2km south of the PCUQ platform, with installation taking approximately 2–3 weeks.

3.2.10 Mooring Facilities

FSO and other 'permanent' floating installations will be moored to foundations designed to hold fast in extreme weather such as 3,000 to 10,000 year storm conditions. This type of mooring system will not have an adverse impact on the seabed given the absence of sensitive seabed habitats at the proposed mooring locations.

The foundation mooring system will comprise piles as in the case of Laminaria and Legendre fields or gravity bases in as in the case of Apache Stag. The pile system will typically comprise piles penetrating the seabed with a padeye (fastening point) to which the mooring lines are connected. The piles will protrude 2–3 metres above the seabed. The gravity system will comprise a box type structure that will be filled with iron ore.

Drilling facilities, temporary installations and mobile units used for drilling subsea wells will be anchored using conventional ship anchoring systems. The system selected will be suited to the seabed composition and condition, the loads to be applied and the vessel concerned. The system selected will able to withstand severe weather conditions with a design criteria of a 10 year storm. Tender Assisted Drilling Rig for platform wells would be typically designed to withstand a 100 year storm with one broken line. Movement outside design limits during drilling operations is not tolerable and therefore anchor drag is not expected which can result in damage to the seabed.

Construction and installation vessels (short term use) for installing platform, pipeline and subsea structures will also be anchored using conventional ship anchoring systems. The system selected will suit the seabed composition and condition, the loads to be applied and the vessel concerned. This system would be able to withstand a 1 year storm. Anchor drag is not therefore expected which can result in damage to the seabed.

3.2.11 Future Subsea Facilities

Further subsea wells, are planned when reserves are required to be drained outside of the platform’s sphere of influence (year 5 onwards). A number of subsea drilling centres have been identified to progressively develop the Sunrise and finally the Troubadour Fields. The future subsea facilities will comprise four production centres, C to F, with a total of up to 32 subsea wells each connected to a production centre comprised of a subsea manifold and cluster of wells. The step out range for subsea

Source: Woodside

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Bucket Foundation for PCUQ Facility

Figure 3-6
Project No.: DE2090.100
Figure prepared by: T.Lee
Date Prepared: 16/10/01

wells is nominally limited to five kilometres. Each drilling centre will be drilled up before moving to the next centre.

Subsea development wells are to be drilled and completed from a conventional semi-submersible mobile offshore drilling unit (MODU), common to the SE Asian Region.

The MODU can drill in water depths of up to 350 m, deeper if pre-laid moorings and specialist mooring anchors / wire are employed, and they are typically capable of drilling 8,000 m along hole depth, with approximately 5,000 m horizontal reach from the wellhead. Thus it is proposed to drill subsea wells to a maximum 5 km horizontal reach, with the wellheads clustered about and connected by 50–100 m jumpers to a subsea manifold. The in-field flowlines will connect to, and control will come from, the wellhead platform. The MODU rig will accommodate and install the subsea equipment.

The Troubadour Gas Field is located in water depths of less than 100 m, is suitable to station a jack-up MODU drilling rig to drill a number of subsea wells, as for the Sunrise clustered subsea wells. Jack-up rigs are being considered for Troubadour, although this concept has not been matured since Troubadour wells are not planned to be drilled until some 10–15 years after start-up. The expectation is that a long legged jackup facility will be available in the region when the Troubadour wells are drilled.

The in-field flowlines will be manufactured from 13 per cent Cr steel or 316 SS clad carbon steel. The flowlines may incorporate a subsea isolation valve (SSIV) adjacent to the platform to protect the platform from the flowline inventory in the event of an emergency. Flowline termination facilities (ESDV facilities and risers) will be installed onto the platform when required.

3.2.12 Intrafield Flowlines

The intrafield flowlines will transport reservoir fluid from the subsea manifolds to the PCUQ platform. Production centres C and F will be connected directly to the facility. Production Centres E and D will be connected in series to the platform. These subsea wells and flowlines will not be required until about year 2010.

The sizing of the flowlines is based on the following criteria:

- Minimum Flowing Tubing Head Pressure (FTHP) of 57 bara (bar absolute) to year 15–20, 17 bara thereafter. Platform arrival pressure of 42 bara to year 36, 10 bara thereafter.
- The produced fluids will contain 4.5% to 5.5% carbon dioxide, saturation water, and in later life, formation water; and will require the selection of a corrosion resistant alloy (CRA) flowline material in order to ensure its integrity over the design life. The line pipe will be manufactured from either 13 per cent Cr steel or carbon steel with an interior clad layer (3 mm) of stainless steel. External corrosion protection will be achieved by corrosion coating and sacrificial anodes.
- The flowlines generally do not pose slugging problems and no slug catcher or additional volume separator is provided.
- Hydrate conditions will occur in uninsulated subsea flowlines during normal steady state operations and on shutdown. The flowlines from Centres C, D and E will be insulated to mitigate against hydrate formation. The flowlines from Centre F do not require insulation due to higher ambient temperature (shallower water).

3.2.13 Waste Management Practices

Waste management practices will be undertaken in accordance with the Woodside 'Waste Management Policy' (**Appendix B**), and through specific waste management plans drawn up by contractors. Construction Contractors will be required to carry out all construction works in an environmentally sensitive manner. The Contractors will also be required to adhere to all relevant environmental legislation while carrying out the works.

All hazardous wastes will be documented, tracked and segregated from other waste. Hazardous wastes will be disposed of onshore in accordance with relevant waste legislation.

3.3 Subsea Pipeline

3.3.1 Route Selection Criteria

The Det Norske Veritas (DNV) OS-F101 (2000) Code, used in the design of the pipeline, specifies certain site selection criteria that must be considered in the routing of a subsea pipeline. The DNV code (2000) states that:

"the pipeline route shall be selected with due regard to safety of the public and personnel, protection of the environment, and the probability of damage to the pipe or other facilities. Factors to take into consideration shall, at minimum, include the following:

- ☐ *Ship traffic;*
- ☐ *Fishing activity;*
- ☐ *Offshore installations;*
- ☐ *Existing pipelines and cables;*
- ☐ *Unstable seabed;*
- ☐ *Subsidence;*
- ☐ *Uneven seabed;*
- ☐ *Turbidity flows;*
- ☐ *Seismic activity;*
- ☐ *Obstructions;*
- ☐ *Dumping areas for waste, ammunition etc;*
- ☐ *Mining activities;*
- ☐ *Military exercise areas;*
- ☐ *Archaeological sites; and*
- ☐ *Exposure to environmental damage, and oyster beds".*

DNV Code (2000) also states that *"expected future marine operations and anticipated developments in the vicinity of the pipeline shall be considered when selecting the pipeline route".*

In relation to route surveys the following is required in accordance with DNV OS F101 (2000):

- ☐ *"A survey shall be carried out along the planned pipeline route to provide sufficient data for design and installation related activities.*
- ☐ *The survey corridor shall have sufficient width to define a pipeline corridor, which will ensure safe installation and operation of the pipeline.*
- ☐ *The required survey accuracy may vary along the proposed route. Obstructions, highly varied seabed topography, or special sub-surface conditions may dictate more detailed investigations.*
- ☐ *An investigation to identify possible conflicts with existing and planned installations and possible wrecks and obstructions shall be performed. Examples of such installations include other submarine pipelines, and power and communication cables. The results of the survey shall be presented on accurate route maps, showing the location of the pipeline and related facilities together with seabed properties and anomalies.*

- *All topographical features which may influence the stability and installation of the pipeline shall be covered by the route survey, including but not limited to:*
    - *obstructions in the form of rock outcrops, large boulders, pock marks, etc. that could necessitate levelling or removal operations to be carried out prior to pipeline installation; and*
    - *topographical features that contain potentially unstable slopes, sand waves, deep valleys and erosion in the form of scour patterns or material deposits".*

Guidelines are also provided for determining seabed properties, such as geotechnical and soil parameters.

Woodside's site selection criteria for subsea pipelines incorporates both environmental and technical criteria and states that the following should be considered:

- The pipeline route shall comply with the Australian State and Commonwealth regulations regarding traversing licensees' blocks, consultation with fishing organisations, communication with local authorities and communication with interested parties;
- Avoidance of areas such as anchorages, sanctuaries, shipping lanes, and military reservations;
- Location of islands, shoals, reefs, atolls etc. along the route;
- The type and intensity of shipping and any designated shipping lanes in the area;
- The presence of fishing grounds (including sensitive fish/shell fish producing areas);
- The type and intensity of fishing activity in the area;
- The presence of military exercise zones, dumping grounds, submarine exercise areas;
- The presence of other pipelines, telecommunications cables, installations, wellheads, large rocks or boulders or other obstructions in the area. A separation of at least 500 m should normally be maintained between the pipeline route and any potential hazard, obstruction or existing/planned installation. Wrecks and sites of historic importance should be avoided;
- Navigation channels, recommended tracks, shipping lanes and principal shipping routes;
- The presence of regularly dredged channels or spoil dumping areas;
- The possibility of future developments in the area;
- The views of other operators whose blocks are crossed by the pipeline;
- Any undesirable geotechnical conditions such as unstable seabed slopes, deep valleys, sediment transport etc;
- The flatness and stability of the seabed, presence of sand waves, 'pock' marks etc., e.g. the avoidance of spans;
- Limitations of the installation equipment with regard to mooring requirements, lay curvature, initiation and termination. The water depth along the pipeline route should be selected such that it does not unduly limit the lay vessels that are able to lay the pipeline. The lay radius must be selected to take account of the minimum achievable radius and maximum acceptable stresses during operation;
- Stability of the pipeline and minimisation of primary (self-weight) and secondary stabilisation requirements (trenching, rock – dumping etc.);
- If trenching is to be employed, the presence of undesirable geotechnical features such as mud, silty sand, hard rock; and

3.3.2 Description of Preferred Pipeline Alignment and Implications

Route 05, the preferred alignment, runs southwards to the Bayu-Undan Wye piece through the JPDA. The route is aligned to avoid shoals and valleys, as much as possible, including the Melita Valley and 'The Boxers' (Refer to **Section 6.2** and **Figure 6-5**). The water depths through which the pipeline traverses range from approx. -140 m to -57 m LAT. The water is at its greatest depth in the vicinity of the Sunrise Gas Field (approx. -140 m) and until Kilometre Point (KP) 37 maintains a level of -100 m.

At KP 40 the level rises to -75 m LAT and until KP 83 fluctuates between -110 and -70 m LAT. From KP 57.48 to KP 57.55 pre-lay rock armour may be laid due to an uneven profile. From KP 85 to KP 100 similar depths are maintained but over this short distance rapid changes in water depth occur. Between KP 100 and KP 150, the western edge of Melita Valley is traversed and although a water depth of -150 m LAT is reached, a relatively gradual rise and fall through the valley is experienced. From KP 185 to KP 185.18 pre-lay rock armour may also be required.

Over only a very short distance 'The Boxers' is encountered (KP 212-213) where the water depth is at its shallowest reaching -57 m LAT. The Wye piece lies at a water depth of -73m at KP 216.7.

The implications of choosing Route 05 are:

- Quantity of rock armour minimised reducing the area of seabed and habitats covered;
- No secondary stabilisation is required reducing disturbance to the marine environment;
- No trenching or backfilling required due to depths of water encountered;
- Route is short following a relatively straight line; and
- No requirement for additional concrete coating.

From the Wye piece it is intended that a pipeline be installed to Wickham Point along the route already approved for Bayu-Undan gas.

3.3.3 Sea Area Usage

Refer to **Section 3.2.3.** No marine parks, subsea cables, ship wrecks etc. are found in close proximity to the gas development area or along the proposed pipeline to the Wye piece.

3.3.4 Infrastructure Requirements

Infrastructure requirements for the construction of the subsea pipeline are minimal, consisting mainly of service vessels. The laying of the pipeline will be a 24 hour per day operation with crew working in 12 hour shifts over a construction period of 70 days. Helicopter transport will be required for the transfer of workers on and off the lay barge. Service vessels will be required to transfer provisions to the barge.

As well as the S-Lay Barge, which is used for subsea pipeline installation (**Section 3.3.6)** a second barge may be required for offloading pre–lay rock dump prior to laying of the pipeline. This rock will be sourced in accordance with environmental regulations. The quantities of rock required, if any, will be small and hence the barge will not be required to spend an extended time offshore.

3.3.5 Pipeline Specifications

Specifications for the pipeline are provided in **Table 3-5.**

The export pipeline will be designed to accommodate to deliver dry gas with a design pressure of 198 barg.

The pipeline will be designed, constructed and operated in accordance with the requirements of the DNV OS-F101 (2000) code. The line pipe is DNV Grade 450, equivalent to API 5L X65 with a wall thickness to resist internal pressure, collapse and local buckling of 23.3 mm, including a 1.5 mm internal corrosion allowance. Internal corrosion is not expected to occur as the gas is considered dry, free of liquid water. A 5 mm external coating of asphalt enamel is selected for external corrosion protection. Concrete coating will be applied over the entire length of the pipeline mainly for stability purposes. The export pipeline route is shown in **Figure 5.1.**

Table 3-5 Sunrise Export Pipeline Specifications

Item	Specification
Pipeline Termination	Wye Piece located along the proposed Bayu-Undan pipeline.
Length	218 km Sunrise to Bayu-Undan Wye piece
Diameter	36 inch from Sunrise to Wye piece
MDQ flowrate	966 MMscfd
Maximum Allowable Operating Pressure (MAOP)	191 bar atmospheric (bara)
Design pressure	198 bar gauge (barg)
Steel Grade	DNV Grade 450 (ie API Grade X65)
Pipe Wall Thickness	23.3 mm
External Concrete Coating	40mm (density: 3040kg/m^3)
External Anti-corrosion coating	5 mm Asphalt Enamel
Internal Coating	1.5 mm internal allowance
Cathodic Protection	Sacrificial Anodes
Pre Lay Rock Dump	As required
Expected Life Time (year)	30

Note: This table only refers to the specifications of the Sunrise to Wye piece pipeline; it does not include details of the Phillips pipeline from the Wye piece to landfall.

In selecting the route of the pipeline deep waters are preferred for technical reasons. One of these relates to cyclones and storm surges, as at greater water depths the effect of cyclones/storms on the pipeline are negligible. Furthermore, the external weight coating will be selected to achieve a stable pipeline, that will not be affected by cyclones and storm surges.

Coating & Corrosion

Any damage incurred due to pipeline corrosion could be very costly. It could render a section of pipeline inoperable for a period of time while maintenance is being carried out. A section of pipe may need to be replaced if damage is potentially severe and a substantial loss of product may result from gas leakage. Gas leakage also represents a major safety and environmental hazard. With these aspects in mind it is vital to prevent the future occurrence of such incidents in the design and construction phases of the pipeline.

Internal corrosion should not be a factor as the condensate will be dewatered and the gas will be dehydrated to a dewpoint well below minimum operating temperature, operating in the absence of free water. The conditions are therefore considered to be non-corrosive. A small internal corrosion allowance will be provided to compensate for corrosion occurring prior to installation and during topsides upset operating conditions. As a precaution small amounts of corrosion inhibitor may be used. External corrosion can occur for a number of different reasons such as atmospheric, chemical or bacteriological attack and from corrosive currents, which may be present in the seabed. Protection against these forms of attack will be in the form of a combination of external coating and cathodic protection, as described below.

External coating will be applied to lengths of pipeline in a specific coating yard. The pipe will be cleaned and primed before application of the protective coating, a 5 mm layer of asphalt enamel, and concrete coating, which is applied for stability purposes.

A cathodic protection supplements the corrosion coating to prevent corrosion of any weak points in the external coating of the pipeline. Cathodic protection will be applied to the pipeline by applying sacrificial anodes at regular intervals. After the installation the cathodic protection system will be monitored frequently to ensure adequacy of protection.

3.3.6 Construction and Installation

The proposed pipeline has been designed to transport gas at a maximum operating pressure of 191 bara. This will allow a flow rate of 966 MMscfd to be achieved. The maximum depth of the pipeline under the sea will be –140 m LAT.

A detailed survey of the subsea pipeline route has been conducted to carry out freespan analysis and the results of this analysis has identified specific areas of the seabed which may require preparatory work before the pipeline can be laid.

For pre-lay rock dumping both large and small diameter sized material is required to create a filter layer, ensuring currents along the seabed do not disturb the rock and hence the position of the pipeline. The rock will be sourced from quarries located either in the Darwin or SE Asia region and transferred by barge offshore. The rock will be offloaded from a vessel preceding the lay barge.

The pipe lengths will be transported by barge from the pipeline coating yard directly to the S-Lay barge located offshore.

Following the pre-lay rock dumping, the pipeline will be laid directly on the seabed from the S-Lay barge. No trenching or backfilling is required, as shallow waters are not traversed. Anchor lines, which ensuing tugs continually reposition according to progress, continually secure the lay barge. The pipeline will be lowered over the stern of the laybarge onto the seabed over a pipe support ramp called a stinger. A typical installation would use a third generation barge as shown in **Figure 3-7**.

The pipeline operation will commence with mobilisation of the lay barge to the site. The lay barge carries a supply of pipe lengths, or joints, sufficient for two or three days pipelaying. The stocks will be continually replenished by pipe haul vessels, which carry pipe from a nearby source – either a dockside or a larger bulk pipe carrier. Once the pipe joints are loaded onto the lay vessel they may be double jointed. This optional activity involves welding two joints of pipe together such that the pair of pipe joints is then handled as a single unit. After a section of the pipe has been laid, an as laid survey is performed to confirm that the pipe is undamaged and laid within the specified tolerance limits.

On completion of the lay operation, the precise end chainage position of the pipeline will be determined by the on-board computer. At this point a lay down head is welded to the end of the pipeline.

Onsite Welding

Single or double pipe joints are fed onto the firing line where joints are welded into the pipeline prior to laying over the stern. The firing line will consist of a number of welding stations where progressive layers of the butt weld are deposited.

Following completion of the weld, the weld will be inspected using Non-Destructive Examination (NDE) techniques and if required weld repairs performed. Finally the field joint coating will be applied to the weld area and the void between adjacent concrete coatings filled with a suitable infill.

Accommodation

During construction of the subsea pipeline the S-Lay barge will be fully contained and provide accommodation facilities. Approximately three hundred personnel will be accommodated on the S Lay Barge. Laying of the pipeline will be a 24 hour ongoing operation with changes in shift every 12 hours.

Source: Woodside

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Typical Lay Barge for Subsea Pipeline Installation

Figure 3-7
Project No.: DE2090.100
Figure prepared by: T.Lee
Date Prepared: 16/10/01

3.3.7 Waste Minimisation and Management

As described in **Section 3.2.13.**

3.4 Pipeline Testing and Commissioning

Testing of the pipeline and ancillary components is an integral part of the commissioning of the pipeline system. Testing will generally take the following forms:

- ☐ Testing of all materials prior to construction: Woodside or its representatives will carry out quality assurance tests during manufacture of all materials. Any materials that fail the quality tests will be marked and quarantined so as to ensure that they are not used as part of the project.
- ☐ Testing of Welds: All welds will be checked in accordance with strict industry standards. Testing of welds will be carried out using NDE techniques.
- ☐ Flooding & Hydrostatic Testing: This test comprises water filling the pipeline and then pressurising to the required test pressure to prove strength and integrity. Due to the large volumes of water required for the hydrostatic testing of the pipeline the sourcing of a suitable water supply is a key environmental concern. This is discussed in more detail below.
- ☐ Drying: Following completion of testing the pipeline will be de-watered and dried prior to flowing gas and condensate. The disposal of the water after testing will ensure that it does not cause excessive erosion of the seabed or contaminate the receiving water body.
- ☐ Instrumentation: All instrumentation will be checked to ensure correct calibration. These tests will be carried out in accordance with appropriate industry guidelines.

All test methodologies and acceptance criteria will be approved prior to the carrying out of any test.

All test results and test parameters will be documented. Where test results fall outside the agreed acceptance criteria repair work or modifications will be carried out. Subsequently, the acceptance test will be repeated.

Flooding: The pipeline will be flooded with filtered seawater treated with corrosion inhibitors, oxygen scavengers and a biocide. The flooding spread consists of:

- ☐ Suction pump and supply hose;
- ☐ Chemical injection facilities;
- ☐ Discharge pumps to pump the filtered, treated seawater into the pipeline; and
- ☐ Temporary pig launcher on the pipeline end.

The filling operation will be performed by launching pipeline integrity gauges (pigs) into the pipeline propelled by treated seawater. This would typically comprise two cleaning pigs followed by two pigs fitted with gauge plates. They would generally be separated by 500–1000 m of filtered but not chemically treated seawater. The pig train is then pumped through the pipeline with filtered and chemically treated seawater. This operation typically takes between 2–3 days.

Hydrostatic Testing: Approximately 90,000 tonnes of treated seawater will be needed for hydrostatic testing of pipeline integrity. Test heads are installed at both ends of the pipeline. A pressure testing spread is mobilised to perform the operation. The pressure of the pipe is slowly raised until the required test pressure is reached. The pressure is allowed to stabilise then the 24 hour test period is commenced. The pressure is continuously monitored throughout the test period. Hydrotest water will be discharged at the Wye.

Minor variations in the test pressure often occur due to temperature change for example and unless these variations can be accounted for, such changes frequently lead to extension of the test period until all parties are satisfied that no leak exists. The pipeline is then depressurised and a formal pressure test report prepared as evidence of a satisfactorily constructed pipeline.

Treatment Chemicals: The choice of chemicals used in the test seawater is important. The mix typically includes a biocide (non-agricultural pesticides) to kill biofouling organisms, an oxygen scavenger (to absorb oxygen thereby minimising corrosion potential) and a corrosion inhibitor to prevent rust formation. The rate at which these chemicals are added to the water and the specific products used will require detailed discussion with the authorities responsible for approving the eventual discharge of the test water. The large volume of treated water to be discharged, could affect marine life in the immediate vicinity of the discharge location. Aspects to consider include toxicity, persistence and tendency to bioaccumulate. The chemicals to be used have not yet been specified.

Dewatering and Pre-commissioning: Pre-commissioning will comprise bulk dewatering followed by drying operations to remove residual water. Bulk dewatering is achieved by propelling pigs through the pipeline with compressed air. Up to 30 bar pressure will be needed to overcome the hydrostatic head in addition to the frictional head of the water and pigs. When successive pigs fail to sweep appreciable quantities of water from the pipeline then bulk dewatering is considered complete and drying operations can be commenced.

3.5 Tie-In Location

On completion of the pipe-laying operation the two offshore ends of the pipeline will be laid in close proximity on the seabed. A welded tie-in will then be made by hyperbaric welding. The Sunrise pipeline will terminate adjacent to the Wye, which will be installed on the Bayu-Undan pipeline. The Sunrise and Bayu-Undan Pipelines will be joined to the Wye by a connecting spool piece. The connection may be by flanges or by hyperbaric welding.

3.6 Gas Field Development – FLNG Scenario

Approvals for a FLNG facility will fall under a separate legislative process and therefore is not described in this EIS. However, should a FLNG market scenario arise the development of the gas field will be take place within the scope described in the preceding sections. This scenario comprises a combination of subsea and WHP wells, with gas and condensate exported to an FLNG facility via a series of flowlines and risers, previously described. Under this option produced formation water including production chemicals may be transferred from the FLNG back to the field for re-injection during the commissioning/operation phases.

4. Description of Operation and Decommissioning Phases

4.1 Offshore Field Operation - OLNG Scenario

4.1.1 Project and Reservoir Lifespans

Field life has been forecast using a minimum production rate of 150 MMscf/d raw gas production. At this point the typical average production rate of a well still producing is some 10 MMscf/d.

The resulting field life ranges from 30 to 75 years. Production declines below the plateau rate during the latter third of field life. It is assumed that gas sales contracts can be extended and managed through the decline phase of the field.

While it is recognised that the full field life ranges from 30 to 75 years, no specific design allowance has been made for extended facilities life beyond a nominal 30 years. Instead, the facilities would be managed and maintained to achieve the life required.

4.1.2 Processes

Figure 4-1 shows that the offshore production facilities are designed to deliver two products; natural gas and condensate. There will be two process trains each having a capacity of 50 percent, known as a 2×50% configuration.

The well production from the wellhead platform and the subsea wells will be manifolded on the wellhead platform and routed across the bridge to the PCUQ platform. All risers, and subsea flowlines (3) and export stabilised condensate to the FSO, will be located on the wellhead platform.

The compression and processing systems will process all wellstream fluids flowing from the field. Processing equipment will include:

- Primary separation;
- First stage gas compression;
- Gas dehydration;
- Hydrocarbon dewpoint control;
- Export gas compression;
- Condensate stabilisation and pumping;
- Produced water treatment; and
- Fuel gas systems.

Compression comprises 5×25%, two-stage centrifugal compressors.

Products include:

- Export gas routed to export gas pipeline;
- Condensate product routed to FSO; and
- Produced water.

FSO Condensate Transfer and Storage

Condensate is transported from the process facilities located on the PCUQ platform to the FSO via a 2 km long 8 inch pipeline. The barge-design FSO will be permanently moored, will weathervane about the forward turret, and will be designed to be on location throughout the field life.

The FSO will be a new build construction and designed to store 750,000 bbl of condensate. The FSO will have export cargo pumping to allow filling of shuttle tankers within 24 hours and inert gas arrangements for this capacity. Offloading will be via stern mounted floating offloading hose to shuttle tanker. Condensate will be offloaded to trading tankers on a routine basis so as not to impact on the production facilities on Sunrise, approximately once every 17 days.

Service Carriers

During operation of the offshore facility a number of support vessels and helicopters will be required. Helicopters will be employed for crew change and delivery of light and urgently needed provisions and equipment. A supply boat will operate between the onshore base and the Sunrise Platforms and FSO on a regular basis.

During FSO offloading, an 'offtake support' vessel will be necessary for mooring, hose connection and transport between the FSO and shuttle tanker.

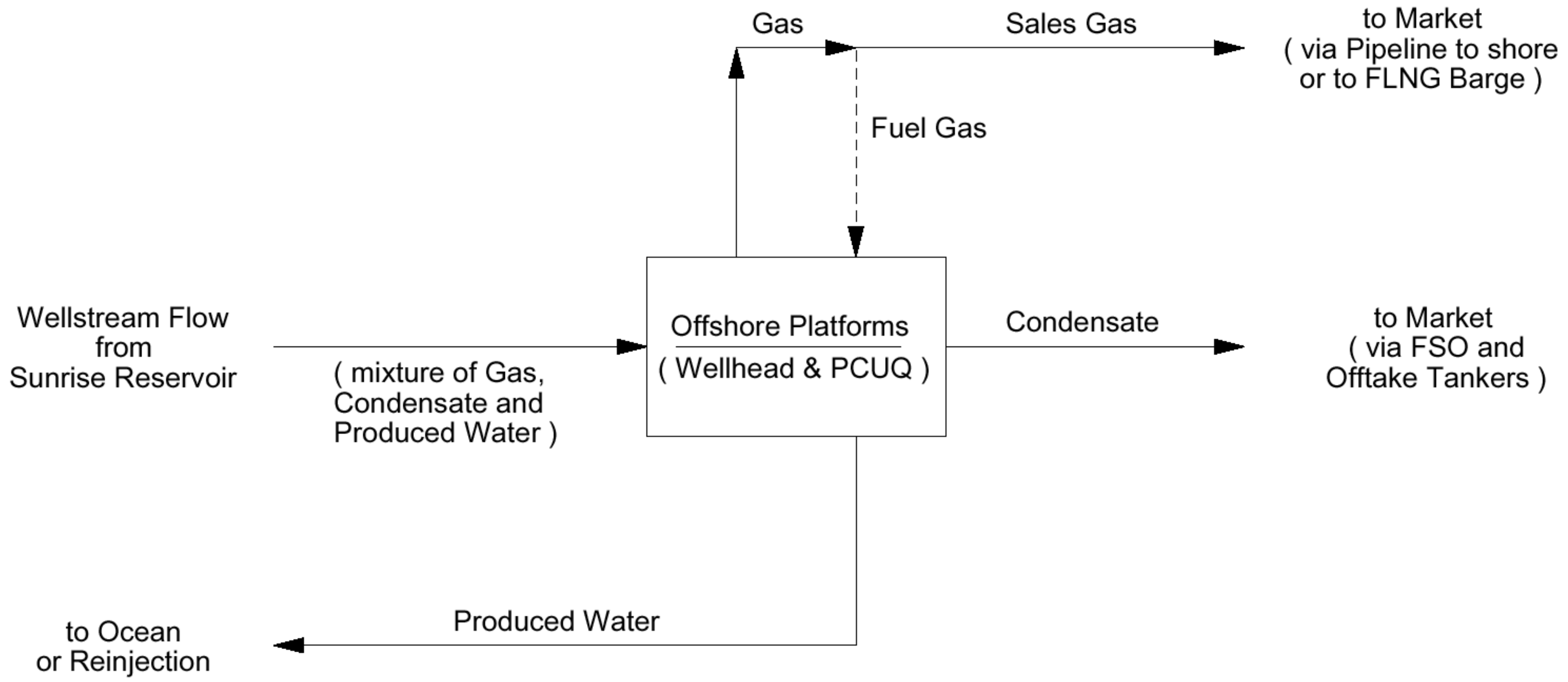
4.1.3 Infrastructure and Utilities

PCUQ

As well as process and compression systems the PCUQ platform includes utility systems, living quarters, support, control and safety systems, flare tower, workshops, switchrooms and temporary refuge. Service vessels can be accessed by the pedestal crane and lay down areas are provided. The 60–100 m long trafficable bridge-link with the wellhead platform will support utility piping as well as electrical and instrumentation requirements.

The living quarters, with structurally integrated helideck is designated as the living, control and administrative centre of the platform, providing facilities for a planned 80 persons. The PCUQ will produce all required utilities, which will then be reticulated to the wellhead platform. Utilities will include:

- ☐ *Waste Heat Recovery/Heating Medium Systems*: Waste heat recovery units on the power generation turbines will supply all heating loads via a circulating heating oil circuit;
- ☐ *Cooling Water System*: A tempered water cooling system will be provided with the Sea Water (SW) Lift Pumps, seawater filtration equipment, Sea Water/Tempered Water Exchangers and Tempered Water Pumps. Completely segregated Seawater and Firewater Systems will be adopted;
- ☐ *Firewater Pump*: Two diesel engine driven firewater pumps (2x100%) will be provided;
- ☐ *Fuel*: Fuel gas, taken from downstream of glycol dehydration will undergo pressure letdown and will be superheated before use. Treated fuel gas will be supplied for use in the power generation dual fuel turbines. (Diesel can be used as an alternative fuel during start-up);
- ☐ *Power Generation*: Power will be provided from the PCUQ platform for all electrical consumers where it is reticulated to the wellhead platform. Maximum diversified power generation demand of around 12 MW will be supplied by turbo-generators arranged in a 3 x 50% configuration using dual fuel turbines. A diesel engine driven generator will be provided for emergency power and for use during black-start;
- ☐ *Fuel*: Aviation fuel storage and heli-fueling facilities;
- ☐ *Air*: Air, instrument and plant air;
- ☐ *Nitrogen System*; for line purging
- ☐ *Closed and Open Drains:* Water from the drain systems will be cleaned and discharged to sea.
- ☐ *Produced water:* Will be cleaned to statutory requirements and discharged to sea or reinjected;
- ☐ *Sewage System*: With macerator to comminute particulate material from black and grey water;
- ☐ *Diesel System*; and
- ☐ *Accommodation:* For 80 personnel – galley, office and recreational facilities.



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Overview of Offshore Process Systems

Figure 4-1
Project No.: DE2090.100
Figure prepared by: T.Lee
Date Prepared: 16/10/01

Wellhead platform utilities will include:
- Closed and open drain systems;
- Diesel storage, treatment and distribution;
- Dedicated sewage system with macerator;
- Service water;
- Seawater will be used for the provision of washwater and fire water; and
- Power generation from dual-fuel generators.

FSO

Utility systems will be installed to allow operations including:
- Inert gas generation;
- Tank venting and tank cleaning facilities;
- Fuel systems;
- Power generation;
- Hydraulic power systems; and
- Firewater systems (2x100% pumps).

Accommodation and utility space will be of conventional stern location and will include sleeping for 10–20 personnel.

4.1.4 Dangerous Goods/Chemicals

As regards the handling, export, import, handling, disposal of dangerous goods and substances the following legislation may be applicable:
- *Northern Territory Explosives and Dangerous Goods Act 1980*
- *Northern Territory Port By-laws 198*
- *Australian Standard AS 3846-98 Handling of Dangerous Goods in Port Areas*
- *The Industrial Chemicals (Notification and Assessment) Act 1990 and Regulations 1990*
- *Northern Territory Marine Act 1981:*
- *Navigation Act 1912 (Cth)*
- *Marine Orders, Part 41 (Dangerous Cargoes) Order No. 15 of 1998 (Cth)*; and
- *Marine Orders, Part 92 (Powers of intervention - Noxious substances) Order No 11 of 1995 (Cth) Marine Orders, Part 93 (Marine Pollution Prevention - Noxious Liquid Substances) Order No 11 of 1999 (Cth).*
- *Marine Pollution Act 1999*

The types and quantities of process, utility and operational related chemicals is not yet known but such products may include some of the following:
- Diesel;
- Cementing fluid chemicals (cement, surfactants, defoamers, inorganic salts, bentonite, barite);
- Drilling Fluids (**Refer to Section 8.2.2.2**);
- Helifuel;
- Methyl Ethyl Glycol (MEG)
- Lube oil;
- Methanol; and
- Other chemicals to be used for potable water treatment, corrosion inhibitors and scale inhibitors, etc.

Depending on the drilling fluid properties required, there may be a need for bacterial control, corrosion inhibition, viscosity, weighting and fluid loss control chemicals to be added to the drilling fluid. Drilling fluid additives will be screened on both their technical requirements and environmental performance. Where technically practicable, the most environmentally acceptable options will be preferentially selected.

All chemicals will be screened on both their technical requirements and environmental performance and the most environmentally acceptable options will be preferentially selected. The HSE Safety Case will review the health, safety and environmental implications of such inventories further. Platform, FSO and supply boat management systems will include:

- Material safety data sheets;
- Labelling;
- Segregated and contained storage areas for different classes of substances; and
- Handling procedures for transfer of materials.

All storage facilities and handling equipment will be required to be in good order and designed and constructed in such a way as to prevent and contain any spills. The type of facilities will be decided during the detailed design phase.

All waste and products will be stored and transported with consideration for dangerous goods segregation and onshore and offshore handling and disposal requirements. The Projects' Waste Management Plans will address these aspects.

4.1.5 NPI Substances

The annual throughput of National Pollutant Inventory (NPI) substances has not yet been quantified. The *National Environment Protection Measure for the National Pollutant Inventory National Environment Protection Act 1994* (Commonwealth), concerned with the reporting of solid, liquid, and gaseous emissions, states that:

- Facility operators are required to report to the National Environment Protection Council if any emissions of a substance from the facility exceed the reporting threshold for that substance in a reporting year;
- Schedule A of the measure made pursuant to s.14 (1) *National Environment Protection Act 1994* provides a list of substances (with thresholds) for which a report is required if the threshold for that substance is exceeded in a reporting year;
- In providing emissions estimates the relevant industry handbook technique must be used. If there is no such technique then a technique that the State Environmental Protection Authority approves must be used; and
- If the required information is not supplied, the State Regulator will take enforcement action.

Typical NPI substances that may be NPI reportable for the Sunrise Project include:

- $NO_{X;}$
- CO;
- $SO_{2;}$
- Particulates; and
- Benzene.

4.1.6 Maintenance & Upgrade Requirements

Approximately every 4 years a shutdown programme will be initiated for inspection, maintenance and upgrading of the offshore facilities.

Operating costs have been included for periodic refurbishment of both wells and surface facilities, and percentages of construction capital costs have been allowed for abandonment of each asset.

The wellhead platform will contain four spare slots for future well requirements. Contingency plans will include capability to retro-fit additional risers or daisy chain risers to tie back additional subsea wells.

The PCUQ platform has the capability to retro-fit additional modules (3,000 ton) on top of legs once the production jack up is installed.

Floating Hose Inspection will take place annually.

4.1.7 Offshore Workforce

Working hours on board the platform will typically comprise 12 hour shifts for the 24 hour operation. Shifts will follow either a 2 week on/off or a 3 week on/off pattern. Accommodation will cater for approximately 80 shift personnel plus a limited number of guests at any given time on the PCUQ platform. 10–20 personnel will be accommodated on the FSO.

Transport to and from the platform will be by means of helicopter or fast ferry.

4.2 Export Pipeline

The subsea export pipeline will operate at 191 bara and transport gas at appropriate flow rates from the field to meet downstream customer demands.

In the event of an emergency a shutdown may be implemented. The shutdown procedure will be based on measurements of pressure and rates of change of pressure at each end of the pipeline. In addition leak detection will be carried out by comparing time integrated inlet and outlet flow rates to provide a system mass balance.

The pipeline condition will be monitored by Remote Operated Vehicle (ROV) equipped with TV/video and an instrumented pipeline inspection tool on a regular basis – possibly every 5 years. The pipeline will be pigged to the Wye piece or landfall and maintenance operations introduced when required. With the subsea pipeline consisting of a 36 inch steel pipeline covered with concrete coating, it is anticipated that maintenance, if and when required, will primarily focus on prevention of freespans and replenishment of rock dump material.

DNV OS F101 states that:
‘*as a minimum monitoring/inspection frequency should be such that the pipeline system will not be endangered due to any realistic degradation/deterioration that may occur between two consecutive inspection intervals….’*

The Code goes on to state that:
‘Instrumentation of the pipeline system may be required when visual inspection or simple measurements are not considered practical or reliable, and available design methods and previous experience are not sufficient for a reliable prediction of the performance of the system’.

The export pipeline will be subject to a formal hazard identification study (HAZID) in which events, which may influence the pipeline, are systematically examined and their consequences assessed. A Quantitative risk assessment (QRA) will then be made of these hazards and where appropriate, risks will be mitigated by engineering and operational solutions.

4.3 Sunrise Gas Field Operation - FLNG Scenario

If this scenario proceeds, the gas field development and operation will take place within the project scope described above; the most significant difference is the operation of the FLNG barge itself, which is being pursued under a separate approvals process and therefore not considered here. In this scenario, a combination of subsea and well head platform wells are required, with gas and condensate exported to a FLNG facility via a series of flowlines and risers, which have been described in the preceding sections. Under this scenario Produced Formation Water including production chemicals, may be transferred from the FLNG back to the field for re-injection.

4.4 Decommissioning

4.4.1 Offshore

Overview

The future aim will be to decommission production facilities and abandon operating areas so as to leave them as near as practicable to their original environmental condition.

Decommissioning guidelines are currently being prepared by NT Department of Business, Industries and Resource Development (formerly NTDME). These guidelines, or the guidance in place at the time of decommissioning will be followed by the Operator at the decommissioning phase.

Offshore Facility

In general decommissioning requirements are considered on a case-by-case basis at the discretion of the relevant regulatory authority at the expiration of the permit, licence or lease, having due regard to the protection of the area's natural resources and IMO guidelines (APPEA, 1996). Provisions include:

- Removal of structures which may snag or entangle fishing gear or anchors;
- Removal of structures which may present a collision hazard to shipping;
- Removal of all platform structures to at least 55 m below the sea surface;
- Complete removal of platform structures in less than 75 m of water;
- Removal to be performed in such a way as to minimise any adverse impacts on navigation or the marine environment;
- Ensuring maintenance plans are developed to maintain any structure that protrudes above sea level (if appropriate);
- Ensuring all structures not completely removed are notified to appropriate authorities to record on nautical charts;
- Pipelines to be purged, and protrusions removed where likely to snag or entangle fishing gear or anchors; and
- Documenting and maintaining in a permanent file all procedures and well work records.

In accordance with APPEA Guidelines (1996) considerations at decommissioning will include:

- Taking account of the needs and views of other maritime/resource users, natural resource managers and affected community groups;
- Current and likely future values and users of the area;
- Disposal or reuse of structures and equipment; and
- Safe decommissioning of wells.

The APPEA Code of Environmental Practice (1996) also identifies several decommissioning procedures stating:
'Equipment and facilities no longer required for production operations must be decommissioned safely taking into account:

- ❑ *Wells are to be cased, plugged, sealed and abandoned in accordance with industry standards and regulatory requirements; and*
- ❑ *All waste materials and equipment generated from decommissioning and decommissioning activities should be managed in accordance with a structured waste management plan'.*

Wells
Well decommissioning and suspension are specifically regulated via

- ❑ Section 107 of the P (SL)A-1967; and
- ❑ *P(SL)A Schedule of Specific Requirements as to Offshore Petroleum Exploration and Production.*

Decommissioning of wells will be planned to achieve the following objectives in accordance with the APPEA Guidelines for *Well Suspension and Decommissioning Offshore (1999):*

- ❑ To isolate formation fluids from each other;
- ❑ To isolate formation fluids from the surface; and
- ❑ To clear the seabed or reinstate land areas.

Wells will be decommissioned in accordance with the guidelines in place at the time and standard industry practice.

Platforms & FSO
Options for removal of the wellhead platform include:

- ❑ Complete removal of jacket;
- ❑ Toppling of jacket on side and leaving as an artificial reef;
- ❑ Cutting of the jacket at seabed and towing to deep water for disposal as an artificial reef; and
- ❑ Removing of the top bays of the jacket.

The production jack up may be removed from site at the end of operations for use elsewhere by reversing the installation technique. The FSO and all mooring systems above the seabed will be completely removed with only anchor piles remaining.

Intrafield Pipelines & Risers
Intrafield pipelines will be cleared of hydrocarbons, depressurised, cleaned and left in place. Risers will be cleaned and removed.

4.4.2 Subsea Export Pipeline

Options for decommissioning which have been considered include, leave in place, full removal, partial removal, deep burial; or a combination of these. At this stage no decision has been made as to the abandonment policy. However, Woodside and any future operator recognise that opinion changes in relation to the best approach to such issues and will fully comply with the regulations and follow industry practice in force at the time of abandonment.

At present the *Petroleum (Submerged Lands) Act 1982* does not stipulate any procedures with regard to abandonment of subsea pipelines. Similarly, DNV OS F-101 does not provide any guidelines.

5. Alternatives

5.1 Introduction

The DIPE guidelines (August 2000) state that an outline of the main alternatives studied by the developer and an indication of the main reasons for the developer's choice is required in the Draft EIS. Furthermore, where alternatives are available, which may still allow the objective of the project to be met, the existing environment should also be detailed.

A broad range of alternatives has been considered. Many of the alternatives will be, or already have been, eliminated on economic, technical, environmental or regulatory grounds.

The main alternatives examined in the validation of this project's feasibility are:
- ☐ Implications of 'No Development';
- ☐ Alternative Development Sites and Pipeline Routes;
- ☐ Alternative Facilities;
- ☐ Alternative Environmental Process Options; and
- ☐ Management of Greenhouse Gas Emissions.

5.2 No Development Option

The petroleum exploration and production industry is important to Australia's overall economic welfare and provides the nation with a reliable and competitively priced source of energy, which directly meets 52 percent of Australia's primary needs. The industry's economic contributions include the following:
- ☐ Production value (1999/00) - $12 bn;
- ☐ Exports (1999/00) - $8.5 bn;
- ☐ Import Replacement Value (1999/00) - $5 bn;
- ☐ Income Tax (1999/00) $1.4 bn;
- ☐ Resource Taxes (2000/01) - >$3.0 bn;
- ☐ Industry Output Multiplier – 1.8 to 2.4;
- ☐ Employment – 20% production change leads to a 0.4% employment change; and
- ☐ GDP – 20% production change leads to a 0.5% change in GDP (APPEA, 2001).

The above contributions reflect direct benefits to the economy, however, companies which operate within the industry provide capital, infrastructure, expertise, technology diffusion and frequently facilitate the capturing of export market opportunities for related industries. It also supports the service sector. A recent study has indicated that nearly 900 businesses in Western Australia alone, including many regional areas, are involved in providing services to the oil and gas industry. A strong and expanding industry will continue to offer a significant long term contribution towards the nation's economic growth (APPEA, 2001).

Although Australian petroleum supplies are currently experiencing a high level of self-sufficiency, this is expected to decline in the next few years, unless there are further commercial discoveries with crude oil and condensate production rates set to decline by 33 percent by 2005 and 50 percent by 2010. An increased reliance on imports of fuel products has implications for national security, management of environmental/greenhouse issues, the balance of payments and jobs in the Australian economy.

If this project does not proceed there will be negative implications for Australia and East Timor where revenues from upstream gas production have a significant role to play. In Australia, upstream royalties and taxes account for 2–4% of government revenue annually (pers. comm Noel Mullen, APPEA 2001), whereas in East Timor; success at Sunrise and Bayu-Undan provide the most immediate opportunity for the rebuilding one of the worlds newest and poorest nations.

Failure to develop Greater Sunrise will also see Australia and East Timor miss opportunities to supply energy exports to global markets where due to its cleanliness and convenience, LNG is in increasing demand.

Failure to commercialise Greater Sunrise will miss an opportunity to increase employment in the gas sector, including downstream gas industries. It will also fail to realise a return on the considerable investment made by the Sunrise Joint Venture since the discovery of the resource. Since 1998 some AU$200 million has already been attracted to the project and invested in identifying development options and potential markets.

The commercialisation of Timor Sea gas will be essential if Darwin is to avoid increased dependence on less environmental-friendly fossil fuels, such as oil and coal. Opportunities to improve greenhouse efficiency in energy use would be missed as would Australia’s opportunity to develop its second LNG industry which provides the basis of large scale exports of natural gas to global markets.

5.3 Alternative Development Sites and Pipeline Routes

5.3.1 LNG Onshore/Offshore

The feasibility of locating an LNG Plant in the Darwin Region based on Timor Sea gas resources was the main focus of a feasibility study undertaken by the NAGV in 1997. The study examined markets, engineering, environmental and economic aspects of the proposed project and the possibility of capturing anticipated market opportunities in the Asian region for LNG and the Northern Territory and adjacent states for domestic gas. The 18-month feasibility study concluded that development of Timor Sea gas was technically feasible but ultimate success depended on the capture of markets and project economics (Woodside, 1998).

In 2001 Phillips Petroleum Co. tabled an onshore LNG concept for Greater Sunrise gas based on a LNG sales opportunity on the west coast of the USA with El Paso Energy. Phillips, as a joint venture participant in Greater Sunrise, has led the marketing effort opposite El Paso to progress this opportunity. Under the co-operation principles, alternative LNG proposals could be tabled by any of the Sunrise Joint Venture participants.

In 2001 Shell tabled a floating LNG concept for Sunrise. Floating LNG (FLNG) may present environmental advantages, as well as reducing cost and construction time. FLNG was considered in the NAGV Feasibility Study (1998) as a possible option. A FLNG terminal would be the first of its kind globally. However, the option of developing the FLNG concept will be progressed through a separate approvals process and so is not considered in this EIS. While the FLNG barge itself is not considered in this EIS, the capacity for the gas field to be developed to supply such a facility is well within the scope of the proposal set out in this document.

5.3.2 Subsea Pipeline Routes

The effect that a pipeline will have on the environment largely depends on the route chosen. Consequently, route selection is of prime importance to minimise any adverse environmental effects. Recognising this, several pipeline route selection studies have been undertaken, since first realisation of the Sunrise Gas Project. The objective of these studies was to identify potentially feasible routes for a pipeline running from the Greater Sunrise gas fields to Darwin.

The Sunrise Gas Project started out as a standalone pipeline with no potential sharing of resources with the Bayu-Undan field. The first shortlist of pipeline routes was therefore based on a more direct route from Sunrise to Darwin. Three routes were shortlisted; one ran across Melville Island, one to the east ,and the other to the west of Bathurst Island. Studies undertaken in 2000 showed that routes to the

West of Bathurst Island were preferred. A number of routes were examined running from Greater Sunrise to the Bayu-Undan Wye piece and two routes shortlisted, Route 05 and 06, as shown in **Figure 5-1.**

No significantly sensitive habitats were encountered along Route 05. Route 06 displayed more extensive areas of hard substrate, supporting epibenthic communities but no particularly abundant communities were found. Baseline environmental conditions were determined by Bowman Bishaw Gorham (BBG) during marine assessments conducted during 2000 and 2001 (refer to **Section 6.6**) around the proposed platform and FSO locations.

Route 05 – Preferred Alignment: Refer to **Section 3.3.2.**

Route 06 – Alternative Option: Route 06, 245.8 km in length, runs in a south-easterly direction towards the Wye piece and does not enter the JPDA. The pipeline runs through Melita Valley and 'The Boxers'. Water depth at the Sunrise Gas Field is –140 to -400 m and drops to its lowest level (-180 m LAT) at Melita Valley (KP[1] 105 and KP 120). The shallowest depths are experienced at 'The Boxers' where between KP 165 and KP 200 an average of -37 m LAT is reached but drops to -80 m in places. Along this route the following engineering designs might be necessary to counteract the uneven profile.

☐	Pre Lay Rock Dump	KP 86.78 to KP 86.92
☐	Pre-lay Rock Dump	KP 96.05 to KP 96.12
☐	Pre-lay Rock Dump	KP 106.04 to KP 106.12
☐	Pre-Lay Rock Dump	KP 168.29 to KP 168.34
☐	Pre-Lay Rock Dump	KP 187.62 to KP 191.00
☐	Stabilisation Rock Dump	KP 175.00 to KP 187.00
☐	Stabilisation Rock Dump	KP 194.00 to KP 200.00

The thickness of the concrete coating would have to be increased through the 'The Boxers' (between KP 165 and KP 175) to maintain stability.

In summary, both routes to varying degrees pass through valleys and shoals. However, Route 05, the preferred and shortest route, does not experience fluctuations in water depths to the same extent as Route 06. Route 06 requires additional stabilisation and rock armour. Route 05 by running in a more westerly direction, results in a longer co-operation pipeline, the installation of the pipeline is relatively straightforward due to a reduction in the quantity of rock armour and degree of stabilisation required.

From the proposed location of the 'Wye' piece, Greater Sunrise gas would be transported to Wickham Point through a pipeline installed within the corridor previously approved for the Bayu Undan environmental assessment.

5.3.3 Alternative Platform Locations

In 2000/2001, Bowman Bishaw Gorham on behalf of Woodside undertook environmental surveys in two separate studies of three shallow bank tops and a proposed platform location in a deep-water location, to identify suitable locations for platform structures in the Sunrise Gas Field area. The banks were identified as Sunrise Bank, Sunrise South Bank and Sunrise West Bank. The Sunrise South Bank was identified as most suitable of the shallow banks from an environmental perspective.

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[1] KP - Kilometre Point

However, it was determined during screening studies that use of a Bank required extended corrosion resistant flowlines, leading to a more costly development than that proposed. Therefore, the platform structure will not be located on one of the banks but at the deep-water platform location, which is suitable from both an environmental and technical perspective.

The banks are described in more detail in **Section 6.6.1** and shown in **Figure 6-10.**

5.4 Alternative Facilities

5.4.1 Drilling Rigs

For the platform wells, studies have been conducted to balance the greater cost of installing individual subsea wells against the cost of providing a drilling platform and the risk/cost of drilling extended reach wells with a resident platform facility. The comparative ease of re-entering wells with a surface wellhead has also been factored into these studies.

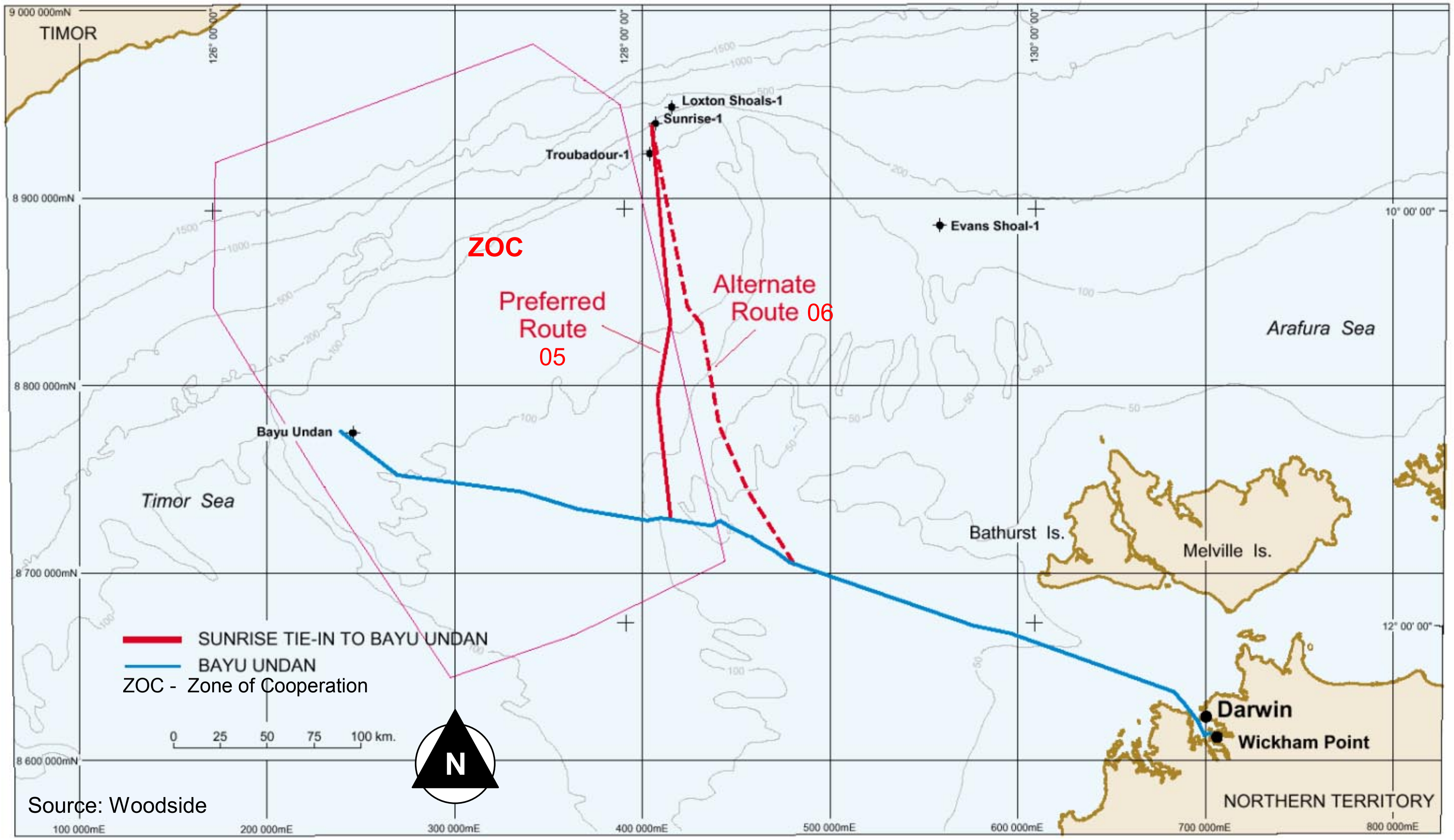
Various platform drilling rig options have also been investigated to minimise the impact of platform facilities, while optimising the platform drilling capability and minimising capital investment in drilling equipment.

Self-Erecting Tender Rig (SETR): This option is similar to the SSETR (Refer to **Section 3.2.6**) except the tender is a flat-bottomed barge rather than a semi-submersible. Studies are being conducted to determine their sea-worthiness in the open seas of the Project area and in these water depths. Drilling costs and drilling rig availability may be improved since there are more SETR barges available in the South East Asian Region.

Permanent Platform Rig: A permanent drilling facility installed on the platform is not being considered as a preferred option at this time because:

- It would require a heavy lift vessel to install the rig onto the platform;
- The rig is not available for work on other projects should the opportunity eventuate;
- Maintenance would all have to be conducted offshore (an expensive option), not on the beach; and
- The majority of rigs being built these days are modular, demountable rigs.

Modular Platform Rig (MPR): A MPR has been demonstrated to mitigate much of the risk associated with the SSETR, (Reference Case) option. The rig is likely to be custom-built for the Project, to achieve the Extended Reach Drilling (ERD) capability and is thought likely to remain in Darwin, available for well interventions between drilling campaigns, should this be required, or for deployment on other drilling projects in the interim. There are interface issues with the platform which have to be addressed, eg platform loading, capping beam spacing and deck area and facilities, before this option can be considered as a preference to the current SSETR in the ‘reference case’. Accommodation of the rig crew and safety issues concerning proximity of personnel to hazardous areas and provision of safety systems have also to be addressed, as there are likely to be 3 - 4 wells drilled from a wellhead platform before the PCUQ facility is installed. Once the PCUQ is installed, accommodation and services could be provided by the PCUQ.



Source: Woodside

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Subsea Pipeline Preferred and Alternative Route Options

Figure 5-1

Project No.: DE2090.100
Figure prepared by: T.Lee
Date Prepared: 16/10/01

5.4.2 Offshore Processing Facilities

An assessment comparing three main concepts was conducted by Woodside to determine the preferred offshore platform as follows:

- ❑ Jack-Up - Hull and topsides with a separate but bridge-linked Wellhead Platform and remote FSO (**Figure 5-2**).
- ❑ Technip Jack-Up - Hull and topsides (with accommodation built into the hull) and a separate but bridge-linked Wellhead Platform and remote FSO.
- ❑ Float-over - Integrated deck topsides with float over installation onto a steel jacket with a separate but bridge linked Wellhead Platform and remote FSO.
- ❑ Floating Production Barge with subsea wellhead facilities.
- ❑ Floating Production Barge with a separate Wellhead Platform.

The Jack-up platform concept was selected as the outcome of an internal design competition with a large floatover-installed integrated deck and a floating production barge - all specified to achieve the same processing function. All options were found to be feasible, and the evaluation process covered cost, schedule and assessments of health, safety environmental and technical risks. The jack-up emerged in the leading position by a small margin in each main area of the evaluation, enabling the decision to be readily endorsed by all JV partners.

5.5 Alternative Environmental Process Options

The Sunrise Gas Project can demonstrate that the best available technologies for reduction of environmental impact of discharges and emissions have been given due consideration. In this regard Woodside produced the report entitled '*Environmental Design Review'* (Woodside, May 2001). Several available technologies have been considered and benefit-cost analysis performed before deciding on the recommended option.

The Woodside Environmental Policy (**Appendix B**) states that Woodside shall seek continuous improvement in energy efficiency and update environmental standards in light of developments in technology, legislation, industry practice and changing community expectations. The Woodside 'Venting and Flaring Policy' requires that "venting and flaring of hydrocarbons will be minimised with the design and operational philosophy of each facility, using best available technical and procedural solutions at reasonable cost".

Emissions and discharges to the environment can be classified under the following broad groups:

- ❑ Atmospheric Emissions;
- ❑ Discharge to sea;
- ❑ Chemicals; and
- ❑ FSO/ Tanker Venting/ Ballast Water discharge.

Atmospheric Emissions: The issues to be considered with regard to atmospheric emissions include:

- ❑ Reduction of CO_2 emissions by minimising continuous flaring;
- ❑ Reduction of unburned hydrocarbon emissions by eliminating continuous venting (Global Warming Potential for methane is 21 times CO_2);
- ❑ Minimise unburnt aromatics (BTEX) to atmosphere (carcinogenic); and
- ❑ Eliminate Ozone Depleting Substances (ODS).

Discharges to Sea: Wastewater will originate from a number of sources, including produced formation water (PFW), drainage water and sources such as cooling water and ballast water. Factors to be considered include:

- ❑ Legislation with respect to free hydrocarbons and particularly dissolved hydrocarbons is becoming more stringent.

- ❑ Need to limit total hydrocarbons consisting of free suspended hydrocarbons and dissolved hydrocarbons in water.

- ❑ Achieving total oil in water (OIW) target in gas condensate field is difficult.
- ❑ Condensation of regeneration offgas to recover heavy hydrocarbons exacerbates the problem of dissolved hydrocarbon (BTEX) in water.
- ❑ Investigation into the feasibility of water injection displays potential for an injection well.
- ❑ Ballast Water and cooling water management.

The following options exist with respect to an injection well:
- ❑ Shallow new well;
- ❑ Injection through the annulus of a production well to a shallow formation possibly in combination with drilled cuttings;
- ❑ Dedicated slimline well to formation depth; and
- ❑ Workover of a production well at the end of its production life.

The technical risks with injection through the annulus are higher than shallow injection well and remains unresolved to date. The ‘workover’ option will require water injection to be delayed until a suitable depleted production well is available. Until such time, a hydrocyclone degasser system can be used to treat water for disposal overboard.

In summary a range of process options which provides the best environmental performance have been identified during the preliminary engineering. Work is continuing to identify in more detail which of these options provides the best environmental performance and which will meet the technical requirements of the final development concept.

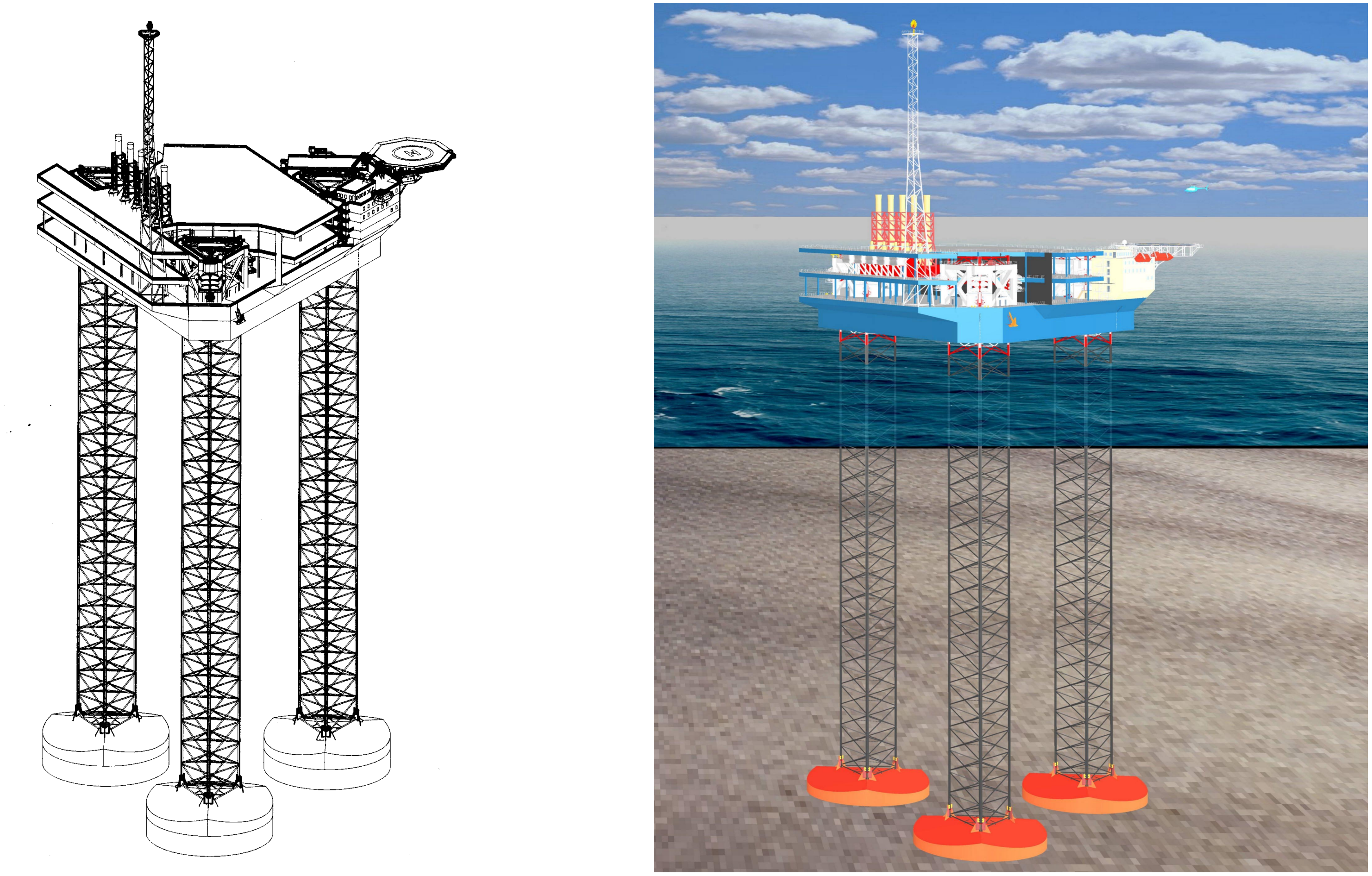
5.6 Greenhouse Emissions and Environmental Implications

A number of greenhouse gas reduction measures are being considered for the Sunrise Gas Project, including emissions reduction and energy efficiency measures, and market-related measures (joint implementation) offsets. Specific measures to be considered as part of the Sunrise Gas Project are:
- ❑ The development and implementation of a greenhouse strategy to minimise emissions of greenhouse gases;
- ❑ Design and operational measures to minimise offshore flaring and venting;
- ❑ The reduction of methane emissions to negligible levels through the combustion of regeneration offgas;
- ❑ Maximising the use of waste heat from gas turbines; and
- ❑ To adopt industry best practice in greenhouse efficient technology and practice wherever practicable (NOI, PPK, 1998).

Natural gas is a clean burning energy source offering significant environmental and cost advantages over other fossil fuels. The LNG export industry replaces other higher carbon density fossil fuels that would otherwise be used for power generation in rapidly industrialising countries across the Asian region, reducing global greenhouse emissions. With Kyoto Protocol targets to be met, LNG and natural gas is set to play a crucial role in attaining the necessary targets, however, 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.

Woodside strongly believes in the benefits of natural gas as an alternative to less environmentally favourable fossil fuels, and believes its use can do much to alleviate air pollution in the highly urbanised and industrial centres of Asia, America and Europe. At the same time, Woodside are making concerted efforts to reduce greenhouse emissions in their own operations, and in recent years have had considerable success.

Australia's LNG participants, including Woodside, endorse the view that natural gas will play an important role in reducing worldwide greenhouse emissions. From wellhead to customer, LNG and natural gas generate significantly lower greenhouse emissions per unit of energy than alternative fossil fuels. While gas production and LNG processing lead to increased greenhouse emissions within the producing country, a far greater reduction in emissions accrues to the customer. As a result, the world environment is a net beneficiary when gas displaces other fossil fuels, particularly coal, as an energy source (**Figure5-3** and **Figure 5-4).**



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PCUQ (Jackup)

Figure 5-2
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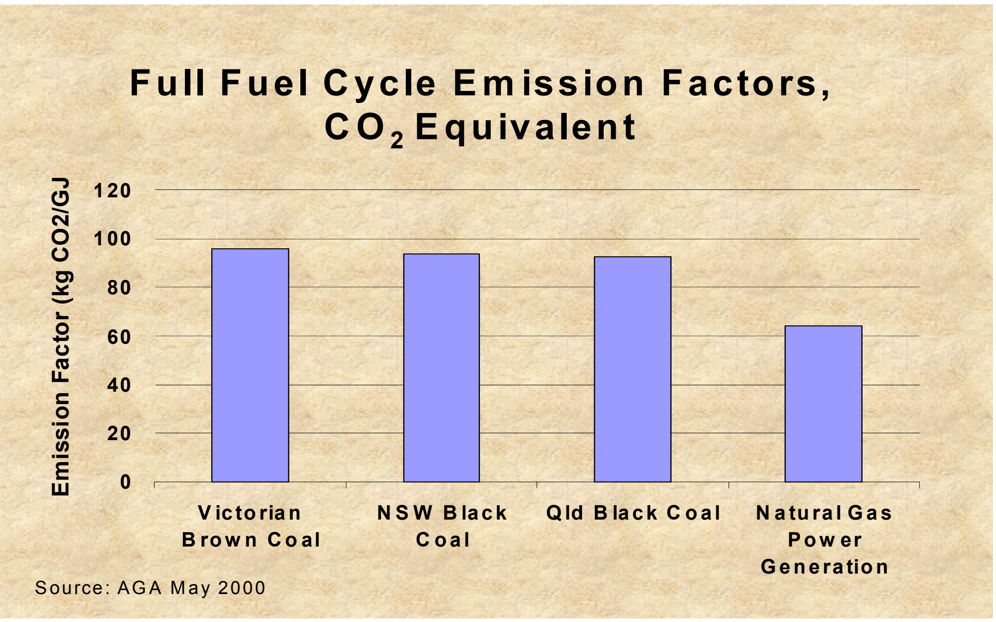


Figure 5-3 Full Fuel Cycle Emission Factors CO_2 Equivalent

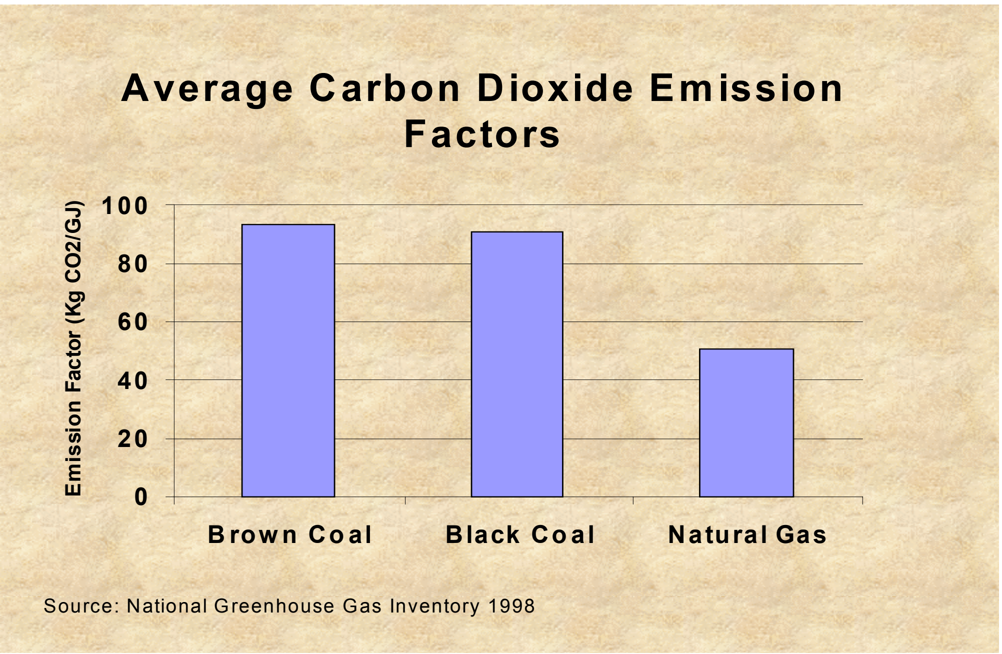


Figure 5-4 Average Carbon Dioxide Emission Factors

6. Existing Environment

6.1 Timor Sea Climate

The climate of the Timor Sea area comprises two distinct seasons, a dry 'winter' from April to September and a 'summer' from October to March, during which most rain falls.

The winter is characterised by steady easterly winds of 5 to 12 m/s originating from over the Australian mainland and travelling over the Timor Sea (the South East Trade Winds). The summer is characterised by the North-West Monsoon, a steady, moist west-south-west to north-west wind reaching speeds of 5 m/s for periods of 5 to 10 days.

The September/October transition season is characterised by the development of low pressure systems over central Australia. Surface winds in the vicinity of the Sunrise Gas Field are likely to possess a westerly component and at other times the synoptic easterlies may persist (WNI, 2001). The winds will be light and frequently less than 5 m/s.

In the March/April transition season, the North-West Monsoon retreats northward resulting in south-easterly winds (WNI, 2001). By the end of April the dry easterly airflow of the winter period is usually well established.

Monthly wind roses typical of the Sunrise area are presented in **Figure 6-1.**

Tropical cyclones form in the area generally south of the equator in the eastern Indian Ocean area, and the Timor and Arafura seas. In the Timor Sea area most of the storms are tropical lows or developing storms passing well to the south of the Sunrise Gas Field; however, the storms can be fully developed at this latitude. Examples of this are tropical cyclone Tracy that devastated Darwin and the much more intense cyclone Thelma that remained offshore until it reached the Kimberley area of Western Australia. The most active months for tropical cyclones in the Timor Sea region are January to March. However, the most severe cyclones likely to affect the region will most often occur in the months of December to April (WNI, 2001). Records of cyclonic activity in the region over the past 30 years indicates only storms with wind speeds less than gale force in the Sunrise area (**Figure 6-2).**

The mean annual rainfall on the south coast of Timor ranges from 1,500 to 3,000 mm (SKM, 1993) with mean annual rainfall for the Sunrise Gas Field expected to be in the order of 1,700 mm with the bulk of the rainfall occurring between November and March. The mean summer and winter air temperatures measured for the Jabiru field for 1984 were 28.4°C and 26.9°C respectively. Jabiru is about 420 km south-west of the Sunrise Gas Field.

6.2 Geology and Soils

6.2.1 Regional Geology and Soils

The development area is situated on the outer shelf and upper slope of the Sahul Platform off the northern margin of Australia in the Timor Sea. The lithospheric plate boundary between Australia and East Timor lies to the north of the area with the bottom of the oceanic trench (Timor Trough) lying about 55 km north at 3,000 m water depth. The Australian tectonic plate is moving northwards and slowly being subducted under the Indonesian Plate. The subducted plate is associated with numerous earthquakes in the region north of Timor, although some deep-seated earthquakes extend south of Timor. A distinct shelf break defining the change between the shelf and upper slope exists at around about the 130 m water depth contour. During the last sea level low stand (approximately 14,000 to 20,000 years ago) the water level would have coincided with this depth contour.

The Melita Valley lies south of the Sahul Platform within the middle shelf zone and a channel system derived f.rom this valley crosses the outer shelf. Seismic lines show the shelf edge to be made up of a series of prograding (outward growing) sediment wedges, each in the order of 100 m thick and presumably generated as deltas. Bedding within these wedges is frequently complex, though downslope from them the strata are more uniformly layered. The steep slopes beyond the shelf edge are caused by the most recent delta fronts. The channel mentioned above appears to have fed the most recent prograding wedge.

Prograding sediment wedges are common features on continental margins forming as deltas off river mouths and are frequently developed during low stands of sea level. They are generally produced by very high sediment accumulation rates. These features are often dormant during high sea level stands such as during the last 14,000 to 20,000 years (approximately). Results of seismic surveys indicate a number of faults that affect the deeper sediments. Some of these faults extend relatively close to the seabed in the vicinity of the proposed development.

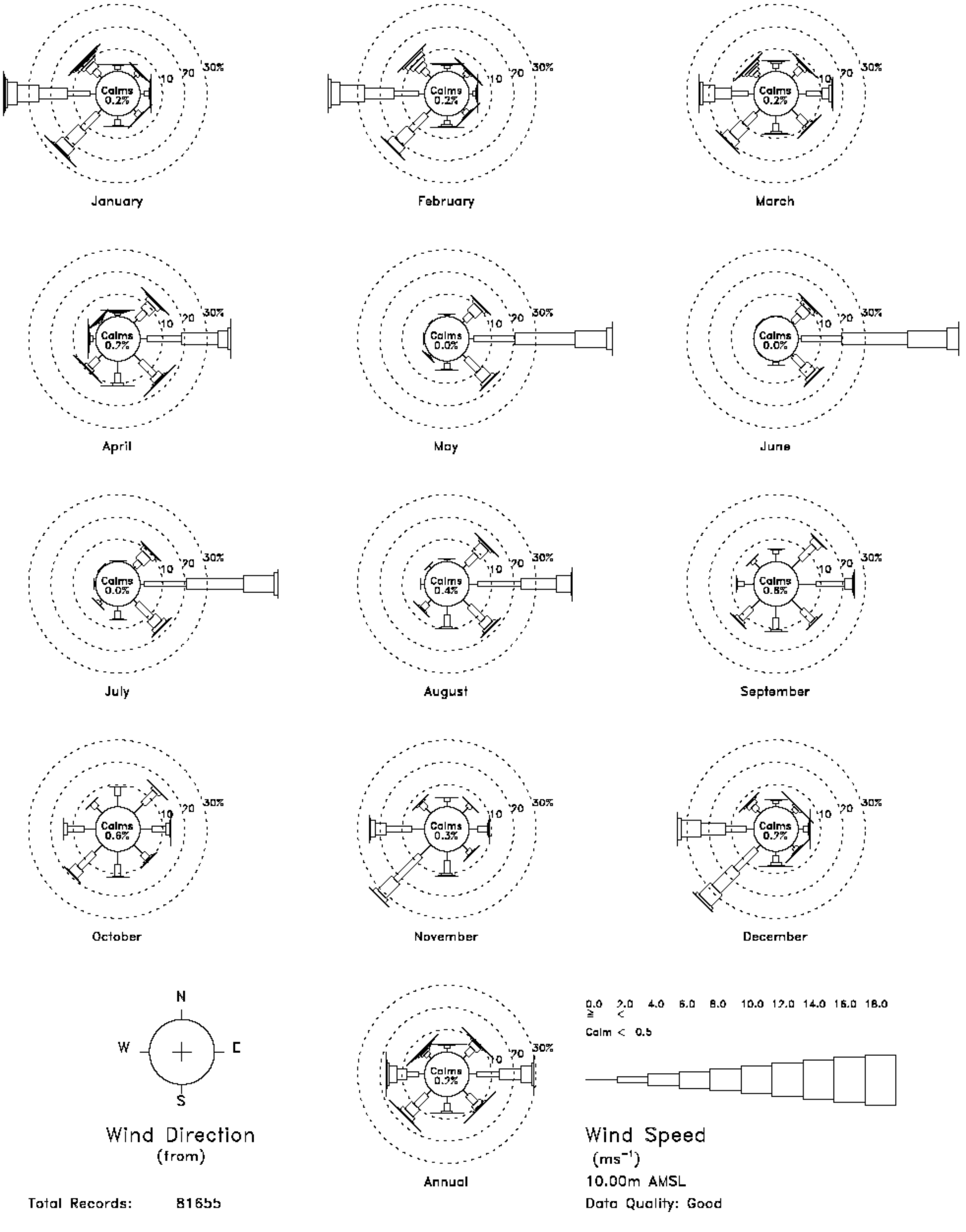
The structural formation of the Sahul Platform is described (Barnes 1998 in Woodside 2001) as an essentially prograding carbonate wedge formed during Miocene times, developed following an early Tertiary phase of faulting. The collision of the Australian plate with the Timor plate produced uplift and the development of a localised mid-Miocene unconformity. As an Australian plate started to subduct, subsidence of the shelf occurred during the Pleistocene, thereby forming space for the accumulation of the Pleistocene sequence. Carbonate sediments have dominated this accumulation near the shelf edge.

The Pleistocene carbonates are characterised by Reef and Shoal facies near the shelf edge. Reef facies are interpreted as carbonate accumulations dominated by reef growth and developed during lower sea levels. The uncemented sediments that exist in places on the surface of the cemented sequence are probably an accumulation of Holocene fine sediments from suspension. The shoal facies are interpreted as carbonate accumulations, sub-aerially exposed and subject to erosion when the Reef facies were being deposited. These were later submerged, and carbonate shoals (mounds) were formed as the sea level rose. In the last 10,000 years, continued subsidence coupled with rapidly rising sea levels have resulted in these mounds not being able to keep up with rising sea levels. Current thinking is that growth of the mounds has also been assisted by the continual cycle of halimed growth and debris generation, which is high in carbonate content. However, storm activity in the area erodes the build up of debris, thereby further stunting the growth of these mounds. The water depths on top of the mounds are rarely shallower than about 40 m.

6.2.2 Subsea Pipeline

The pipeline route is 218 km in length to the Wye location of the proposed section. Water depth ranges from 72 m to 140 m along the Sunrise to Wye section. The route crosses various valleys and gulleys and reaches a depth of approximately 151 m at the centre of Melita Valley at a KP of 130 km from the platform.

The pipeline route travels approximately 3 km before reaching the shelf break (approximately 135 m depth). From KP 3 km to KP 95 km the pipeline traverses the Sahul Platform, where the water depth reduces gradually to approximately 70 m. However, localised gullies are crossed at KP 50 km and KP 60 km. The Melita Valley, which is a Graben feature, is crossed in its broad upper reach area, between about KP 95 km and KP 190 km. Water depths over this region can reach as much as approximately 150 m. Beyond 190 km to the location of the Wye (KP 218 km approximately), the pipeline traverses the edge of Bathurst Terrace where water depths are in the vicinity of about 70 m.



Source: WNI Science & Engineering (2001)

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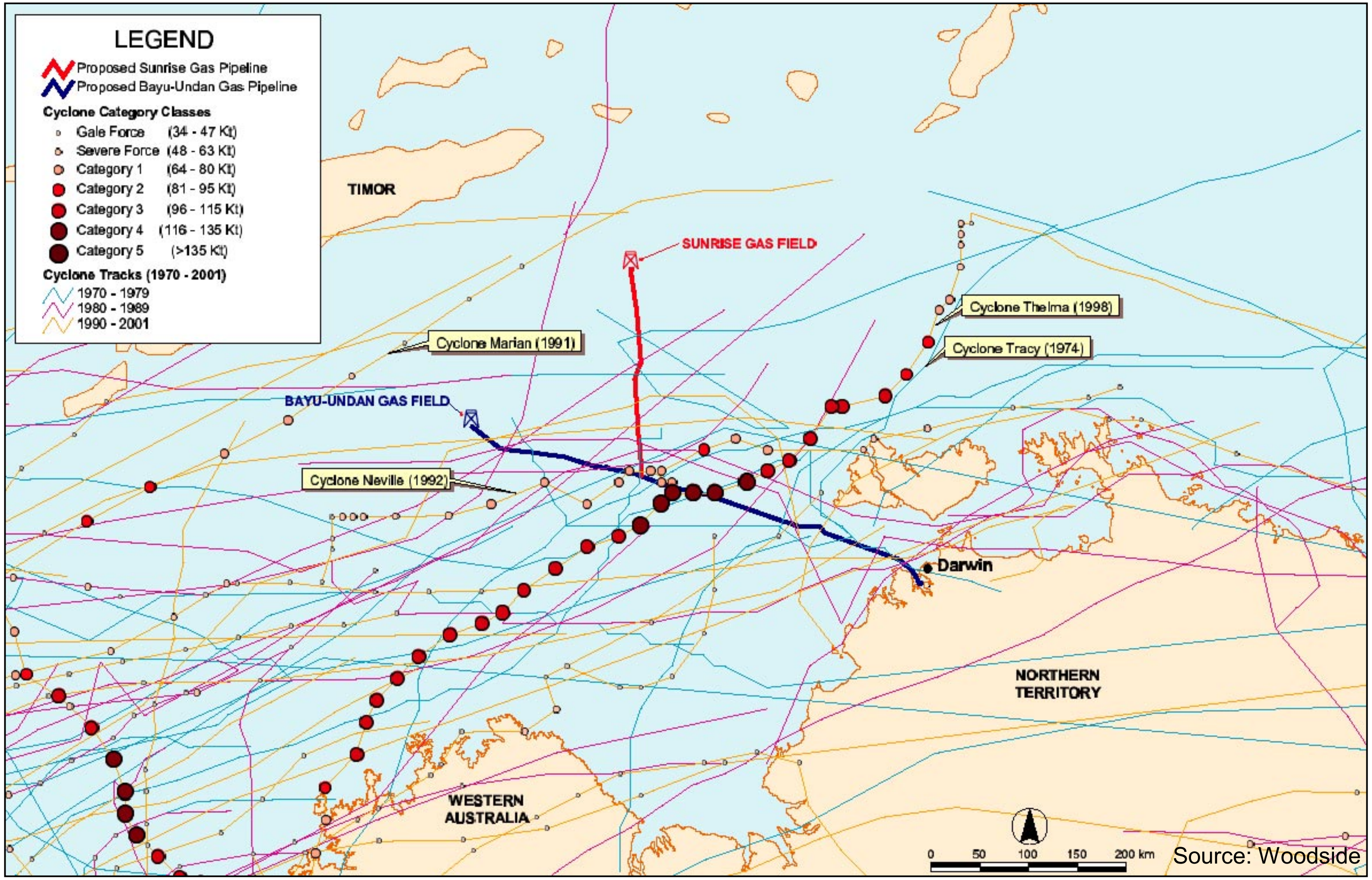
Wind Roses for the Sunrise Gas Field

Figure 6-1
Project No.: DE2090.100
Figure prepared by: T.Lee
Date Prepared: 16/10/01



Source: Woodside

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Cyclonic Activity in the Timor Sea Region (1970 – 2001)

Figure 6-2

Project No.: DE2090.100
Figure prepared by: T.Lee
Date Prepared: 16/10/01

Initially a reconnaissance geophysical investigation to gather preliminary geotechnical information to finalise the pipeline route was undertaken during May/June 2001. Subsequently, a reconnaissance geotechnical investigation was undertaken along the proposed pipeline route between Sunrise and the Wye from June to July 2001. This included fieldwork and testing of soil samples recovered. As part of this programme, piston core samples commenced at the Wye and proceeded to the platform location. Following this Piezocone Penetration Test (PCPT) testing was undertaken. Based on the geotechnical investigation results the route can be divided into five zones of similar surficial sediments summarised as follows and illustrated in **Figure 6-3:**

- ☐ *Zone 1*: KP 0 to KP 21 km – the materials in this zone are characteristic of the surficial soils within the area of the prograding sediment wedge, found to be an old delta front. Samples are described as carbonate sandy silt below a depth of approximately 0.7 m with the layer above being of a marginally coarser grading.
- ☐ *Zone 2*: KP 21 to KP 71 km – in this zone, a surficial layer, generally classified as carbonate silty exists to depths of between approximately 0.5 m and 0.7 m.
- ☐ *Zone 3*: KP 71 to KP 115 km – similar characteristics to Zone 2 except that the surficial layer has a higher clay size particle content and is classified as a carbonate clayey sand.
- ☐ *Zone 4*: KP 115 to KP 179 km – the surficial soil over this area is remarkably similar to a depth of 2.5 m below seabed and is classified from samples as a carbonate clay.
- ☐ *Zone 5*: KP 179 km to Wye – the surficial layer in this zone varies from carbonate clay to clayey sand with gravel.

6.3 Seismicity

The Timor Trench lies immediately north of the Sunrise Gas Field and to the south of the island of Timor. Subduction earthquakes, caused by one edge of one crustal plate being forced below the edge of another, associated with the Timor Trench dominate the earthquakes of the Sunrise Gas Project area.

It should be noted that detailed seismograph coverage for the area was limited until 1964 when there was a significant improvement in world wide coverage, including the Timor Sea area. For the period prior to 1964, data compiled from various historical catalogues for major events between 1900 and the 1963 was used for the study.

The Sunrise Gas Field is located at the southern boundary of the Timor Trench, on the Australian Plate, which is subducting to the north under Timor. The subduction zone is steeply dipping with the rate of activity along the subduction zone appearing to be greatest to the east (towards the Banda Sea) than to the west (towards Sumbawa). There appears to be an absence of seismicity to the north-west of the Sunrise Gas Field under East Timor, although this may not be a long-term feature of the seismicity of the area.

Although it is not possible to use the distribution of earthquakes to delineate active faults in the immediate area of the Sunrise Gas Field because of the proximity to the Timor Trench, it is reasonable to expect that shallow earthquakes will occur in the area. Earthquake activity is dominated by the subduction events to the north and it can be assumed that these will continue in the pattern of the past 100 years. Earthquake activity is not dominated by the earthquakes in any particular location or time period.

At the Timor Trench, the subduction zone earthquakes are shallow at the offshore trench and are deepest to the north with most subduction earthquakes occurring at depths down to approximately 200km. Few events lie between 300 and 500 km although some events do occur at depths exceeding 600km. Events deeper than 300 km are too deep to create damage at the surface for major engineered structures.

Figure 6-4 identifies the earthquakes that occurred in the Sunrise Gas Field area since 1900. However, it should be noted that the locations of events recorded prior to 1964 are highly uncertain with those occurring after 1964 increasingly accurate with an uncertainty of 10 to 20 km. **Table 6-1** (extracted from Seismology Research Centre, WEL 2001b) identifies the strongest earthquakes in the region since 1900, within 600 km of Sunrise. However, of the 131 earthquakes listed in the original table (Seismology Centre, 2001) only five of these reach an intensity of 5. Note that **Figure 6-4** identifies earthquakes by both depth and magnitude. A formula is then used to calculate intensity. Magnitude is defined as a number indicating the "size" of an earthquake. It is closely related to the amount of energy released during the rupture, or to the rate at which energy is released. There are a number of magnitude scales in use, each measured in a different way. If the word magnitude is used without qualification, in the past it usually referred to the Richter magnitude ML, but is now usually the moment magnitude MW. The ML, MS and MW scales give similar numerical values

In summary, Woodside has undertaken extensive research into the issue of seismicity for the Sunrise Gas Development. Subduction earthquakes associated with the Timor Trench, located north of the Sunrise field and south of Timor, dominate the Sunrise area. Subduction earthquakes are the result of the Australian tectonic plate being deflected (subducted) under the Indonesian tectonic plate. Being located on the subducting plate, the seismicity of the area is less onerous than the area north of the subduction zone. However, detailed probabilistic and deterministic analyses have been undertaken to determine the seismic design criteria relevant to this development. Deterministic hazard studies consider the effect of specific large earthquakes rather than the cumulative effect of all possible earthquakes as considered in a probabilistic study. Detailed results of this study are presented in Seismology Research Centre (2001). These criteria will be used to ensure that the development is designed to safely withstand the maximum credible seismic event defined for this area.

Further details on this research can be found in – Seismology Research Centre (2001). "Review of Seismicity, Sunrise". Prepared for Woodside Energy Limited, June 2001.

There are no computed intensities for the Sunrise Gas Field exceeding a Modified Mercalli (MM) Intensity of 5, either for large or distant earthquakes or smaller nearby events. Damage is not experienced for intensities less than about MM 6. Based on the Modified Mercalli Intensity scale, well-engineered structures should not experience damage for intensities less than about MM 8. Since 1900 the location of the nearest earthquake to Sunrise was located 138 km away in East Timor with an intensity of 3, a Peak Ground Acceleration (PGA) of 64.48 and magnitude 5.2.

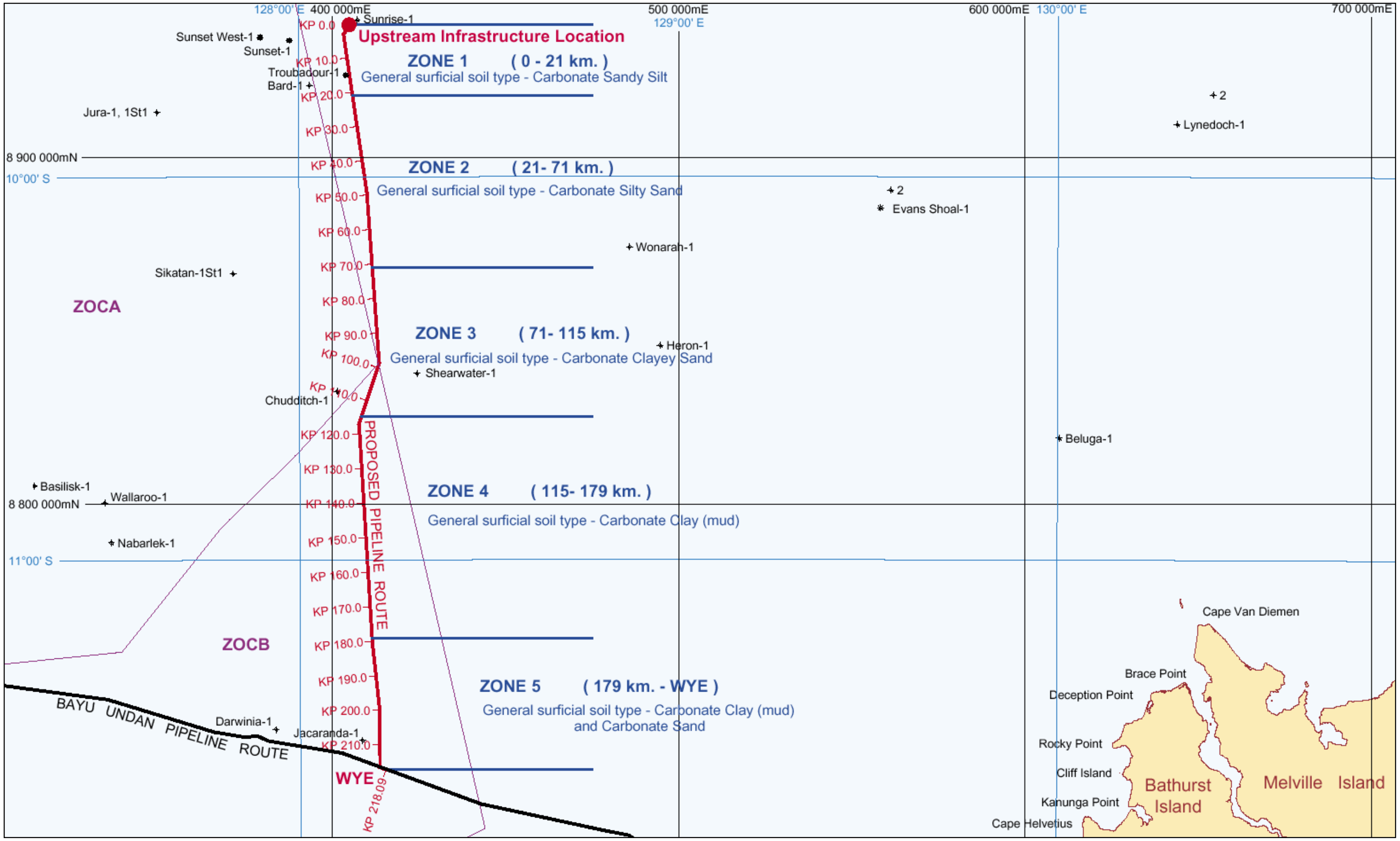
Table 6-1 Strongest Earthquakes Experienced within 600 km of the Sunrise Gas Field since 1900

Year	Origin	Location		Magnitude[1]	Distance from Sunrise (km)	Intensity[2]	PGA[3] (mm/s^2)
		Latitude	Longitude				
1917	Banda Sea	7.50 °S	128.00 °E	Ms 7.8	231	5	161.20
1918	Banda Sea	8.00 °S	127.50 °E	Ms 7.8	190	5	141.63
1952	East Timor	8.00 °S	126.60 °E	Ms 7.2	245	5	102.88
1962	Banda Sea	7.44 °S	128.30 °E	Ms 7.2	237	5	104.13
1963	Banda Sea	6.94 °S	129.53 °E	Ms 8.2	328	5	118.00

1 Preferred magnitude, scale and value. Different scales give different values depending on many factors. The preferred magnitude is usually the average of magnitudes computed from several seismographs.

2 Intensity calculated at Sunrise using Esteva & Rosenblueth attenuation function.

3 PGA - Peak Ground Acceleration calculated at Sunrise in mm/s^2 using Esteva & Rosenblueth attenuation function.



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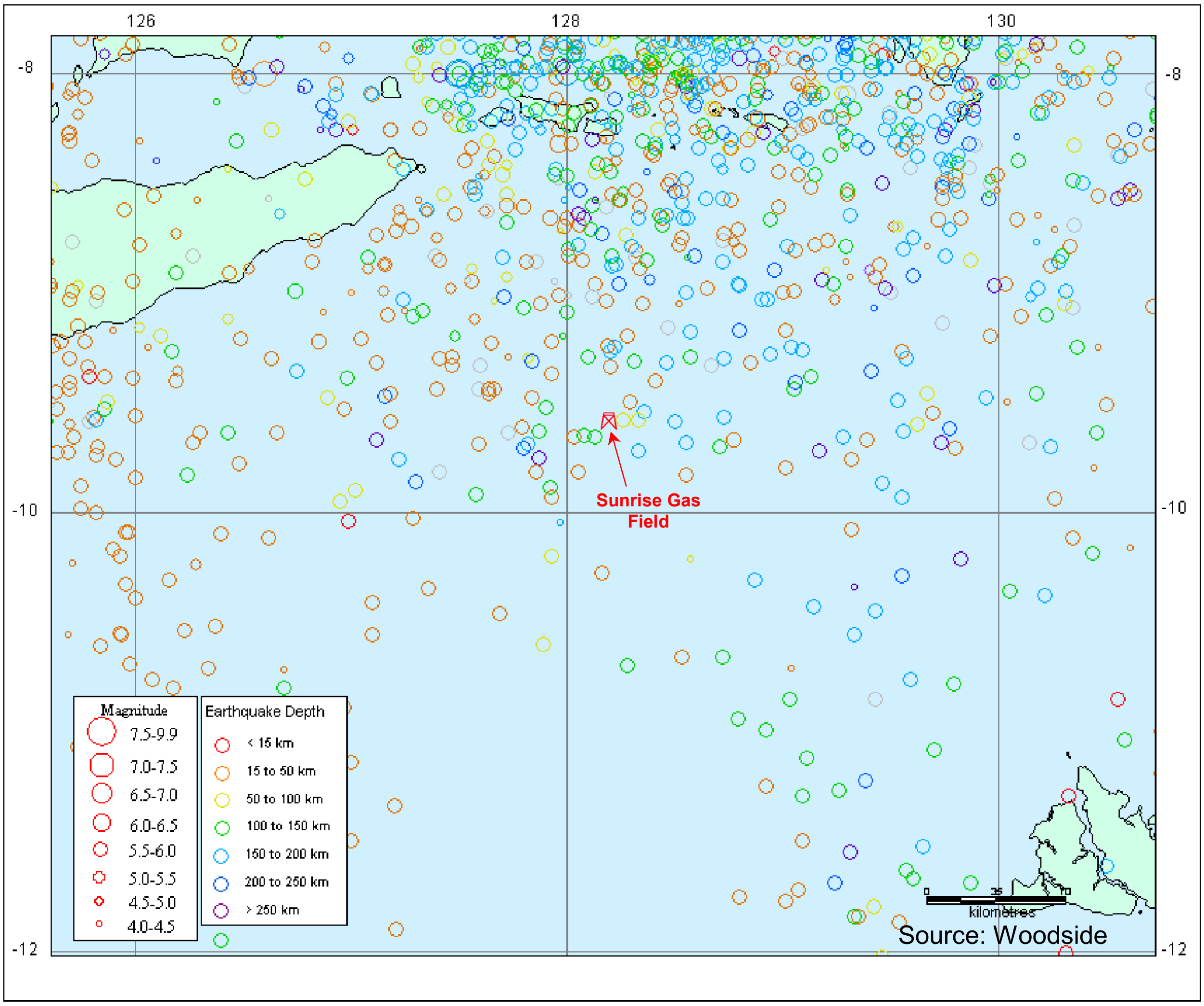
Site Investigation Zones

Figure 6-3

Project No.: DE2090.100
Figure prepared by: T.Lee
Date Prepared: 16/10/01



Source: Woodside

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Earthquake History in the Sunrise Gas Field Area Since 1900

Figure 6-4
Project No.: DE2090.100
Figure prepared by: T.Lee
Date Prepared: 16/10/01

6.4 Bathymetry

6.4.1 Sunrise Gas Field

The seabed in the vicinity of the Sunrise Gas Field lies approximately 160 m below the water surface. The gas field lies at the top of the steep shelf break where the depth drops to about 300 m over a distance of 15 km. There are four shallow shoal features adjacent to the southern part of the Troubadour Gas Field, including the Sunrise Bank. These shoals are covered by minimum water depths of approximately 40 to 50 m. The bathymetry of the Sunrise Gas Field is illustrated in **Figure 6-5.**

6.4.2 Subsea Pipeline

Route 05 – Preferred Alignment: Refer to **Section 3.3.2.**

From the Wye to shore the pipeline covers the same corridor as the Phillips Bayu-Undan pipeline. The bathymetry between the Wye and shore is suitable for the construction and operation of a natural gas pipeline (Dames & Moore 1997). While the general alignment of the pipeline will be within the corridor roposed for the Bayu-Undan pipeline the final detailed alignment is yet to be determined.

6.5 Hydrodynamics and Oceanography

6.5.1 Sunrise Gas Field

Metocean data for ZOCA permit 91-03, located to the south-west of the Sunrise Gas Field, has previously been described in a report prepared for Woodside Petroleum Pty Ltd (Sinclair Knight Merz, 1993). Oceanographic data has also been collected by Woodside for the Laminaria Field, approximately 280 km from the Sunrise-2 Well location (Woodside, 1995). A metocean monitoring programme including meteorological, wave and current measurements across the shelf and around the Sunrise production platform area commenced in October 2000. Data from the programme, which is available from October 2000 to March 2001, has been used to revise previous estimates of environmental design criteria for the development (WNI, 2001). Information on the biological and physical characteristics of the seabed has been reported in environmental assessments for Ludmilla-1 well in AC/P16. The following summarises the metocean conditions expected for the Sunrise Gas Field.

6.5.2 Waves

The ambient wave climate for the Sunrise Gas Field and associated pipeline is composed of both sea and swell waves.

Sea waves are locally generated wind waves and as such the sea wave climate at Sunrise Gas Field is closely allied to the prevailing wind regimes **(Figure 6-6),** with westerly and southwesterly seas prevailing from December to March, shifting to predominantly easterly seas from April to October. Sea waves in the area may have periods ranging from 2 or 3 seconds to as long as 6 or 7 seconds.

Swell waves are surface wind waves that have propagated to a site following generation by remote storms (i.e. 200 – 7000 km away). Swell reaching the Sunrise area results predominantly from storms in the Southern Ocean or the southern portion of the Indian Ocean. As such, the predominant swell direction at Sunrise Gas Field is from southwest to west, with a period usually greater than 10 seconds, commonly ranging up to 18 seconds and occasionally 20 seconds. Shorter period swell (6 to 10 seconds) may result from tropical cyclones and from winter easterlies over the Arafura Sea and eastern portions of the Timor Sea (WNI, 2001).

In summer the one and ten year return period significant wave heights are 2.4 and 3.9 m, respectively. Whilst for winter the expected relevant significant wave heights are 2.8 m and 3.5 m, respectively. During cyclones the hundred year return significant wave height is in the order of 7.0 m.

6.5.3 Tides

The tides of the Kimberley Shelf region are unusual as they retain a substantial amplitude at a relatively large distance from the coastline (WNI, 2001). The tides are semidiurnal (two highs and two lows per day) with a small diurnal inequality (difference in heights of successive highs and successive lows). The tidal range is typically 4 metres during spring tide and 1.8 m during neap tide (Australian National Tide Tables). Tides are expected to flow east-north-east and ebb west-south-west in the upper 100 m of the water column, whilst flooding south-east and ebbing west-north-west in the lower portion of the water column. Tidal current speeds in the order of 0.6 m/s (springs) and 0.2 m/s (neaps) are anticipated (Woodside, 1995). The tide levels for the Sunrise Gas Field are presented in **Table 6-2** (WNI, 2001).

Table 6-2 Estimated Tide Levels for Sunrise

Tide	Level (m)
Highest Astronomical Tide (HAT)	3.1
Mean High Water Spring (MHWS)	2.8
Mean High Water Neap (MHWN)	1.9
Mean Sea Level (MSL)	1.7
Mean Low Water Neap (MLWN)	1.7
Mean Low Water Spring (MLWS)	0.4
Lowest Astronomical Tide (LAT)	0.0

Source: WNI (2001) *Preliminary Metocean Conditions Sunrise Pipeline Timor Sea, R1032.*

6.5.4 Currents

Surface currents for the Sunrise Gas Field are strongly influenced by the semidiurnal tide and to a lesser extent by the wind-driven and drift current contributions.

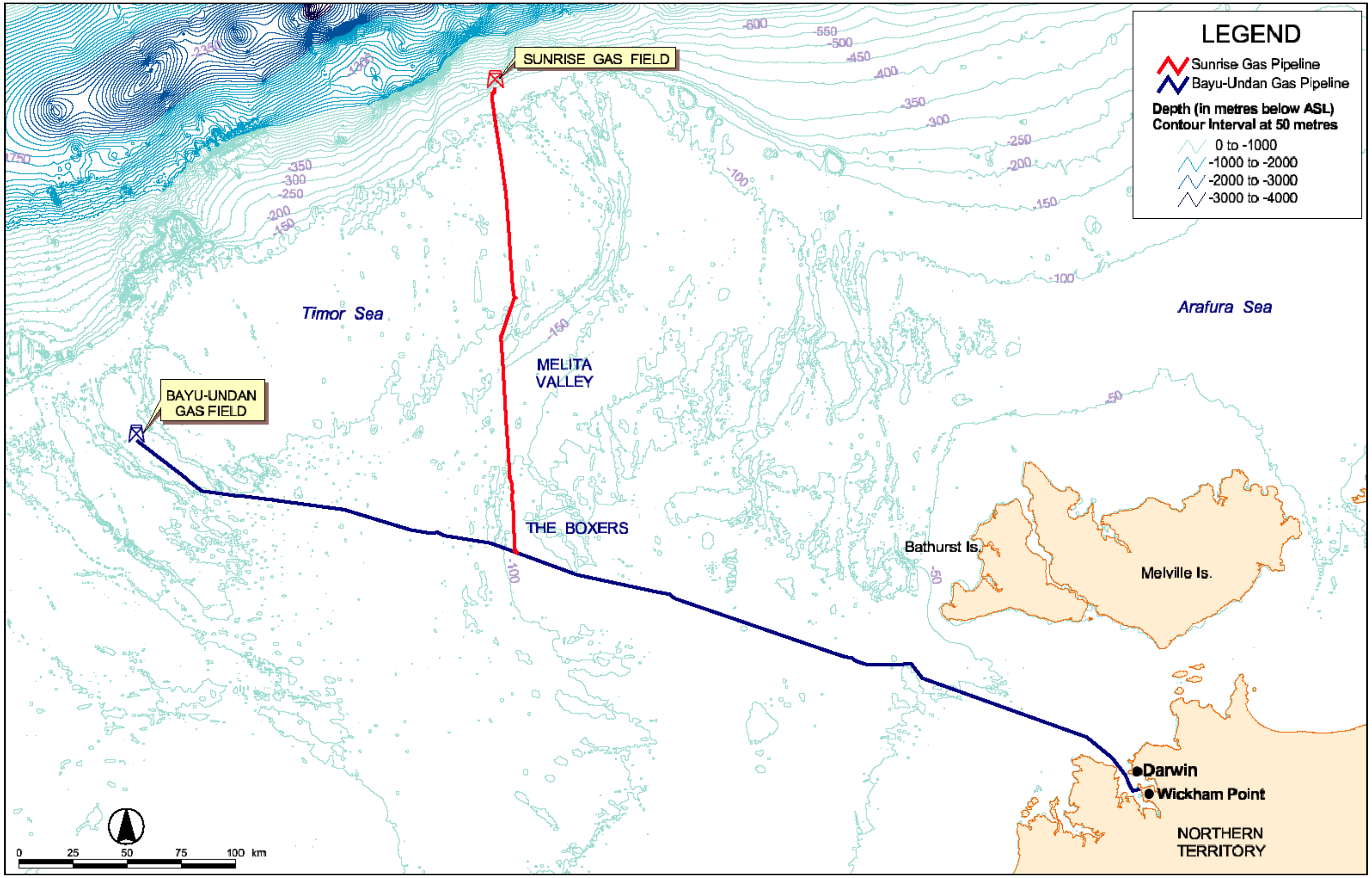
Tidal currents are directed across the local bathymetry, flooding to the south-southwest and ebbing to the north-northwest. Tidal current speeds will range up to 0.4 m/s, during spring tides and reduce to 0.2 – 0.3 m/s during neaps.

Surface currents are expected to reflect seasonal wind regimes, with summer easterly to north-easterly currents, and winter westerly to south-westerly currents. Local wind-driven surface currents are likely to attain maximum speeds of 0.7 m/s during extreme monsoonal or Trade Wind surges. More typical speeds would be in the range of 0.2 to 0.4 m/s (WNI, 2001).

Non-tidal currents drift to the west-northwest with speeds approaching 0.1 m/s and a maximum of 0.6 m/s. Current roses illustrated in **Figure 6-7** through **Figure 6-9** show the direction and speed of currents in the vicinity of the Sunrise Gas Field at a depth of 20 m below the sea surface, at 100 m below the sea surface and at 260 m below the sea surface respectively. Generally, the current speeds do not significantly vary from month to month and summer to winter at all depths.

6.5.5 Water Temperatures

The mean monthly surface water temperatures in the vicinity of the Sunrise Gas Field are expected to vary between about 26°C and 30°C. Waters are expected to be stratified all year round with the thermocline nearer the surface in summer (50 m) than in winter (100 m).



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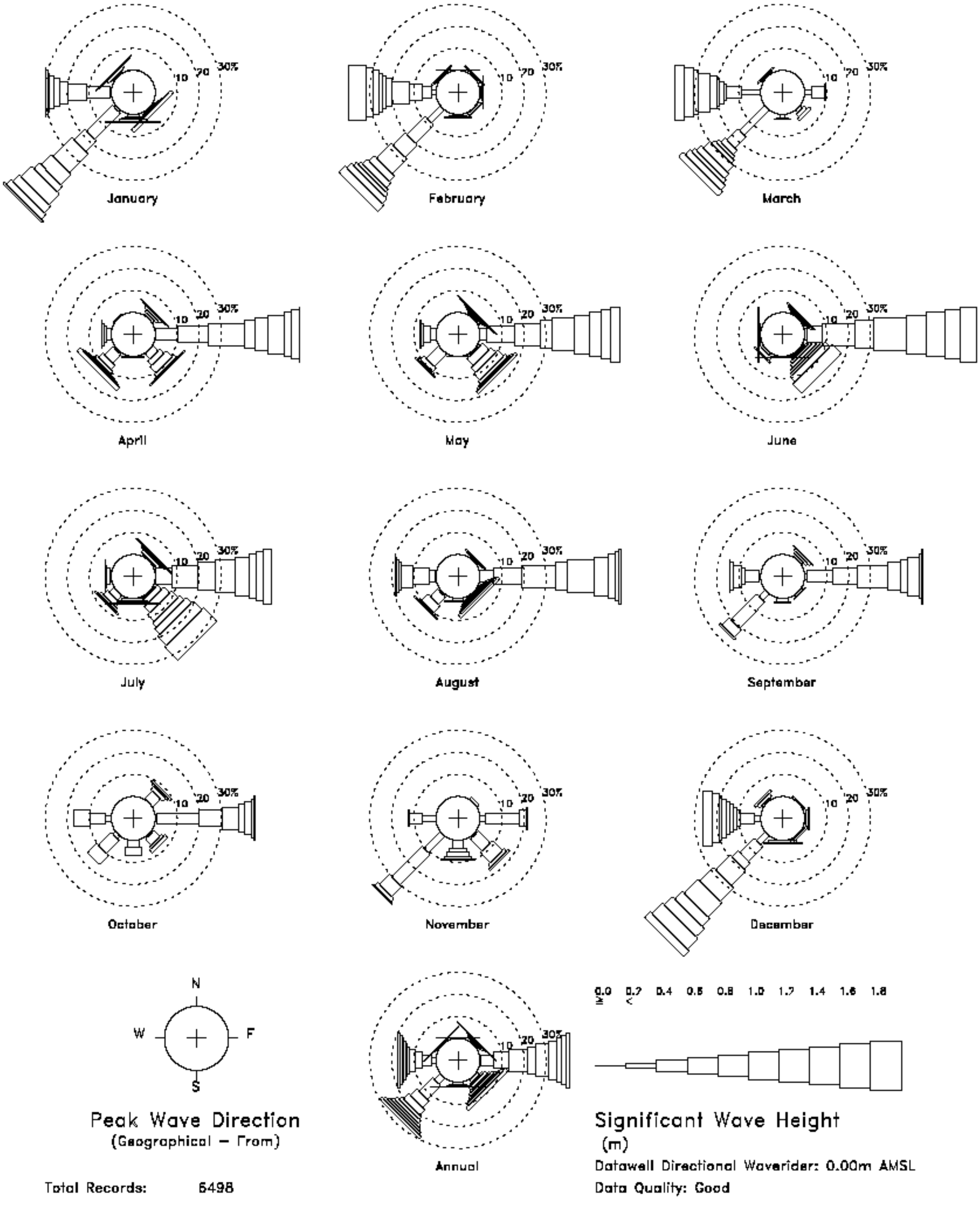
Bathymetry of the Sunrise Gas Field and Pipeline Route

Figure 6-5
Project No.: DE2090.100
Figure prepared by: T.Lee
Date Prepared: 16/10/01



Source: WNI Science & Engineering (2001)

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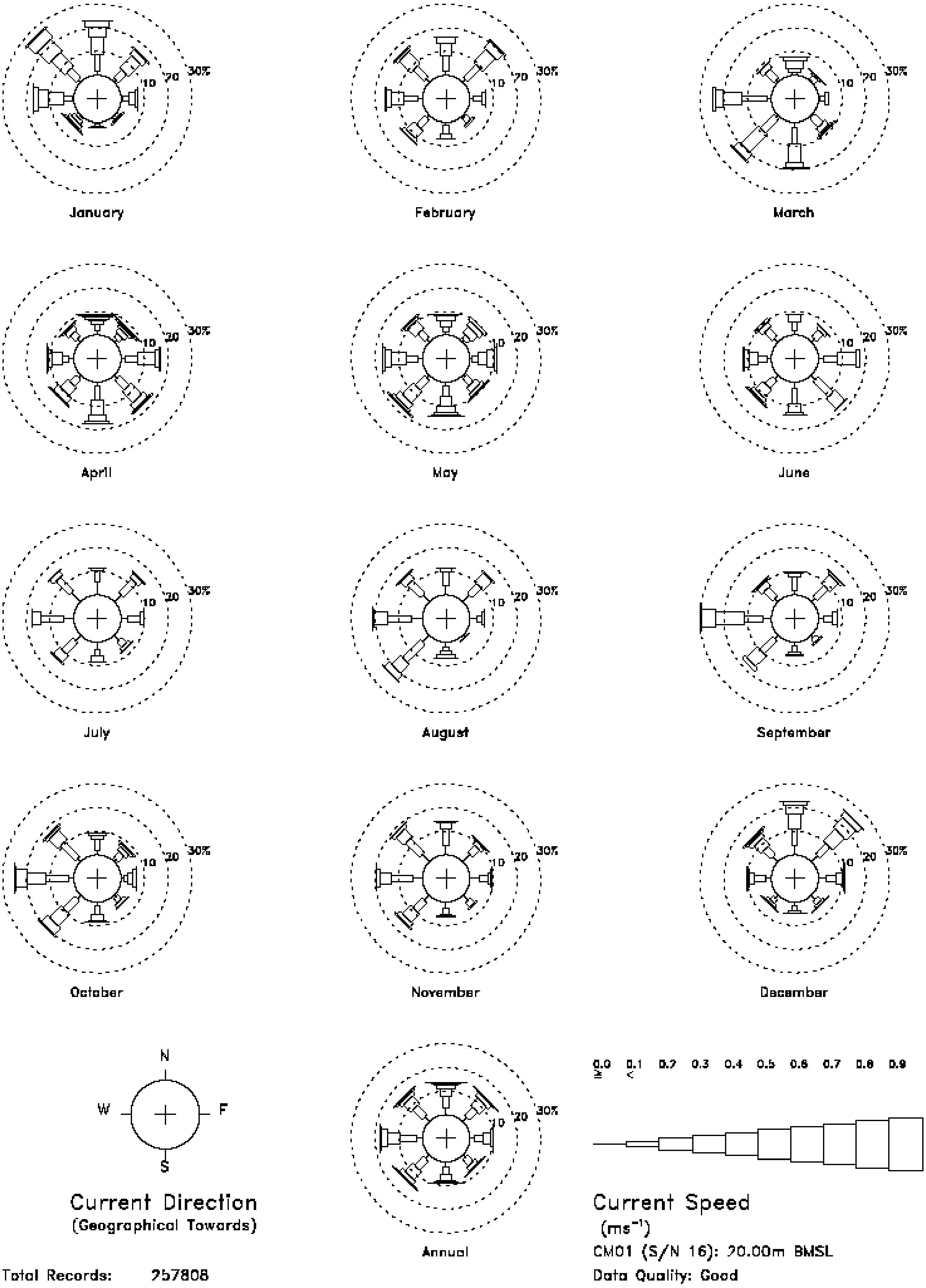
Wave Heights in the Vicinity of the Sunrise Gas Field

Figure 6-6

Project No.: DE2090.100
Figure prepared by: T.Lee
Date Prepared: 16/10/01



Source: WNI Science & Engineering (2001)

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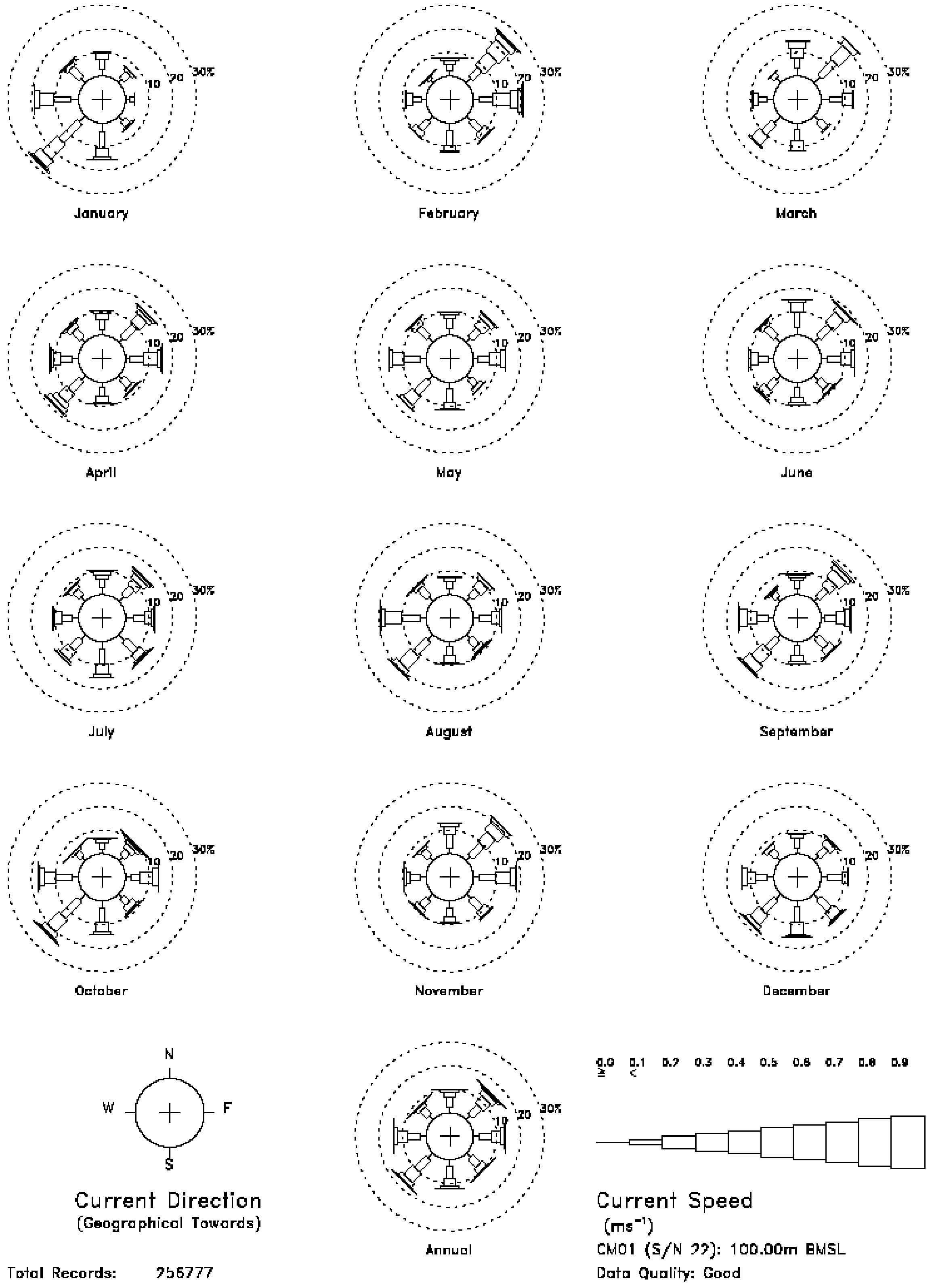
Current Rose for the Sunrise Gas Field at 20 m Below the Sea Surface Level

Figure 6-7
Project No.: DE2090.100
Figure prepared by: T.Lee
Date Prepared: 16/10/01



Source: WNI Science & Engineering (2001)

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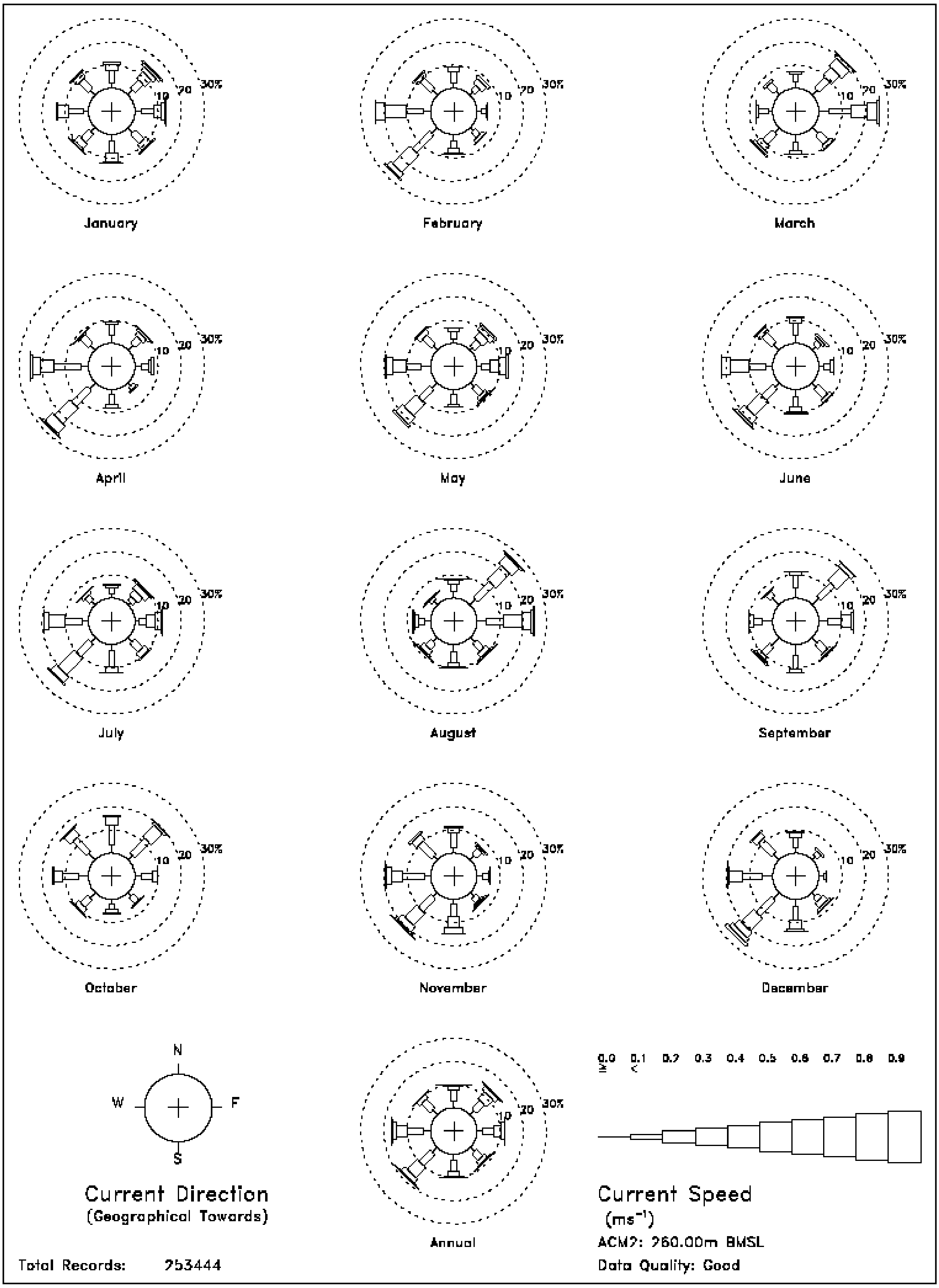
Current Rose for the Sunrise Gas Field at 100 m Below the Sea Surface

Figure 6-8

Project No.: DE2090.100
Figure prepared by: T.Lee
Date Prepared: 16/10/01



Source: WNI Science & Engineering

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Current Rose for the Sunrise Gas Field at 260 m Below the Sea Surface

Figure 6-9
Project No.: DE2090.100
Figure prepared by: T.Lee
Date Prepared: 16/10/01

6.6 Major Offshore Habitats, Communities and Species

6.6.1 Sunrise Gas Field

A Jack-Up is the platform type to be used for offshore processing and does not require a permanent installation. The foundation on the seabed will be by means of bucket foundation, which will sink into the seabed. Environmental surveys of the Sunrise Gas Field were undertaken by Bowman Bishaw Gorham (2000, 2001) for potential platform locations. The biological survey of the area investigated the following locations as shown on **Figures 6-10** through **6-12.**

- ☐ Sunrise Bank;
- ☐ Sunrise South Bank;
- ☐ Sunrise West Bank; and
- ☐ Proposed Platform and FSO deep-water location and surrounding areas.

The crests of the three banks range in depth from approximately 40–50 m below Mean Sea Level. Each of the three banks support extensive areas of benthic communities considered as being both diverse and abundant. Sunrise and Sunrise West Banks support communities comprising a mixture of scleractinian corals and octocorals with varying amounts of the calcifying algae *Halimeda*. The coral-dominated communities comprise mainly deep-water species of horizontal morphologies adapted to low light regimes. These communities extend over almost the entire apex of each bank. Benthic communities are most well developed on the eastern margins and across the eastern part of the shallows on both banks.

In contrast, the distribution, diversity and abundance of communities on the Sunrise South Bank are much more limited. The diverse benthic communities on the Sunrise South Bank are confined to the northern half and the western side of the bank. Within these areas, the epibenthic community is very abundant, diverse and extensive. Beyond this zone, the sediments are virtually bare of attaching organisms. The bare area extends from approximately the middle of the bank to its southern limit and over the entire width of this area.

The southern half of the Sunrise South Bank differs to other shallow areas that were investigated by Bowman Bishaw Gorham (2000). The seafloor substrate comprises soft sediments with very little *Halimeda* gravel and notable lack of coral rubble. The biotic community is very sparse and comprises mainly of motile organisms such as holothurians and sea stars. The lack of hard substrate in the southern half of the Sunrise South Bank suggests that the area has not supported a high density of epibenthic communities in the near past nor is it expected to support them in the near future.

In comparison, the abundance and diversity of organisms of coral communities typical of the Sunrise and Sunrise West Banks, together with the distribution of these communities on the banks, supports the conclusion that these banks are of higher environmental significance.

The proposed platform (deep-water) location is generally characterised by a relatively level substrate comprised of sand and shell fragments which were not heavily bioturbated. The area supported sparse epifauna comprised of hydroids, seapens, sea whips and solitary hard corals. To the north of the proposed platform location is an east-west oriented ridge with a steep drop-off to the north. Reefal habitat was observed in water depth of 126 to 150 m and supported a diverse epibenthic community of gorgonians, sponges, soft corals, crinoids and black corals (*Antipathes* and *Cirripathes*).

Infauna

Benthic grab sampling by Bowman Bishaw Gorham (2001) of the proposed platform location documented 451 animals comprising 170 species belonging to 9 phyla. There were no strong apparent spatial patterns in the faunal distribution. The results are summarised in **Table 6-3** and briefly described as follows:

- *Annelida* (segmented worms) and *Arthropoda* (subphylum *Crustacea*) were the dominant phyla, together contributing over 80% of the individuals and 75% of the species;
- The *Annelida* assemblage was the most species-rich and abundant comprising of 32 families of polychaete worms; only three families: *Glyceridae, Lumbrinereidae*, and *Syllinae*, were represented by more than 20 individuals;
- The *Arthropoda* assemblage comprised 46 species of crustaceans which was dominated by gammarid amphipods; and
- *Echinodermata* (*echinoderms* – sea cucumbers, brittle stars), *Mollusca* (molluscs – bivalves) and *Cnidaria* (also known as *coelenterates* – includes jellyfish, corals, hydra, anemones) contributed more than 13% of the individual animals and more than 17% of the number of species.

Table 6-3 Infaunal Abundance in the Vicinity of the Sunrise Gas Field

Phylum	Common Name	Total Abundance	Percent Abundance	Species Richness	Percent Species Richness
Annelida	Bristle worms	262	58.1	82	48.2
Crustacea	Amphipods, crabs, shrimps, copepods, isopods	115	25.5	46	27.1
Echinodermata	Sea cucumbers, brittle stars	43	9.5	18	10.6
Cnidaria	Seapens, zooanthids, corals, hydroids, jellyfish	7	1.6	6	3.5
Mollusca	Bivalves	10	2.2	6	3.5
Porifera	Sponges	4	0.9	4	2.4
Sipuncula	Peanut worms	6	1.3	4	2.4
Nemertea	Ribbon worms	3	0.7	3	1.8
Bryozoa	Lace corals	1	0.2	1	0.6
Total		**451**		**170**	

Source: Bowman Bishaw Gorham (2001) *Sunrise Gas Project Pipelines Routes and Facilities Location Survey Report*

Zooplankton

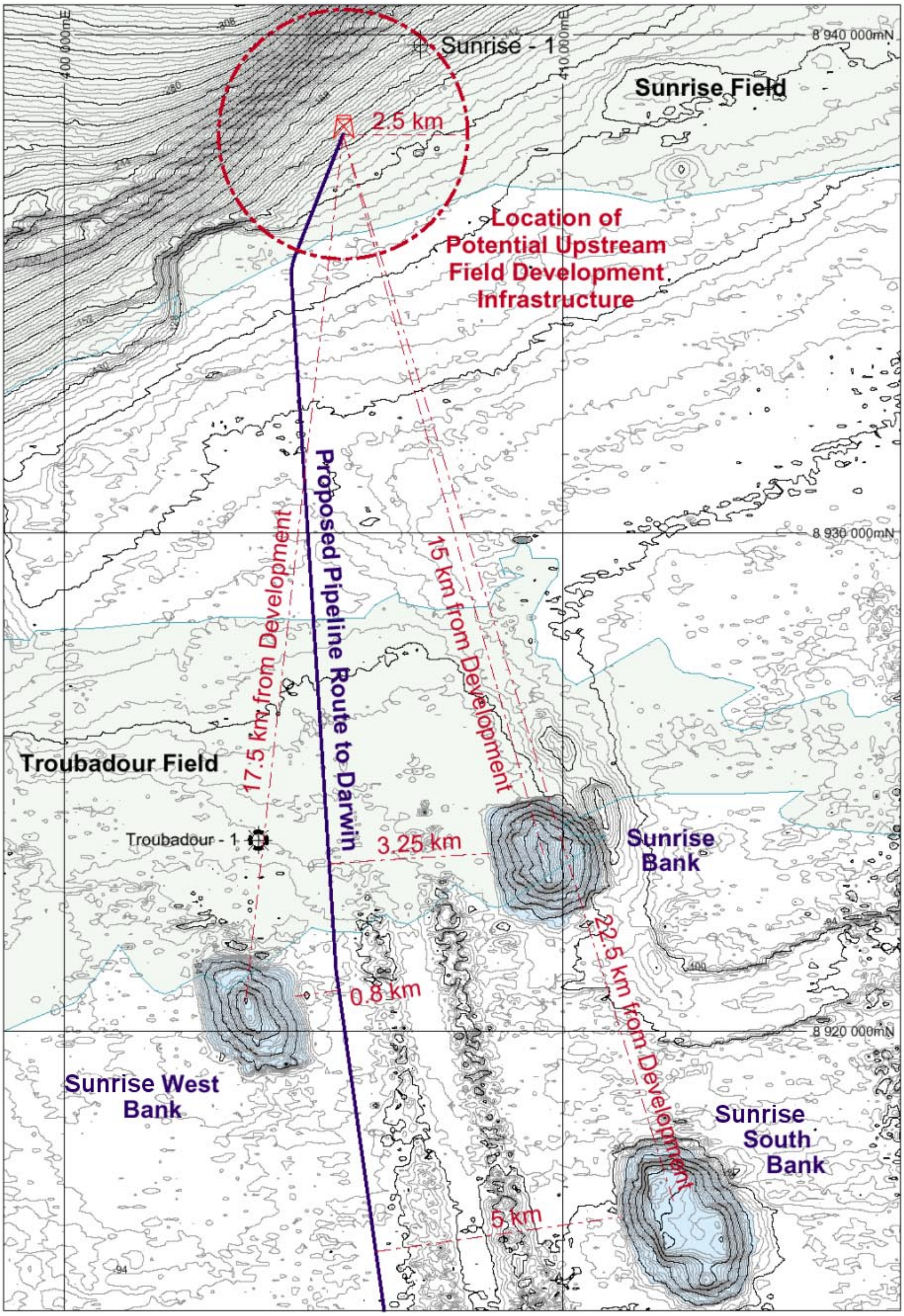
A total of 66 zooplankton taxa were identified indicating the presence of a relatively diverse zooplankton community. The zooplankton ranged from protists to vertebrates (**Table 6-4**). Most major phyla were represented including *Sarcomastigophora* (*foraminiferans* and *radiolarians*), *Annelida* (segmented worms – polychaetes), Chaetognatha (arrow worms), *Mollusca* (molluscs – gastropods, bivalves), *Arthropoda* (crustaceans – copepods, euphausids, ostracods) and *Chordata* (urochordates – appendicularian (Larvacean) tunicates*).*

Densities of zooplankters were highly variable ranging between 3,000 and 1,008,000 individuals/L. There were no apparent spatial trends in zooplankton density during the sampling period. *Copepods* were dominant accounting for at least 51% of the zooplankton community and were also the most diverse group with 40 taxa identified representing at least 9 families. The results of the survey indicate that densities of zooplankton vary widely and that the majority of assemblages are dominated by *calanoid*, *harpacticicoid* and *cyclopod copepods* on a numerical and gravimetrical basis.

Table 6-4 Zooplankton Abundance in the Vicinity of the Sunrise Gas Field

Phylum	Total Abundance	Percent Abundance	Species Richness	Percent Species Richness
Collected 11 May 2001				
Sarcomastigophora	29,494	13.0	10	15.9
Annelida	160	0.1	1	1.6
Chaetognatha	6,415	2.8	1	1.6
Mollusca	2,222	1.0	3	4.8
Arthropoda	155,918	68.9	40	63.5
Chordata	2,689	1.2	1	1.6
Unidentified	29,495	13.0	7	11.1
Collected 12 May 2001				
Sarcomastigophora	235	5.5	4	16.7
Mollusca	52	1.2	1	4.2
Arthropoda	3,549	83.8	17	70.8
Unidentified	399	9.4	2	8.3

Source: Bowman Bishaw Gorham (2001) *Sunrise Gas Project Pipelines Routes and Facilities Location Survey Report*



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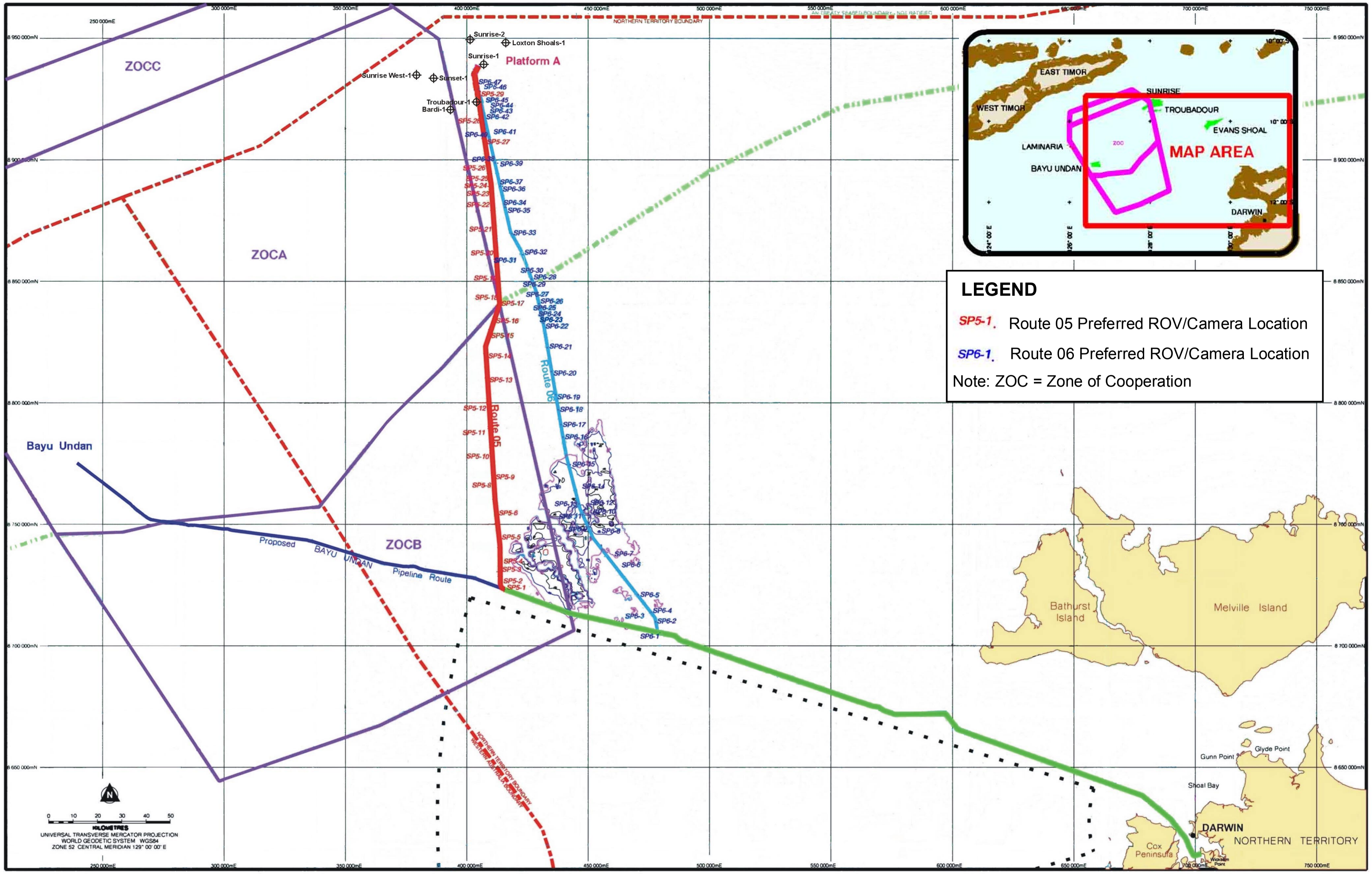
Sunrise Banks Location Map

Figure 6-10
Project No.: DE2090.100
Figure prepared by: T.Lee
Date Prepared: 16/10/01



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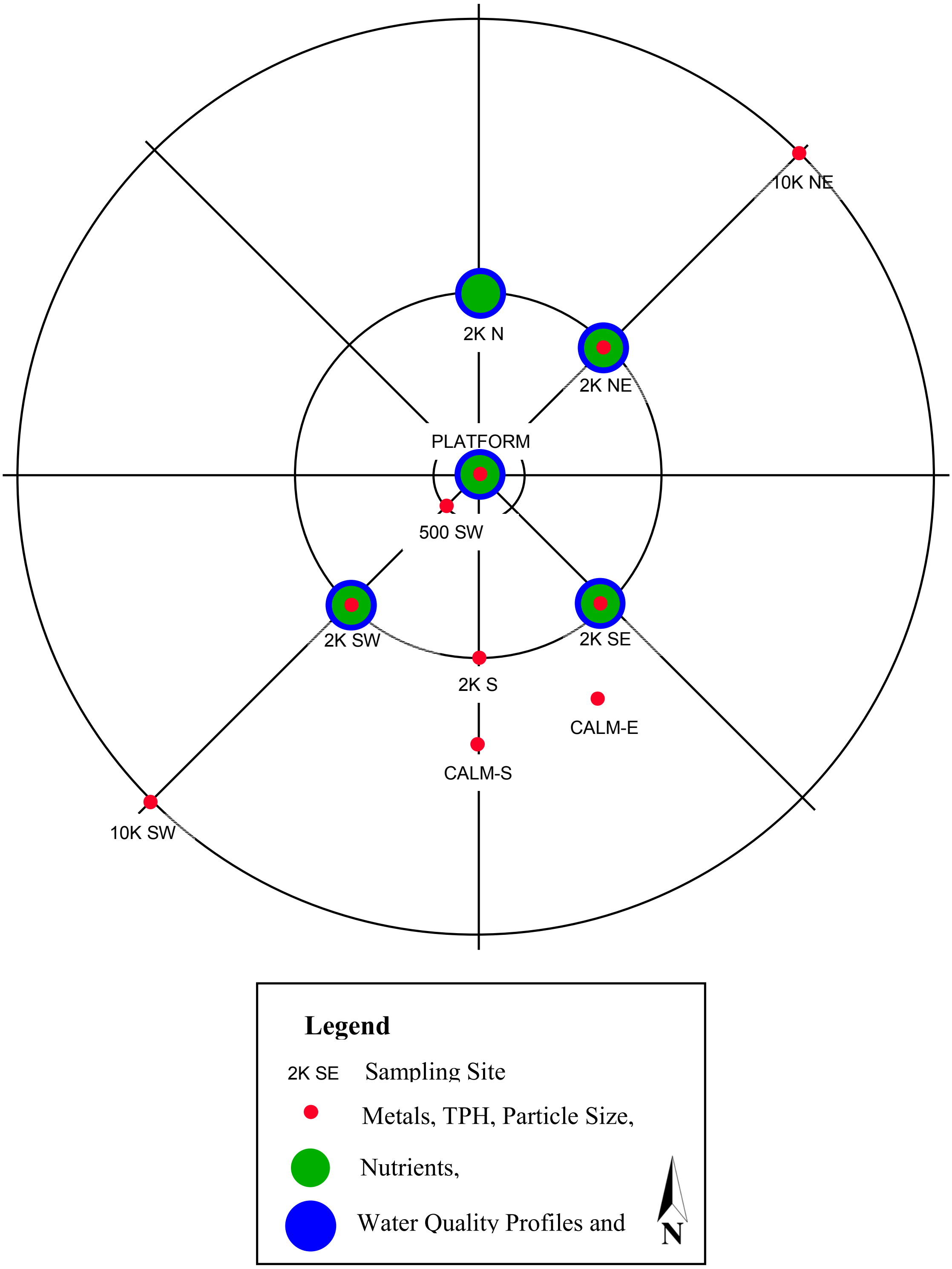
Pipeline Environmental Survey Sites

Figure 6-11
Project No.: DE2090.100
Figure prepared by: T.Lee
Date Prepared: 16/10/01



Source: Bowman Bishaw Gorham (2001)

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Diagrammatic Representation of Sampling Sites– at Sunrise Platform Location

Figure 6-12
Project No.: DE2090.100
Figure prepared by: T.Lee
Date Prepared: 16/10/01

Phytoplankton

The levels of phytoplankton in the surface waters, as indicated by chlorophyll concentrations, were extremely low (Bowman Bishaw Gorham 2001). The total range in concentrations was 0.07 to 0.14 µg/L. The concentration of phaeophytin, which is a breakdown of pigment, was also low and below detection. These data suggest a very low density of phytoplankton in the area typical of deepwater tropical regions, although on a local scale phytoplankton abundance is considerably lower than the 0.7 to 2.3 mg/L reported for the Gulf of Carpentaria and the Arafura Sea (Hallegraeff 1995).

6.6.2 Subsea Gas Pipeline Route

As part of the proposed development of the Sunrise Gas Field, Bowman Bishaw Gorham were commissioned to undertake a survey of habitats along the proposed pipeline route from the Sunrise Gas Field to the Bayu-Undan Wye.

The working corridor required for construction of the subsea pipeline will be 10 km in width. Should the pipeline have to deviate from the route surveyed by BBG in 2000/2001, for technical or engineering reasons, further marine surveys and assessments will be undertaken to identify any sensitive marine habitats, so that impacts on these habitats can be minimised.

The following descriptions of seafloor habitats have been extracted from the results of the survey.

Remotely Operated Vehicle (ROV) surveys along the pipeline route indicates that the seabed substrate comprises sediments ranging from soft muds to coarse sands containing large shell fragments and other rubble of biogenic origin. These sediments support epibiotic communities. Infauna populations are highly variable as indicated by the presence/absence of visible burrows.

Hard substrate comprising of low profile limestone pavements partially overlain by thin veneers of sand or silt are the most common occurring substrate along the length of the proposed pipeline route. Such substrate support moderate densities of filter feeding organisms, mainly sea whips, branching and fan gorgonians, sponges of various morphologies, soft corals of the genus *Dendronephthya* and black corals of the genus *Cirripathes*. Mobile fauna associated with these communities included crinoids, asteroids, urchins and some small fishes. Supporting a similar diversity of epibenthic organisms was also the reef community of approximately one metre in height.

6.7 Protected Fauna

At the commencement of the *Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act*) on 16 July 2000, the national list of threatened species, ecological communities and threatening processes consisted only of those previously listed under the *Endangered Species Protection Act 1992*.

Under the *EPBC Act* new categories have been added for listed threatened species and ecological communities. Critically endangered, conservation dependant and extinct in the wild have been added to the previous categories of endangered, vulnerable and extinct for threatened species and critically endangered and vulnerable have been added to the previous category of endangered for ecological communities.

New nominations for species and ecological communities will be assessed under the *EPBC Act* by the Threatened Species Scientific Committee (TSSC) according to the criteria for the new categories and listed accordingly. The TSSC will reconsider the status of the initial national list of threatened species and communities in line with the new refined EPBC categories as information is updated and made available for assessment.

A total of nine species listed under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* could be expected to pass periodically through the Sunrise Project area. (**Table 6-5**).

Table 6-5 Threatened Species that May be Present in the Sunrise Gas Project Area

Category	Species Name	Common Name
Species that are Endangered	*Caretta caretta* *Lepidochelys olivacea* *Balaenoptera musculus*	Loggerhead Turtle Pacific Ridley Turtle Blue Whale
Species that are Vulnerable	*Chelonia mydas* *Eretmoochelys imbricata* *Natator depressus* *Dermochelys coriacea* *Balaenoptera borealis* *Balaenoptera physalus*	Green Turtle Hawksbill Turtle Flatback Turtle Leatherback Turtle Sei Whale Fin Whale

There are no threatened ecological communities in the Sunrise Gas Project area.

A number of cetacean species may occur in the region including Sperm, Bryde's, Killer, Short-finned pilot and False killer whales, and Spinner, Bottlenose, Blue and White and Spotted dolphins. Whale encounters are expected to be unlikely, however dolphins are more likely to be encountered.

Shallow sections of shoals are potentially a feeding ground for green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) turtles (Sinclair Knight Merz, 1993). While a number of turtle species may be expected to transit the region, they are unlikely to be encountered in the survey area. The shallow shoal features to the south are unlikely to be utilised by turtles for feeding, given minimum water depths of between 30 and 40 m.

6.8 Ecological Considerations and Conservation Status

Timor Sea and Offshore Waters

The habitat in the vicinity of the Sunrise Gas Project, including the production facilities and subsea pipeline, has no defined conservation status; however, this does not mean that it is in any way less ecologically significant. The benthic habitat is not unique to the project area and is well represented in the Timor Sea on Australia's continental shelf. Epifauna such as soft corals, sponges, hydroids, infaunal assemblages and, to a certain degree, hard corals quickly recolonise disturbed seabeds because they are resilient organisms. The loss of a few hectares of benthos from what is likely to be thousands of square kilometres of similar habitat is not considered a significant impact.

The most ecologically important marine habitats in the Timor Sea region, in terms of biodiversity and productivity, are the various shallow intertidal coral reef and mangrove areas located about 150 km from Sunrise to East Timor and over 450 km to Darwin Harbour. The closest surveyed sub-surface coral reef habitat is Echo Shoals 140 km to the south-west. A number of other shoals occur in the region including Troubadour Shoals 50 km south-east of the Sunrise Gas Project, Bellona Bank 90 km to the south-west, and Martin Shoal 80 km to the east. However, none of these shoals have been adequately surveyed. Evans and Tassie shoals to the east-south-east of the Sunrise Gas Project have recently been surveyed as part of an offshore methanol plant development; however, the data is presently not available. The nearest mangroves lie much further away, 550 km on the south-west coast of Timor, 270 km on east Bathurst Island and 480 km on North Kimberley coastline.

The Sunrise Gas Field and subsea pipeline, does not occur within any marine parks, reserves or specially protected areas. The Beagle Gulf Marine Park (approximately 380 km from the Sunrise Gas Project) has been proposed as a means of coordinating marine and coastal resources. It extends along the marine and coastal area from Cape Ford to the eastern side of Cape Hotham and seaward to the extent of the Northern Territory jurisdiction; however, it does not infringe on the pipeline/gas field development.

6.9 International Obligations for the Protection of the Marine Environment

Relevant international obligations for the protection of the marine environment have been discussed in **Section 1.7**.

6.10 Heritage Conservation & Aboriginal Sacred Sites

Searches were undertaken of the following:

- ☐ The Northern Territory Heritage Register held by the Heritage Branch of the Department of Infrastructure, Planning and Environment, DLPE;
- ☐ The Sites Register, formerly held by the Museums and Art Galleries of the Northern Territory – MAGNT, now held by the NT DIPE;
- ☐ The Register of the National Estate, held by the Australian Heritage Commission;
- ☐ The sites database held by the NT branch of the National Trust of Australia; and
- ☐ The Northern Territory Wreck database compiled by the Maritime Archaeology and History section of MAGNT.

The results of these searches confirmed that all known sites have been avoided and no adverse impact is expected

6.11 National Parks & Conservation Reserves

Several existing/proposed marine protected or park areas lie in Indonesian waters within the region. The following summarises these protected areas listed by Hatcher (1988). The closest of these is 1,400 km away to the north-west:

- ☐ ***Northeast Roti*** – 1,000 ha Bakan Landu managed marine reserve;
- ☐ ***Southwest Timor*** – 1,000 ha Teluk Kupang/Pulau Kera marine recreation park;
- ☐ ***Komodo Island*** – 12,000 ha of marine waters of the Komodo Biosphere Reserve and National Park;
- ☐ ***Northwest Flores*** – the 5,000 ha Kepulauan Tujuhbelas Wildlife Reserve;
- ☐ ***Northwest Tanimbar*** – the 800ha Palau Angwamese marine nature reserve; and
- ☐ ***Northern Sumbawa*** – the 2,000 ha Pulau Rakit and 1,000 ha Pulau Satonda marine recreation parks.

The nearest Australian marine conservation zone and protected area is the Ashmore Reef National Nature Reserve, which lies approximately 240 km to the southwest of the Sunrise Gas Field. The reserve occupies an are of about 583 km^2 and is considered to be of high conservation significance. However it is too far from the Sunrise Gas Field to be impacted by the Project.

7. Socio-Economic Environment

7.1 Local and Regional Economic Structure

Northern Territory, Australia

Darwin is the capital city of the Northern Territory and its proximity to major economic growth areas in the Asia Pacific region provides a stable foundation for the Territory to play a major role in the future of the Asia Pacific Region. Darwin is the economic focus for Northern Australia and as a result Darwin's economy closely reflect the economic prosperity of the Northern Territory (Darwin City Council, 2001). With continued growth in mining and tourism Darwin's role as the socio-economic focus for the Territory will be further expanded and enhanced (Darwin City Council, 2001).

Darwin is serviced with a seaport comprising land connections to a major international airport and national highway system. Darwin is also equipped with world standard communications systems and has emerging information technology capabilities.

Traditionally secondary industry was seen as the focus of the economy but in latter years the tertiary service and information technology sectors have provided the impetus for economic redevelopment.

The Northern Territory economy differs from most Australian economies including:

- The public sector – there are a high number of public servants in Darwin compared to other capital cities;
- The mining and tourism industries - both industries are significant contributors to the Darwin economy;
- The ownership of dwellings – Darwin has a high amount of public housing compared to the rest of Australia; and
- The manufacturing sector – Darwin has very few manufacturing industries compared to the rest of Australia (Darwin City Council, 2001).

The Northern Territory's demographic characteristics are unique with regard to size, composition and distribution.

Natural resources include mineral deposits, coastal fishing resources, extensive pastoral operations and relatively new infrastructure.

Table 7-1 NT Population Employed in Manufacturing and Construction Industries[1]

Employment Area	Darwin & Environs	Katherine Region	Central Region	Northern Territory Total
Petrol/coal/chemical production & manufacturing (undefined)	11	0	3	17
Petroleum refining	12	4	27	43
Petroleum & coal product manufacturing	7	0	0	7
Basic chemical manufacturing	6	0	3	16
Other chemical manufacturing	21	3	7	34
General construction	104	66	23	226
Building construction	844	70	216	1223
Non-building construction	344	66	145	633
Construction trade service	56	0	13	76
Site preparation services	288	34	44	442
Building structure services	420	21	66	516
Installation trade services	946	127	239	1416
Building completion services	668	33	153	914
Other construction services	306	20	40	400
Construction undefined	227	23	36	305

Source: *Australian Bureau of Statistics (1996)*

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[1] Note: 2001 Census Data is not yet available.

Over the 10 years 1989–99, the Territory economy averaged a real annual growth rate of 5.7%, higher than the national average of 4.5%. The Territory's success is largely based on international trade with merchandise exports increasing by 74% during 2000-01, due almost entirely to an increase in oil exports.

The mining industry in the Territory remains the single largest contributor to GSP, with 17.7% in 1999/00. The value of mineral and energy production is estimated to have doubled in 2000–01 to $3.2 billion.

It is estimated that the Territory economy is growing at a rate of approximately 5%. Much of this has resulted from the movement of defence force personnel and their families to the Top End. With this program of relocation ending in 2000, it is thought there may be some negative impact on short to medium term economic growth. However, the short and longer term prospects remain strong due to the commencement of the Darwin to Alice Springs railway and the recent commencement of production from the Laminaria/Corallina fields in the Timor Sea.

Over 2000–01, the Territory's economy experienced relatively subdued growth after the strong growth phase of the mid to late-1990s. Real Gross State Product (GSP) grew by an estimated 4.6% to $6.7 billion in 2000–01. This primarily reflected the significant boost to output associated with peak levels production from the Laminaria/Corallina oil field in the Timor Sea.

The tourism industry accounts for around 6.8% of Territory GSP, a higher proportion than in any other Australian State or Territory. The NT Tourist Commission estimated expenditure at around $727.2 million in 2000.

Rural industries and fisheries account for 3.1% of GSP in the Northern Territory and have significant flow-on benefits to other sectors of the economy. The value of rural industries and fisheries production in 2000 is estimated at $445 million, a 6.1% increase on 1999 (Northern Territory Government, 2000).

East Timor

East Timor has been in a state of transition since August 1999 when the great majority of the population voted for independence from Indonesia, in a UN sponsored referendum. Immediately after the results were announced, pro-integrationist militia went on a violent rampage, destroying most of the infrastructure in the country. Consequently, at present, facilities and infrastructure in East Timor are very limited.

The capital is Dili, on the north coast of East Timor, which is serviced by a harbour capable of taking medium sized cargo ships. The airport at Dili is capable of taking medium to large passenger and cargo aircraft (eg Boeing 737). The only other airstrip capable of taking similar sized aircraft is that near the town of Baucau, some 100km to the east of Dili. Baucau airport is capable large passenger and cargo aircraft and has been used for military purposes since its construction by the Japanese during WW2.

East Timor is very much an agriculturally based economy, primarily subsistence agriculture. However prior to the referendum, agricultural production for export exist in the form of coffee, livestock, cocoa and banana. At that time, seventy five percent of the labour force were involved in agricultural production (World Bank 1999c UNDP 1999). Pre-referendum studies indicated under-production and very poor productivity – likely due to the Indonesian presence and to land use conflict. Post referendum violence and destruction almost completely halted production and export in these sectors.

Today, some of these sectors (particularly coffee) are recovering as the country is being rebuilt (ICR Program - Columbia University, 1999).

Pre-referendum figures indicated marine resources potential of some 600 000 tonnes annually, however, less than 1% of that resource was being harvested (ICR Program - Columbia University, 1999).

The current annual budget of East Timor is in the region of US$70 million, with an annual GDP of less than US$20 million (UNTAET, 2001).

The only sector of potential (and major) significance to East Timor is that of the oil and gas industry, which has the potential to contribute in the region of US$50 million over the life of the project.

7.2 Demographic Characteristics

Northern Territory, Australia

The Northern Territory occupies approximately one sixth of Australia's landmass but only accounts for one percent of the national population. It has a population density of 0.1 persons per square kilometre, which is well below the national average.

Relative to its landmass the Northern Territory has a small population of about 195,400 of whom approximately 103,000 reside in and around Darwin and its satellite city of Palmerston (Northern Territory Government, 2000). The Territory has the youngest population in Australia with an average age of 28.6 years compared with the national average of 34.9 (Northern Territory Government, 2000).

The population of the Northern Territory was estimated to have increased by 1.4% during 2000. Much of the population increase is believed to have occurred due to natural increase (births) and interstate migration. From December 1998 to December 1999 the natural increase in the Territory was 2,762 persons, providing a population growth rate of 1.5% which was well in advance of the national growth rate. Evidence suggests the rate of growth from natural increase is concentrated in the aboriginal population (Darwin City Council, 2001).

The average projected growth rate for the Northern Territory between 2000 and 2100 is 1.9% per year, and 2.2% per year for the Darwin region, the latter incorporates Palmerston and adjacent rural areas in Litchfield Shire (Darwin City Council, 2001).

East Timor

The population of East Timor is approximately 800,000, with the majority located in the eastern and western sections of the country, both in the coastal and mountain plateau regions. The least populated area is the mountainous central area of the country.

The last census, taken in 1990, indicates an age and sex structure typical of that of societies that have experienced prolonged periods of war. Much fewer adults, particularly males and the great majority of the population under the age of 30, (ICR Program - Columbia University, 1999).

7.3 Current Employment Levels and Characteristics

Northern Territory, Australia

Darwin Region has a workforce of approximately 40,808. Less than one percent of the population is involved in the agriculture, forestry and fishing industry and a relatively small percentage of the population involved in the manufacturing industry, at 4.9%. However, nearly eight percent of the population is involved in the construction industry, two percent higher than the Australia-wide figure, indicating a high level of development in and around Darwin. A relatively high percentage of the population is also involved in government administration and defence.

Northern Territory Employment growth during 1998–99 was estimated to be approximately 3.8% (Northern Territory Government, 2000). The local construction workforce, estimated at over 6,000, provides a substantial basis for large-scale construction projects (Northern Territory Government, October 2000).

East Timor

The large majority of the East Timorese population is employed in the agricultural sector and the society is largely agrarian. Prior to the referendum, most of the senior government postings were operated by Indonesian transmigrants, and commerce by Chinese or Mestico East Timorese. Today, there are major efforts being undertaken to re-build East Timor and to involve the East Timorese population in all levels of society and the labour force.

7.4 Community Services and Facilities

7.4.1 Education

Northern Territory, Australia

A full range of primary and secondary education is available in Darwin with many schools catering for boarders from remote areas of the Territory and also fee paying students from countries in South East Asia, including Brunei, Malaysia, Singapore, China and particularly Indonesia.

There are 24 primary schools and eight secondary schools in Darwin, two of which have boarding facilities, and also three special schools and two multi-level schools (pre-school to Year 12). Some schools specialise in specific areas of study and most teach Asian languages such as Mandarin, Indonesian and Japanese. There is an emphasis on Vocational Education Training courses in several secondary schools. In addition, there are 7 schools in the Palmerston – East Arm area with others in the surrounding rural areas.

The Northern Territory University is situated in Casuarina in Darwin's Northern suburbs with a student population of 9,000.

East Timor

Almost all educational facilities in East Timor were destroyed during the post-referendum violence and destruction. The provision of education (in a western sense) in East Timor really only began after the second world war and the greatest focus was on primary school education. The notable exception were secondary schools run by the Catholic church, particularly Jesuit run institutions.

Again, significant re-building is underway and today most primary and secondary schools have re-opened. The Universitas Nationale de Timor Loro Sae in Dili is opened again in 2000 and is undergoing development.

7.4.2 Health Services

Northern Territory, Australia
Two hospitals, one private (Darwin Private hospital) with 150 beds and one public (Royal Darwin Hospital) with 257 beds, provide a full range of medical and surgical services. In the rare event that services are not available, patients are flown to a suitable hospital elsewhere in Australia or doctors are flown to Darwin. Territory Health Services also provide a wide range of services at Community Care Centres, at Darwin and Casuarina, and Remote Area Centres.

There are also two privately run nursing homes, a palliative care service and the Menzies Research Centre in Darwin (Darwin City Council, 2001).

Specialist services are provided by Territory Health Services through the Specialist Outreach Services. This includes the funding of the Royal Flying Doctor Service for Central Australia and the operation of the Aerial Medical Services in the Top End of the Northern Territory.

East Timor
Health care in East Timor is limited and has been under significant strain since the post-referendum violence. A new hospital in Dili is planned as well as regional community health care clinics across the country.

7.5 Housing and Accommodation

Northern Territory, Australia
Although home ownership has increased in the Northern Territory in recent years, the figure still remains behind the Australian average with only nineteen percent of households in Darwin owned outright compared to the Australian average of 41 %.

Another significant difference between Darwin and the rest of Australia is the high level of property rented at 46 %, compared to 28.7 % for Australia. This is reflective of Darwin’s young and transient population and the high percentage of public housing available.

There is a high proportion of rental housing available in Darwin in contrast to other Australian cities. However, rental costs in Darwin are high with the highest median weekly rent for a 3 bedroom house compared to all other states and the ACT (Darwin City Council, 2001).

A high proportion of accommodation in Darwin and Palmerston – East Arm are rental properties including more than 30 hotels and a large number of serviced apartments. Vacancy rates in Darwin are traditionally volatile affected by seasonal conditions due to the high influx of tourists during the dry season and the onset of the wet season when many migrate south (Darwin City Council, 2001).

East Timor
Housing and accommodation in East Timor also suffered badly during the post-referendum violence and again, a major re-building program is underway. This is significantly complicated by land ownership conflict owing to land changing hands numerous times (by both sale and forced dispossession) during the phases of Traditional Ownership / the Portuguese period / the Indonesian period and since.

7.6 Transport Network and Usage

It should be noted that during 2002, the Sunrise Gas Project will be undertaking a study of East Timor's capacity (current and planned) to provide marine and air transport supply facilities to the proposed development.

7.6.1 Port and Shipping Facilities

Northern Territory, Australia
Shipping in Darwin is served by a modern container and general cargo terminal, a 70 tonne rail mounted container crane and roll-on/roll-off facility, and the new East Arm Port facility. The harbour is capable of accommodating ships to approximately 50,000 DWT with a 11.5 metre draught. Ships with larger drafts may also be handled but their movement is dependent on the state of the tide within the harbour (Darwin City Council, 2001).

Stage One of the new East Arm Port has been constructed close to the Trade Development Zone. It provides an additional 490 metres of land-backed wharf and a hard-stand of 11 ha. Ships will be able to use these facilities in any tidal conditions. The bulk liquids terminal has a least depth of 14 metres and the general purpose wharves have a least depth of 13 m. Incorporated into the design of the new port is a direct connection to the Darwin to Alice Springs railway, linking the port directly to Australia's national rail network. This rail link will increase the volume of goods passing through the new port (Darwin City Council, 2001).

Stage Two of the port will accommodate a high-capacity container facility in line with the completion of the Adelaide to Darwin railway. It will also incorporate a bulk liquids terminal.

Once Darwin's new port is operational the existing port will only provide for visiting passenger cruise ships, naval vessels and fuel ships. When fuel storage facilities are relocated from Frances Bay to East Arm in the next few years, fuel ships will no longer need to visit this port either.

East Timor
There are four ports in East Timor. The two major ports are at the capital in Dili and at Com in the country's north-east. Both of these have the capacity to handle medium sized cargo shipping but are limited due to depth; Dili at 16–17m and Com at 10–11m. Both have potential for expansion and current plans for this are being made.

7.6.2 Air Transport Facilities

Northern Territory, Australia
Darwin International Airport, located midway between Singapore and Sydney, is the gateway to Australia's north. The Airport is located 15 km north of Darwin's CBD and is a joint use facility for domestic, international, general aviation and military flights. The civilian airport is located within and on the northern side of the RAAF Base Darwin.

A large number of regional and small private charter operators service all parts of the Territory. International air is facilitated by six carriers who fly to all parts of the world. In the 1998/99 financial year, 1,219,000 passengers, including 342,000 from overseas, passed through the terminal. NT Airports Pty Ltd signed a long-term lease for Darwin airport in 2000.

East Timor

The airport at Dili is capable of taking medium to large passenger and cargo aircraft (eg Boeing 737). The only other airstrip capable of taking similar sized aircraft is that near the town of Baucau, some 100km to the east of Dili. Baucau airport is capable large passenger and cargo aircraft and has been used for military purposes since its construction by the Japanese during WW2.

7.6.3 Road Network

Northern Territory, Australia

As the Northern Territory has been dependent on road transport for most of the delivery of domestic freight in the absence of suitable railway and shipping services, an extensive and high quality network of roads has developed. The network of roads is designed and maintained by the Department of Transport and Works.

There are 3 elements of the National Highway System that service the Territory, providing links to Queensland, South Australia and Western Australia. The all weather sealed roads allow freight and passengers to reach any part of Australia in three days (Darwin City Council, 2001). The Stuart Highway is a National Highway and the primary link to the port facilities in Darwin for the mining, pastoral and agricultural industries. The highway is in an excellent condition and is used to transport all types of goods to and from Darwin. The route also provides a strategic link to the port facilities in Darwin (Darwin City Council, 2001).

Urban arterial roads have been developed to provide direct, fast, and convenient connections between CBD, suburban centres, employment and recreational centres.

Access to the Middle Arm Peninsula is provided by a bitumen-sealed road, Channel Island Road, constructed to service the Channel Island power station. This road is mainly used by power station employees and recreational fishermen.

East Timor

The road system in East Timor is in very poor condition. Often, roads to the southern part of the island are impassable due to damage resulting from the Wet Season. Consequently, most supply of the southern population centres is undertaken by landing barge. Significant expenditure would be required to ensure an efficient road network in East Timor.

7.7 Mineral and Energy Exploration

Large oil and gas fields lie north of Darwin in the Timor Sea, holding enough resources to supply export markets with power and fuel far into the 21st century. The Timor Sea is one of Australia’s most active areas, with commitments to drill more than 115 exploration wells in the period 1999–2003 at a cost of A$1.3 billion. Sixteen discoveries over four years and an exploration success rate of 28% have ensured that ongoing development and exploration programs are underway (Darwin City Council, 2001).

Exploration in the Timor Sea commenced in the 1960s with the first discovery of oil at the Jabiru field in 1983. There still remains a large potential for further field discoveries in the Timor Sea as the current distribution of exploration wells is estimated to be one for every 13,900 square kilometres.

Natural gas resources have been discovered at Bayu-Undan, Loxton, Sunrise, Troubadour and Evans Shoals in the Timor Sea and at Tern and Petrel in the Bonaparte Basin (Leprovost Dames & Moore, 1997).

Exploration in the central area of the Timor Sea has been previously restricted as a result of boundary issues between Australia and Indonesia. Resolution of these issues resulted in the development of the disputed area as the Zone of Cooperation (ZOC), which has since been superseded by the Joint Petroleum Development Area in 2001.

Exploration in ZOC (JPDA) commenced in 1991 and has resulted in a number of discoveries including: Elang Oil Field, Bayu-Undan Gas Field, Sunrise and Troubadour Gas Fields (Woodside) and the Laminaria/Corallina Oil Field (Woodside) as well as Newfield, Modec and more recently Blacktip Gas Fields.

Darwin's current energy needs are met by gas-fired power station located on Channel Island in Darwin Harbour. It has a capacity of 186 megawatts and utilises gas from Amadeus Basin in Central Australia. The installation of an additional turbine will increase capacity by 35-40 megawatts to approximately 225 megawatts. This is expected to be completed by April 2000 (Darwin City Council, 2001).

7.8 Recreational Resources and Activities

Northern Territory, Australia

Due to a young population and a climate conducive to outdoor activities, the Territory's sports participation rate is very high with many people playing a number of sports. The region is well supplied with recreational facilities, sporting teams and natural recreational attractions.

Proximity to the coast and conservation areas provide for nature-based recreational activities such as fishing, sailing, bird watching, camping and bush walking.

Darwin and Palmerston have four public pools, two artificial lakes and at least 17 recreational ovals. The Marrara Sporting Complex which is 11 km from Darwin and 18 km from Palmerston caters for international class hockey, basketball, a variety of football codes and athletics.

There are also numerous facilities that cater for the performing and visual arts, several museums and libraries.

The waters of Darwin Harbour are used for recreational fishing, diving, sailing, windsurfing and swimming. Darwin is known to support one of the highest percentage of recreational fisherman in Australia (Dames & Moore, 1997). Recreational fishing occurs mainly in the creek lines supporting extensive mangrove habitats where mudcrabs and barramundi are commonly found. The deep channel areas of the Harbour and coral reefs are also popular for pelagic fish.

Diving is also popular around coral reefs in particular those areas off Weed Reef, Mandorah and West Point. The numerous shipwrecks within the Harbour also attract considerable attention from divers.

The main swimming beaches of Darwin Harbour are Nighcliff, Casuarina Beach and beaches at Fannie Bay through to Mindil Beach (Dames & Moore, 1997).

East Timor

Little exists in the way of recreational facilities in East Timor, although work is being undertaken on the Dili stadium as soccer is very popular.

7.9 Tourism

Northern Territory, Australia

Tourism in the Timor Sea is limited to mainly coastal diving, fishing and sightseeing charter trips and cruises. A large majority of this tourism is land based. Darwin was estimated to have 1,026,000 visitors during 2000; a three percent increase on 1999 figures. The length of stay of visitors was 4.4. days in 2000, 0.3 days lower than in the previous year. Visitor expenditure in the Territory grew by 5% compared to the previous year to reach $727.2 million. This was the largest level of spending on record and was nearly $32 million above the 1999 figure. Growth was driven by the international market, which experienced a 13% increase in visitor numbers and a 19% increase in expenditure. However, the number of interstate visitors decreased sharply in 2000 (Northern Territory Tourist Commission, 2001).

Tourism comprises an estimated 6.8% of the Northern Territory's Gross State Product (GSP). As an industry, tourism is the Territory's biggest employer, accounting for more than 11% of wage and salary earners. The industry is growing rapidly, as is evident in the growing number of domestic and international arrivals. From 1991 to 1999 the NT has experienced an average growth in tourist numbers of 7% per annum. It is estimated that visitors spent a total of $337.7 million while in Darwin over the 1999/2000 financial year. Increasingly, tourists are visiting Darwin, not only as the gateway to Kakadu National Park and Central Australia, but also as a sophisticated and vibrant destination in its own right (Darwin City Council, 2001).

In recent years Darwin has gained importance as a port of call for an increasing number of cruise ships. In addition, hundreds of passengers use local tourist amenities and venture inland as far as Kakadu and Litchfield National Parks. On-going development of the Darwin Wharf Precinct, including the recent $1.3 million cruise ship terminal, enables this component of the tourism industry to expand with more cruise ships opting to stopover in Darwin. The increase in tourism has fuelled a mini building boom in accommodation development catering to different sectors of this market. From five star accommodation to backpacker lodges; all levels of visitors are catered for with a range of options. Much of this development has occurred within the Darwin CBD, primarily along The Esplanade and Mitchell Street (Darwin City Council, 2001).

Healthy growth is displayed in ABS figures for the June Quarter 1999 that show an increase of 15% in visitor nights at hotels, motels and serviced apartments compared to the same period of the previous year. This growth is also evident in increases in takings and occupancy rates during the 1999 June Quarter for hotels, motels, guesthouses and serviced apartments (Darwin City Council, 2001).

East Timor

East Timor is a place of significant natural beauty, both in the mountains and tropical coastline. There is major potential for East Timor to become a destination for tourism although infrastructure is currently lacking.

7.10 Commercial Fisheries Activities

A number of fisheries lie within the Fisheries Zone and NT waters as shown on **Figure 2.2**. The nearest commercial fishery, Timor Reef Fishery, is located 75 km south-east of the Sunrise Gas Field. However, traditional fishing is expected to occur in the vicinity of the Sunrise Gas Project area. The main commercial fisheries relevant to the Sunrise Gas Project are:

- ☐ *Western Tuna and Billfish Fishery*: The Western Tuna & Billfish Fishery (WTBF) extends westward from Cape York Peninsula (142°30'E) off Queensland to 34°S off the west coast of Western Australia, seaward of the 200 m isobath. Yellowfin tuna, bigeye tuna, broadbill swordfish and to a lesser extent albacore tuna, skipjack tuna and longtail tuna are the main species taken in the WTBF. Fishing permits included: pelagic longline (52), purse seine (5), and minor line including hand line, rod and reel, troll (67 in total) and pole (21). (http://www.afma.gov.au/). The subsea pipeline route runs from the outer limits and into the heart of this fishery for approximately 100 km on its approach to the Bayu-Undan pipeline.

- *Spanish Mackerel Fishery*: The spanish mackerel fishery is based on the Spanish Mackerel (Scomberomorus commerson) and is mainly located within the Darwin and Gove areas. Spanish Mackerel is also a by-catch of the shark fishery. The species is important in commercial, recreational and artisanal fisheries. The fishery is strongly seasonal, with most effort taking place between June and December. The subsea pipeline route runs from the outer limits and into the heart of this fishery for approximately 100 km on its approach to the Bayu-Undan pipeline.
- *Northern Prawn Fishery (WA and NT)*: This extends from Cape York Peninsula Queensland to Cape Londonderry, WA in the west and for approximately 50km offshore and covers more than one million square kilometres. The white banana prawn, the brown tiger prawn and the grooved tiger prawn constitute about 80% of the total catch. The fishery is managed by the Commonwealth, through Statutory Fishing Rights granted under the Northern Prawn Fishery (NPF's) Management Plan. The Northern Prawn Fishery continues to be the most valuable fishery managed by the Commonwealth; the value of the annual catch over recent years has varied around A$120 million. Total catch for the fishery in 1998 was approximately 8265 tonne. The prawn season is based around the six months from April to June and from August to December. The NPF fleet comprises 132 vessels (1998) with most of the catch frozen and exported to Japan (www.landcare.gov.au/). The subsea pipeline route runs from the outer limits and into the heart of this fishery for approximately 100 km on its approach to the Bayu-Undan pipeline.
- *Timor Reef Goldband Snapper Fishery:* The Timor Reef Fishery is an important commercial fishery for the Northern Territory, and has been in operation since 1982. This fishery is located to the north/north-west of Darwin and comprises fin fish of which Goldband snapper is the main resource making up 75%. The total area of the Timor Reef Fishery is about 28,000 km^2. The fishery supports approximately 15 licencees, with approximately 20 vessels targeting primarily Goldband Snapper *Pristipomoides multidens* and closely related species, known collectively as Goldband Snapper for marketing purposes. All vessels currently use droplines. Goldband Snapper is thought to occur in greatest abundance along the sides of shoals and on light rubble substrate and are targeted as the commercial fishery. According to some of the fishermen who hold licences for the fishery, the area is exploitable west of the 130° Meridian, in the Evans Shoal area. Snapper are widespread throughout the tropical Indo-Pacific region and in Australia they are fished in waters north of latitude 20^{o}S. Commercial concentrations have only been found in the 90–150 m depth range within specific areas of Timor Reef Fishery. This fishery is managed by the Territory/Commonwealth Joint Authority under NT law. The pipeline route from the Sunrise to the Bayu-Undan Wye piece runs through the western edge of the Timor Reef Fishery for approximately 40 km.

Table 7-2 Timor Reef Fishery Statistics

Year	Catch (kg/a)
1995	154,750
1996	317,126
1997	311,354
1998	482,270

Source: DPIF.

- *Coastal Line Fishery*: This is a multi-species fishery based on several coastal species such as jewfish, cod, shark, golden snapper and other snapper species. The fishery extends from the high water mark to 2 nm offshore. This fishery is pertinent in that it lies along the route of the pre-approved Phillips Bayu-Undan subsea pipeline route.

Table 7-3 Coastal Line Fishery Statistics

Year	Catch (kg/a)
1995	115,853
1996	114,607
1997	81,638
1998	63,220

Source: DPIF.

The area of continental shelf and slope waters covered by the Sunrise Gas Field is only lightly exploited by Indonesian longline fishermen. Minor effects on this fishery could result from restriction of access to fishing grounds and loss or damage to fishing gear.

There is the possibility that support vessels could disrupt the activities of dropline vessels operating in the Timor Reef Fishery. Support vessels are likely to transit the Timor Box area en route to and from the onshore service base.

8. Environmental Impacts & Mitigation Measures

8.1 Introduction

The aim of Section 8 is to identify the environmental impacts and mitigation measures for the proposed Sunrise Gas Project. The chapter is structured so that both impacts and mitigation measures are discussed within the following phases:

- Drilling and Associated Activities;
- Installation and Construction;
- Commissioning and Operation; and
- Decommissioning.

Tables summarising the source of impact, potential environmental impacts, their effect and duration are included at the beginning of each phase.

8.1.1 Impacts

The impacts on the environment have been classified under the headings listed below and in accordance with the order of occurrence of the activity; drilling program, installation/construction, commissioning/operation and decommissioning. However, not all of the impacts listed will be relevant to every phase of the project.

- Atmospheric Emissions;
- Discharges to Sea;
- Noise, Vibration, Light and Heat;
- Waste to Shore; and
- Other Impacts

Where possible, environmental impacts are placed into context so that their significance and magnitude are considered. The classification of impacts has been standardised throughout the report in accordance with classification definitions as stated in **Table 8-1**.

Table 8-1 Classification of Impacts

Category	Type	Description
Change	Negative Positive Neutral	A change which reduces the quality of the environment A change which improves the quality of the environment A change which does not affect the quality of the environment
Duration	Temporary Short-term Medium-term Long-term Permanent	Impact lasting for one year or less Impact lasting one to seven years Impact lasting seven to twenty years Impact lasting twenty to fifty years Impact lasting over fifty years
Effect	Negligible Minor Moderate Significant Serious	No likely environmental damage Temporary impact with no impact on sensitive resources Recoverable environmental loss with localised impact on sensitive resources Severe recoverable environmental loss with regional impact on environmental resources Widespread chronic environmental loss with widespread impact on environmental resources

Source: EPA Classification

8.1.2 Mitigation Measures

Whilst mitigation measures implemented during the course of the construction, operation and decommissioning phases of the Sunrise Gas Project are vital for the protection of the environment, mitigation measures also form an inherent part of the pre-construction planning process.

This has taken the form of extensive and in depth consultation with all relevant government and non-government organisations (NGOs), as well as the public, to ensure consideration of all relevant impacts and concerns, and the implementation of appropriate mitigation measures. This process has already commenced for the Sunrise Project, with all relevant regulatory authorities and organisations consulted with, and the onset of the public consultation phase of the project (Chapter 10).

Consultation with adjacent marine users including fishermen, port authorities, traditional marine resource users, shipping companies, conservation groups and other affected parties will form an integral part of the ongoing consultation process facilitating good working relationships and the exchange of information between interested parties.

In-depth planning has also gone into the physical location of the development with careful environmental considerations given to the final location. Selection of the pipeline routes have been optimised to take into account potential environmentally sensitive areas. Baseline surveys have been undertaken identifying benthic communities to minimise placement on sensitive marine habitats.

An Emergency Response Plan and Oil Spill Contingency Plan which has already been prepared for the Timor Sea region will be implemented for the Sunrise Gas project which will address emergency and contingency arrangements and oil spill incidents. These plans will include:

- Oil spill trajectory modelling capability based on site specific metocean conditions and knowledge of oil weathering rates;
- Identification of oil-sensitive marine and coastal resources and priority protection areas;
- Identification of internal and external emergency organisations, responsibilities and resources (human and equipment and materials) for oil spill response, and call out details; and
- Spill response and clean up strategies for offshore and shoreline.

Mitigation measures have been based on APPEA’s ‘Code of Environmental Practice’ (APPEA, 1996). The Draft EMP contained in the following Chapter 9 provides further detail on the environmental safeguards required to prevent or limit damage to the environment.

8.1.3 Commitments

Commitments will be carried across the life of the project by Woodside and other future operators. During the planning and design phases, prior to drilling and construction, the following commitments will be adhered to, as detailed in **Chapter 9**. During the design phase equipment and machinery will be selected to minimise environmental impacts.

- Prepare a Drilling Environment Plan to ensure efficient power generation and planning of vehicle and vessel movements;
- Prepare a Facility Environment Plan to ensure efficient power generation, planning of vehicle and vessel movements and overall optimal operation;
- Obtain approval for non-water based drilling fluids. An Environment Plan will be drawn up and approved for the drilling programme prior to commencement;
- Implement an Emergency Response Plan (ERP);
- Implement WEL existing Timor Sea Oil Spill Contingency Plan. Amend this plan if required;
- Issue Notice to Mariners alerting them of development and associated activities;
- Minimise flaring where possible;
- Install breakaway self-sealing couplings on floating hoses that contain condensate;
- Design an adequate stormwater drainage system to allow oily waste and potential contaminated liquid waste to be collected and contained separately from clean stormwater;
- Install appropriate noise attenuation controls including silencers cladding where practicable;
- Prepare and implement a Waste Management Plan;
- Issue Notice to Mariners alerting them of development and associated activities;

- Prepare and implement greenhouse gas strategy to minimise emissions of greenhouse gas;
- Design and implement operational measures to minimise flaring and venting;
- The reduction of methane emissions to negligible levels through the combustion of regeneration offgas; and
- Maximise the use of waste heat from gas turbines.

8.2 Impacts during Drilling and Associated Activities

Table 8-2 overleaf summarises the source of impact, potential environmental impacts, their effect and duration for the Drilling and Associated Activities phase which includes:

- Wellhead platform installation; and
- Drilling of platform and subsea wells.

Table 8-2 Summary of Potential Environmental Impacts for Drilling and Associated Activities

Project Component	Source of Impact	Potential Environmental Impact	Effect	Duration
Wellhead Platform Installation	a) Physical presence of production and wellhead platforms. b) Power generation during installation c) Lighting. d) Disposal of construction wastes. e) Presence of construction and support vessels. f) Discharge of sewage and greywater. g) Discharge of domestic waste including food scraps.	**Atmospheric Emissions** ▪ Greenhouse gases produced by drilling unit power generation (primarily CO_2) ▪ Atmospheric pollutants (primarily NO_x, SO_x, VOCs and smoke/particulates); **Discharges to the Sea** ▪ Potential localised reduction in water quality. **Noise, Vibration, Light and Heat** ▪ Potential disturbance to marine biota and birds. ▪ Potential attraction of marine organisms to the lights such as turtles **Waste to Shore** ▪ Improper disposal.	Negligible Negligible Negligible Negligible Negligible Negligible	Short-term Short-term Short-term Short-term Short-term Temporary
Drilling of Platform and Subsea Wells	a) Anchoring/spudding of drilling unit. b) Cuttings discharge and adherent drilling fluid. c) Use of water based drilling fluids for the initial section of each well or for vertical wells. d) Use of non-water based drilling fluids for deviated sections of wells. e) Activity of support/supply vessels f) Discharge of drilling chemicals and hydrocarbons attached to cuttings only. g) Discharge of sewage and greywater. h) Discharge of domestic waste including food scraps. i) Oily water discharged to the environment during installation and operation of drilling facilities. j) Disposal of domestic waste including paper and plastics etc. k) Power generation. l) Lighting. m) Refuelling at sea.	**Atmospheric Emissions** ▪ Greenhouse gases produced by drilling unit power generation (primarily CO_2) ▪ Atmospheric pollutants (primarily NO_x, SO_x, VOCs and smoke/particulates); **Discharges to the Sea** ▪ Smothering effects of accumulated drill cuttings on marine biota. ▪ Increased turbidity in the area from cuttings discharge ▪ Potential accumulation of metal and hydrocarbon concentrations in seabed sediments leading to toxicity. ▪ Potential bioaccumulation/ bioconcentration by marine biota of contaminants in non-water based fluids. ▪ Potential anoxia of sediment due to natural degradation. ▪ Potential reduction in water quality in the area. ▪ Potential of a significant fuel spill. **Noise, Vibration, Light and Heat** ▪ Potential disturbance to marine organisms and birds due to noise and vibration. **Waste to Shore** ▪ Improper disposal. **Other Impacts** ▪ Disturbance to seabed and potential changes to seabed characteristics from drilling unit spud cans.	Negligible Negligible Negligible Negligible Negligible Negligible Negligible Negligible Moderate Negligible Negligible Negligible	Short-term Short-term Short-term Short-term Short-term Short-term Short-term Short-term Short-term Temporary Temporary Temporary

8.2.1 Wellhead Platform Installation

Before the commencement of the platform-based drilling program, a wellhead platform must be installed from where a number wells will be drilled. A wellhead platform is not required for drilling any of the subsea wells.

The platform will not be constructed on site but rather it will be towed to the offshore lease area, offloaded and assembled in two main parts; topsides and substructures. Sources of impacts associated with the installation of the wellhead platform are as follows:

- Physical presence of production and wellhead platforms;
- Power generation during installation;
- Lighting;
- Disposal of construction wastes;
- Presence of construction and support vessels;
- Discharge of sewage and greywater; and
- Discharge of domestic waste including food scraps.

In relation to these sources, the following potential impacts are discussed in **Sections 8.2.1.1** to **8.2.1.4**:

Atmospheric Emissions

- Greenhouse gases produced during power generation (primarily CO_2); and
- Atmospheric pollutants (primarily NO_x, SO_x, VOCs and smoke/particulates).

Discharges to the Sea:

- Potential localised reduction in water quality.

Noise, Vibration, Light and Heat:

- Potential disturbance to marine biota and birds.

Waste to Shore:

- Improper disposal.

8.2.1.1 Atmospheric Emissions

Power will be required to install and construct the platform. Diesel power generators will result in the following emissions to atmosphere:

- Carbon dioxide (CO_2);
- Nitrogen oxides (NO_x);
- Sulphur dioxide (SO_2);
- Carbon monoxide (CO);
- Volatile organic compounds (VOC); and
- Smoke and particulates.

The diesel consumption rate during drilling has been estimated at 10-20 tonnes/day. The resulting combustion emissions will not result in a significant reduction in air quality as the quantities will be relatively small, and the project area is isolated and far from sensitive receptors.

8.2.1.2 Discharges to Sea

Discharges to sea are derived from a number of potential sources including the discharge of sewage, greywater, domestic waste and foodscraps. The workforce on board vessels will generate sewage and putrescible wastes which will need to be discharged to sea.

The normal procedure (prescribed under the *P(SL)A*) is for food scraps and sanitary effluents to be passed through a grinder or comminuter so that the final product can pass through a screen of <25 mm diameter, which is conducive to the rapid biodegradation of the waste on discharge to sea. These discharges will occur on a regular basis and may lead to an extremely localised and temporary reduction in water quality, including a slight increase in nutrient availability. This routine discharge is therefore considered to have a short-term and negligible impact on the marine environment.

8.2.1.3 Noise, Vibration and Light

Potential exists for marine fauna to be disturbed by noise and vibration as a result of motors or heavy construction work on site during installation of bucket foundations, etc. Transportation of the platform and other components of the facility to the Sunrise Gas Project area will also produce noise and vibrations.

The frequency of whale and turtle visitations to the Sunrise Gas Project area is perceived to be low (Woodside, 2000); although whales, turtles and dolphins are known to occur within the wider region.

The response of Australian marine fauna to acoustical emissions from oil and gas activities will range from no effect to various behavioural changes (McCauley, 1994). Cetaceans (whales, dolphins, porpoises, etc.) are sensitive to sounds below the water surface. For some offshore developments there is the potential that severe sound waves created from drilling activities could induce stress, and any pulsating or modulating effects may cause abandonment of important habitats, such as calving and nursery sites (McCauley, 1994). Smaller toothed cetaceans, such as dolphins and porpoises are known to have poor hearing in the low frequency range and may be able to approach operating vessels closely without adverse behavioural or pathological effects (Woodside, 2000).

Electro-physical studies have indicated that the best hearing range for marine turtles is in the range 100–700 Hz; however, no definitive thresholds are known for the sensitivity to underwater sounds or the levels required to cause pathological damage (McCauley, 1994). Turtles would avoid areas where sound was at such levels long before it caused them any physical harm.

Disturbance to fish is expected to be minimal as fish will be expected to avoid acoustical emissions which reach levels that may cause pathological effects. Fish have been found to be exposed to elevated acoustical levels (>205 dB re 1µPa) without lethal effects (APPEA, 1998). This is comparable to background non-biological sea noise of 85–95 dB or $1\mu Pa^2/Hz$ under extreme windy conditions and 80 dB re $1\mu Pa^2/Hz$ for rainfall (McCauley, 1994).

As disturbances associated with the drilling programme will be localised, and the effect on marine mammals, turtles and fish is expected to be moderate. Further to this, it is important to note that whales, turtles and fish are highly mobile and will temporarily avoid the Sunrise Gas Project area, if disturbed as a result of drilling operations.

Artificial lighting and well testing flares have the potential to disorientate and confuse hatchelling turtles, pregnant females turtles and seabirds. The project location is several hundred kilometres away from the nearest turtle hatching grounds, so lights from the drilling rig are not expected to impact on turtle hatchlings. Lights on the rig may result in marine life and seabirds concentrating in the immediate vicinity of the rig; however, the operation is short-term and therefore the impact is not expected to be significant.

8.2.1.4 Waste to Shore

A variety of construction waste will be generated during installation of the wellhead platform. Typical wastes may include piping, sheet metal, empty drums, concrete and plastics. All waste generated will be collected during construction and shipped back to shore for disposal or alternatively reused, recycled or recovered at approved sites. If inappropriately managed, landfill facilities can result in adverse impacts on the receiving environment such as groundwater or surface water; however, the potential environmental impact from inappropriate disposal will be negligible as Woodside will ensure that all waste is disposed of properly, and in accordance with regulatory waste management requirements.

8.2.2 Drilling of Platform and Subsea Wells

The sources of impacts resulting from installation of both platform and subsea wells are as follows:

- Anchoring/spudding of drilling unit;
- Cuttings discharge and adherent drilling fluid;
- Use of water based drilling fluids for the initial section of each well or for vertical wells;
- Use of non-water based drilling fluids for deviated sections of wells;
- Activity of support/supply vessels;
- Discharge of drilling chemicals and hydrocarbons attached to cuttings only;
- Discharge of sewage and greywater;
- Discharge of domestic waste including food scraps;
- Oily water discharged to the environment during installation of drilling facilities and operation through inappropriate deck drainage system;
- Disposal of domestic waste including paper and plastics etc;
- Power generation;
- Lighting; and
- Refuelling at sea.

In relation to these sources, the following potential impacts are discussed in **Section 8.2.2.1** to **8.2.2.5**:

Atmospheric Emissions:

- Greenhouse gases produced by drilling unit power generation (primarily CO_2); and
- Atmospheric pollutants (primarily NO_x, SO_x, VOCs and smoke/particulates).

Discharges to the Sea:

- Smothering effects of accumulated drilling cuttings on marine biota;
- Increased turbidity in the area if cuttings discharged at the surface;
- Potential accumulation of metal and hydrocarbon concentrations in seabed sediments leading to toxicity;
- Potential bioaccumulation/bioconcentration by marine biota of contaminants in non-water based drilling fluids;
- Potential anoxia of sediment due to natural degradation;
- Potential reduction in water quality in the area; and
- Potential of a significant fuel spill.

Noise, Vibration, Light and Heat:

- Potential disturbance to marine organisms and birds.

Waste to Shore:

- Improper disposal.

Other Impacts:

- Disturbance to seabed and potential changes to seabed characteristics from drilling unit spud cans.

8.2.2.1 Atmospheric Emissions

Power will be required to install and construct the platform and to drill the wells. Diesel power generators will result in the following emissions to atmosphere:

- ☐ Carbon dioxide (CO_2);
- ☐ Nitrogen oxides (NO_x);
- ☐ Sulphur dioxide (SO_2);
- ☐ Carbon monoxide (CO);
- ☐ Volatile organic compounds (VOC); and
- ☐ Smoke and particulates.

The emission of the gases listed above will not result in a significant reduction in air quality as the quantities will be small, and the project area is isolated and far from sensitive receptors. Woodside will minimise emissions by installing new and efficient diesel generators.

8.2.2.2 Discharges to Sea

Drilling Fluids

Drilling muds can enter the marine environment by three methods:

- ☐ As a whole mud discharged overboard;
- ☐ From spillage; and
- ☐ Through adherence to discharged drill cuttings.

The former is highly unlikely to occur as drilling mud is continually recycled. The principal method is through the latter when drill cuttings are brought to the surface for intentional discharge.

During well construction the drilling muds are reused several times and all attempts are made to separate as much of the muds from the cuttings using different methods such as shakers and centrifuges. However, not all of the mud can be separated from the cuttings and inevitably drill cuttings are discharged with adherent mud. This is one of the most significant chemical impacts on the marine environment, depending upon the type of drilling muds used.

The target for total surface losses of drilling muds will be about 10% of the cuttings volume, ie approximately 80 m^3 mud loss based on a single 7 km directional well (Asia Pacific ASA, 2001). Once the muds have surpassed their usability they are usually either discharged to sea (water-based muds) or shipped back to shore (all other muds) where they are either returned to the manufacturer for recycling or disposed of in an approved method such as land farm or incineration.

As discussed in Section 3.2.7 an alternative to discharging the cuttings/adherent mud over board is to re-inject all of the drill cuttings and adherent muds, into a dedicated shallow well drilled from the wellhead platform. The feasibility of using a dedicated re-injection well is still in the preliminary stages of design. Discharge of the cuttings from the platform to the seabed is considered the most likely disposal method.

Water Based Drilling Fluids

Water-based muds (WBM) are comprised of clay (bentonite-sodium montmorillinite) hence the term drilling “mud”. The clay has improved viscosity ie hole cleaning capability, reducing mud loss to the formation, and improving the quality filter cake on the wall of the hole. Ground barite ($BaSO_4$) is added for mud density (Craddock, 1999).

A water-based mud will be used in the construction of both the subsea wells and platform wells. It will be used for drilling the top-hole section of the platform wells, typically down to approximately 3 200 m. This is normal practice in Australia where water-based muds are used for 36, 26 and 17.5 inch sections. WBMs would not be reinjected rather all WBMs, left after the drilling campaign, will be discharged to the sea after the completion of the wells.

The impact of drilling muds and cuttings on benthic and demersal species is dependent on local environmental variables e.g. depth, current, wave regimes, substrate type etc. Impacts fall into two categories (Thatcher, 2000):

- ☐ Short-term effects due to either toxicity or burial by drilling mud and/or cuttings; and
- ☐ Longer term effects due to chemical contamination or physical alteration of sediments.

Water Based Drilling Muds

Water-based muds (WBMs) are low toxicity and comprise a low bioaccumulation potential and are, therefore, unlikely to cause significant impact on marine organisms. These water-based muds are routinely accepted for discharge in open waters by the DBIRD and other regulatory authorities.

WBMs use fresh or seawater as the continuous phase and the most common systems include bentonite, potassium chloride, polymers and partially hydrolysed polyacrylamide. WBM may also contain a range of additives such as biocides, weighting agents, alkaline chemicals, various salts, defoamers, corrosion inhibitors, scale inhibitors, drilling lubricants, lost circulation materials and pipe release agents. WBM do not deliver optimal performance in highly deviated, horizontal and /or long reach stepout wells. However, WBMs provide the least environmental impact due to their non-toxic nature an ability to disperse and biodegrade rapidly (Terrens et al., 1998).

Recovery of the benthos following the discharge of WBM occurs rapidly. Evidence for this is provided by a field experiment conducted by Bakke, et al. (1985). In this study, trays of seabed sediment devoid of flora and fauna were covered with a 10 mm layer of water base mud slurry, returned to the sea and periodically sampled to assess recolonisation. Sampling of trays found colonisation by algae (principally diatoms), meiofauna and macrofauna components commenced immediately. Peak meiofauna densities were reached within 2 weeks and macrofauna diversity was found to be comparable to mature sediment communities within one year.

A post WBM drilling survey on the North West Shelf (NWS) undertaken by Woodside (Hanley, 1993) demonstrated that little environmental effect remained after three years. Levels of barium, lead and chromium were slightly elevated at stations within 200 m of the Wanaea 3 wellhead and cluster analysis of dominant taxa demonstrated that a different community persisted at Station 1, only 10 m from the wellhead. This difference was believed to be due to the variation in sediment composition (increased SiO_2 and grain size) rather than to any chemical effect.

Oil Based Drilling Muds

The first oil based muds used were diesel-based, containing a high proportion of toxic aromatic hydrocarbons (>25%). In the early 1980s, there was considerable concern in the North Sea regarding the discharge of drill cuttings coated with diesel based OBMs, and the use of diesel based drilling muds was banned in the North Sea in 1984. Subsequently, base oils with lower aromatic hydrocarbons were used, as toxicity was traced to aromatic content. These muds are referred to as Low Toxicity Mineral Oils (LTO) and have a lower concentration of aromatic compounds. However, more efficient solids control equipment and cuttings treatments were developed to reduce the amount of oil-on-cuttings. Limitations on the amount of oil that could be discharged to the marine environment were then introduced. In 1996, the maximum oil-on-cuttings allowed in the North Sea was 1% (by dry weight).

The main chemicals used in oil-based drilling muds include:

- Base oil – with reduced aromatic and polynuclear aromatic components. New systems use vegetable oil, polyglycols or esters amongst others;
- Brine Phase $CaCl_2$, NaCl, KCl;
- Gelling products Modified clays reacted with organic amines;
- Alkaline Chemicals e.g. $Ca(OH)_2$;
- Fluid Loss Control: Chemicals derived from lignites reacted with long chain or quaternary amines; and
- Emulsifiers: Fatty acids and derivatives, rosin acids and derivatives, dicarboxylic acids, polyamines.

Of a total of 694 wells drilled offshore in Western Australia since 1971 only 73 wells have used LTOBM or SBM. Of these wells none used diesel-based muds and only 22 used LTOBM. Of the 184 wells drilled offshore in Northern Territory, LTOBM was used for 2 wells in the 1980's with cuttings recovered and not dumped at sea.

The environmental issues with OBMs are related to toxicity, uptake and bioaccummulation of hydrocarbons from the cuttings piles on the seabed.

For the Sunrise Gas Project oil-based muds may be best suited to the drilling of a dedicated re-injection well, approximately 900 m in depth, should that option proceed. However, the OBM would only be used in the drilling of the middle or lower sections of the well and would therefore not be discharged but reinjected into the dedicated well, thereby eliminating or limiting the environmental effects. In this case the cuttings would be disposed to the well annulus between the casing and the well bore in the form of a slurry.

Synthetic Based Muds (SBMs) including Ester-Based Drilling Muds (EBMs)

A synthetic based drilling fluid, such as 'Biogreen' or 'Nexus', is a necessity for drilling extended reach platform wells. SBM's are normally used in the 12.25 inch and/or 8.5 inch hole sections.

Due to rapid settling SBMs do not disperse in the water column and do not increase water column turbidity. The percentage of oil on cuttings is dependent on the following factors:

- Formation characteristics;
- Rate of drilling; and
- Solids removal equipment efficiency.

The SBMs displaying less viscosity and greater hydrophobicity, for example esters, will have the greatest dispersibility. Several studies have been conducted globally into the environmental effects of SBMs. Impacts on the marine environment are normally gauged by four environmental processes discussed below:

- Fate, Persistence and Biodegradability;
- Ecotoxicity; and
- Bioaccumulation/bioconcentration.

Fate, Persistence and Biodegradability

SBMs biodegrade in the environment. In general, for a given concentration, the degradation for esters (EBMs) is greater than for other SBMs (Neff *et al*. in Macro-Environmental, 2001). Biodegradation results for Biogreen, also suggest that persistence time in the sediments will be short, although this will be affected by depth of burial and oceanographic conditions. Biodegradation of Biogreen has been calculated at around 50% in anaerobic conditions after 60 days and between 61% and 98% in aerobic conditions after 28 days indicating that Biogreen is highly biodegradable.

A closed-bottle biodegradation test was used (Papp and West in Craddock, 1999) to select a drilling mud, based on a fish oil ester, for Woodside's Goodwyn Alpha wells, drilled in 1998 and 1999. The two ester-based muds tested were based on the fish oil based ester (Biogreen), and a palm oil ester (Petrofree), of the other two muds tested one was a Paraffin-Based Mud (PBM) and the other a SBM. It was concluded that the two ester based drilling muds biodegrade faster and more completely than the other muds tested. Results from Woodside's closed bottle anaerobic biodegradation test were 85% and 58% ultimate biodegradation for the ester-based muds, compared to 11% and 18% respectively for the SBM and PBM. After 20 days no ester-based muds remained within the solvent extracted aqueous phase.

Thatcher (2000) compiled data required for regulatory approval in the North Sea, Gulf of Mexico and Australia; the relevant biodegradation results are detailed in **Table 8-3** below.

Table 8-3 Available Biodegradation data for Ester Based Muds

Protocol	Fish oil Based Ester	Palm Oil Based Ester
28 day aerobic degradation %	61	-
28 day aerobic biodegradation %	86	93
28 day aerobic biodegradation %	98	-
28 day anaerobic biodegradation %	45-55	82.8

Source: Thatcher 2000

Ecotoxicity

A guide to toxic grades used to classify drilling fluids and other substances is provided below. The LC_{50} concentration is the concentration of the test substance that results in the mortality of 50 per cent of the test population over a given time period and EC_{50} is the concentration that gives a defined affect on 50 per cent of the test organisms (URS, 2001).

Toxicity Rating		*LC50 Value (mg/L)*
Very Toxic	-	<1
Toxic	-	1–100
Moderately Toxic	-	100–1000
Slightly Toxic	-	1000–10000
Almost Non-Toxic	-	10000–100000
Non-Toxic	-	>100000

Various toxicity tests and protocols can be used depending on location. Suspended Particulate Phase (SPP) toxicity bioassay tests were conducted on Biogreen drilling mud and base oil using three Australian marine species (Tsvetnenko & Evans in Macro-Environmental, 2001). Whole fluid toxicity tests on Biogreen are presented in **Table 8-4**.

Table 8-4 Toxicity Tests on Biogreen

Species	Unit	Results	Comments	Base/Whole Fluid Tested
Isochrysis sp.	96hr IL_{50}	>100 000	Non-toxic	Whole Fluid
Isochrysis sp.	96hr IL_{50}	>100 000	Non-toxic	Base Fluid
Gladioferens imparipes	48hr LL_{50}	>100 000	Non-toxic	Whole Fluid
Gladioferens imparipes	48hr LL_{50}	67 100	Almost non-toxic	Base Fluid
Penaeus monodon	96hr LL_{50}	>100 000	Non-toxic	Whole Fluid
Penaeus monodon	96hr LL_{50}	>100 000	Non-toxic	Base Fluid
Corophium volutator	10 day LC_{50}	>11 633	Almost non-toxic	Whole Fluid
Corophium volutator	10 day LC_{50}	3 000	Slightly toxic	Base Fluid
Abra alba	96hr EC_{50}	300–1 200	Moderately to slightly toxic	Base Fluid
Arcatia tonsa),	48hr LC_{50}	>5 000	Slightly toxic	
Skeletonema tonsa	EC_{50}	>2 000	Slightly toxic	
Skeletonema costatum	72hr EC_{50}	2 333	Slightly toxic	

Source: Tsvetnenko & Evans in Macro-Environmental, 2001

LC_{50}-The concentration that results in fatality of 50 % of the test organisms

EC_{50}-The concentration that gives a defined (sub-lethal) effect on 50 % of the test organisms.

IL_{50} – Inhibition Load for 50 % of the test organisms.

LL_{50} – Lethal Load for 50 % of the test organisms.

The results presented in **Table 8-4** are comparable to the results for the Biogreen base oil which were as follows:

- ❑ 96h IL50 for growth of *Isochrysis sp*., >100,000 mg/L.
- ❑ 48h LL50 for *Gladioferens imparipes* >67,100 mg/L almost non-toxic.
- ❑ 96h LL50 for *Penaeus monodon* >100,000 mg/L.

In ecotoxicity tests (**Table 8-4**) on commercially important Western Australian species, the Biogreen has been rated as "almost non-toxic" to "non-toxic". Toxic or sub-lethal effects are only likely to occur within hundreds of metres from the discharge point, beyond which the muds will be adequately dispersed and diluted. Rapid biodegradation of Biogreen suggests that the impact on benthic organisms will be short lived (half life of 110 – 133 days for esters).

The use of an ester-based mud, such as Biogreen, is likely to only have a short-term, negligible impact on the surrounding environment.

Bioaccummulation/Bioconcentration

Bioaccumulation typically refers to the uptake and retention of a contaminant by an organism while bioconcentration refers to the net accumulation of a contaminant resulting from simultaneous uptake and release.

When testing the potential for bioaccumulation the rate of uptake and release of test organisms should also be considered. Rapid depuration may reduce the potential for bioaccumulation. Where there is potential for the bioaccumulation of heavy metals that may be contained in drilling muds the bioavailability of heavy metals in these compounds should be considered. In most cases, the heavy metals are bound up in the muds or are in a form that is not released and thus not available for biota to bioaccumulate. The bioaccumulation potential of a drilling mud can be expressed as the ratio of the equilibrium concentrations of dissolved substances in n-octanol and water (also known as Log_{10} Pow). The Log_{10} Pow value should be below 7 *(*Tsvetnenko & Evans 1998).

Bioaccumulation can be expressed as a Log Bioaccumulation Factor (BCF), which is the ratio of the concentration in the organism's tissues to the ambient concentration in the environment (expressed as dry weight or lipid weight). The lower the BCF value the better as this would indicate that whilst the organism has taken up some contaminant, the rate of uptake and release has stabilised such that the body burden of the organism is no longer increasing.

Whilst drilling fluids have very low concentrations of heavy metals, cadmium and mercury show high bioaccumulation potential in most biota. Cadium and mercury are used to estimate potential bioaccumulation as they provide a worst case scenario. The Log_{10} Pow and Log Bioaccumulation Factor for potential ester based drilling muds is given in **Table 8-5**.

Table 8-5 Available Bioaccumulation Data for Potential Ester Based Muds

Protocol	Biogreen	Petrofree
Octanol/Water Partition co-efficient (log Pow)	1.69	4.99
Log Bioconcentration Factor (*Mytilus edulis*)	3–7.6	3.51 (lipid wt.)

Source: Tsvetnenko & Evans 1998

Based on the data provided, both Biogreen and Petrofree would have a low potential for bioaccumulation. The low Log Pow indicates that the metals are unlikely to be readily bioavailable and the low Log BCF indicates that biota are unlikely to accumulate sufficient quantities of heavy metal to cause them harm.

Effects of SBM Cuttings on Benthic Communities

Biological effects on benthic communities due to the deposition of SBM/EBM cuttings may result from one or any combination of the following:

- Toxicity of the drilling muds ingredients;
- Effects of sediment anoxia, caused either by the depletion of oxygen during the microbial biodegradation of organic materials in the SBM cuttings, or by the burial/smothering of organic material following the deposition of SBM cuttings (Craddock, 1999);
- Direct burial by drill cuttings solids; and
- Changes in texture and physical/chemical properties in the sediments.

Several studies have been conducted on the effects of EBMs on the marine environment. A seabed monitoring program around the Fortescue platform in the Bass Strait was undertaken focusing on the initial drilling of 21 wells using only WBM, and a further 18 wells, seven of which were drilled with an ester-based mud for some of the lower-hole sections.

The following summarises the findings of the studies (Terrens *et al.* in Craddock, 1999):

- The highest concentration of ester in the sediment was observed at completion of drilling within 100 m of the platform;
- The ester concentration had reduced from 6,900 ppm to an average of 230 ppm after four months and was not found after 11 months;
- The impact on sediment in fauna was limited to 100 m from the discharge point, with recovery evident within 4 months of the completion of drilling;
- Infauna showed a rapid recovery after drilling had concluded; and
- Over the past 20 years of drilling operations a huge amount of field data has been gathered through environmental surveillance projects. The findings of these projects are summarised in **Table 8-6**.

Table 8-6 Summary of Field Studies of the Fate and Effects of SBM Cuttings Discharges[1]

Water Depth (m)	Cuttings Discharge	Field Surveys	SBM Fates	SBM Effects
North Sea				
30	477 t	4 (pre 1,4 & 11 months)	<200 m, ester concentrations to 4,700 mg/kg at 4 months, still detected after 11 months. > 200 m, esters near background. Est. ½ ~133 d.	At 4 months, sediments to 75 m anaerobic. Benthic fauna diminished < 200 m. Evidence of some recovery <200 m after 11 months.
67	96.5 t	3 (at end of drilling, 1 & 2 y)	< 200 m accumulation of high concentration of ester. Decrease after 1 & 2 years	Impoverished fauna < 100 m, no impacts >200 m, recovery 1 year.
30	Not reported	1,4 &b 11 months after drilling.	Maximum recovered concentration of ester 410 mg/kg after 4 months, decreasing to 251 mg/kg after 11 months.	Effects were extensive at the 4 month. Survey showed reduced abundance and diversity. Effects still remained after 11 months but localised to within 200 m of well site.
150	304 t	2 (post drilling 1 year)	Highest ester concentration 8,400 mg/kg at 25 m after drilling dropped to 1,800 mg/kg after 1 year. Some contamination to 200 m.	Number of individuals increased, species numbers and diversity decreased at stations with highest ester concentration.
Australia				
70	2,000 m^3	5 (pre-drilling to 11 months after drilling)	Ester concentration declined rapidly from maximum of 12,000 mg/kg after drilling to 200 mg/kg 6 months later.	Change in benthic community structure with 100m of platform shortly after drilling with recovery within 4 months.

Source; Macro-Environmental, 2001.
Note: [1]This complete table from Macro-Environmental (2001) refers to all SBMs not only ester-based muds.

The key conclusions are briefly summarised below (Macro-Environmental, 2001; Thatcher, 2000):

- Ester-based muds degrade relatively rapidly compared with other mud types;
- Benthic community responses are often associated with a decrease in oxygen concentration in surface sediment layers;
- Organic enrichment appears to be the main mechanism of adverse impact from SBM cuttings on benthic communities;
- Recovery of the contaminated area begins one year after discharges of ester-based muds cease;
- Effects on benthic fauna from SBM discharges are rarely seen outside a radius of 500 m; and
- When effects are observed changes in benthic communities usually include a decrease in the number of taxa and biological diversity, however, the total number of individuals and biomass of benthic fauna present may increase in some cases.

Environmental conditions differ between the Timor Sea and the North Sea but conditions in the former may favour a faster recovery of the discharge area. This is dependent on the type of drilling mud used, water depths, sea temperatures, cyclonic/current activity etc. An increase in the latter two factors is known to increase the rate of biodegradation and recolonisation of the discharge area in ester based muds (Thatcher, 2000).

Drill Cuttings

The impact of drill cuttings on the marine environment has been somewhat discussed in the preceding discussion on drilling muds, as muds are usually only discharged as an adherent to cuttings. Impacts specifically relating to cuttings are expanded upon below.

In the Sunrise Gas Field, drill cuttings will primarily comprise carbonates, marl, shale/siltstone and sandstone. The major volume of cuttings deposited on the seabed will be from the hole sections drilled with WBM. However, there will be the possibility that cuttings and drilling fluids will be lost down hole to the formation as a result of lost circulation (Craddock, 1999). The cuttings (and adherent WB &S/EB muds) will be discharged to the seabed as the base case.

The potential environmental impacts that will be associated with the discharge of drill cuttings will include:

- Smothering effects of accumulated drill cuttings on marine biota;
- Increased turbidly within the vicinity of the discharge point;
- Potential occurrence of Naturally Occurring Radioactive Material (NORMS); and
- Potential accumulation of metal concentration from formation materials leading to toxicity.

Risk of Cuttings Reaching Sensitive Environments

Asia-Pacific ASA was commissioned by Woodside to undertake discharge modelling of drill cuttings to determine dispersion and deposition of cuttings, which would facilitate the determination of potential environmental impacts.

Determination of release trajectories and fates

Modelling was undertaken by Asia-Pacific ASA using MUDMAP and OILMAP based on the parameters provided in **Table 8-7,** which is currently representative of the conditions produced by the directional drilling programme. The modelling has been based on the discharge of all cuttings from the wellhead platform and not the subsea wells, and excludes the potential for resuspension and transport of cuttings by seabed currents, thus predicted cumulative loads can be considered as conservative estimates of sedimentation loads.

The model was prepared to simulate a release under representative wind and tidal conditions for three defined sets of conditions:

- NW Monsoon (generally occurring April–September);
- SE Trade Winds (generally occurring October–March); and
- A period when calm (< 5 knots) and variable wind conditions coincided with neap tides. Weak tides are most common during the transitional seasons (September/October and March/April).

Table 8-7 Summary of Model Parameters for Fate of Drill Cuttings With EBM[1]

Parameter	Value
Total volume of drill cuttings	800 m^3
Total volume of ester based fluid	80 m^3
Discharge orientation	12 inch vertical pipe
Pipe release depth	Approx. 28 m above MSL [2]
Mean density of drill cuttings	2,550 kg/m^3
Density of combined discharge	2,600 kg/m^3
Period of discharge	240 hours (10 days)
Duration of simulation	480 hours (20 days)
Water temperature	28 °C
Salinity	32 ‰ [2]

Note 1: As the design phase of the Sunrise Project proceeds the parameters used in the modelling exercise will be firmed up and increasingly accurate values generated.
Note 2: MSL- Mean Sea Level, ‰-parts per thousand

The drilling program is expected to generate a total of about 800 m^3 of cuttings for a single seven km directional well, with which it is assumed that approximately 80 m^3 of ester based drilling fluids (10% of cuttings volume) would be lost from the recirculation systems. Cuttings are expected to range in size from fine material of about 20 µm up to chips of material at about 700 µm (**Table 8-8**). Ester based drilling fluids are also expected to adhere to cuttings and settle out with them (Terrens *et al.*, 1998) which would result in a predicted mean density of cuttings of about 2,600 kg/m^3.

Table 8-8 Assumed Particle-size Distribution for Drill Cuttings

Mean size (µm)	Proportion of volume (m^3)	Settling Velocity (cm/s)
707.1	0.56	9
353.6	7.45	4
176.8	17.08	1.6
88.4	18.3	0.45
44.2	12.18	0.1
22.1	44.43	0.04

Results of modelling

The results of modelling are given in **Figure 8-1** to **Figure 8-6** and are summarised in **Table 8-9**. Modelling indicates that the area over which cuttings would settle, hence the seabed locations that could be affected, will vary with prevailing environmental conditions. Cuttings released under SE Trade Wind conditions (winter) are predicted to principally settle out in a south-westerly direction, up to approximately 155 km from the point of discharge (**Table 8-9**, and **Figure 8-1 to Figure 8-2**). The footprint predicted under these conditions extended to Echo Shoals and covered an area of approximately 5,245 km^2. With this area of coverage, the load at any one location is expected to be low. The peak cumulative cuttings load and thickness at any location within the footprint is estimated to be approximately 7.5 g/m^2 and 2.9 µm, respectively, as an average over a grid cell (**Table 8-9**, and **Figure 8-3** to **Figure 8-4).**

Cuttings discharged at the Surise Gas Field will not impact on the island of Timor nor the Indonesian Archipelago. The Timor Trench will effectively limit the distribution of cuttings as the material will not be capable of resurfacing once it has settled onto deeper waters.

Cuttings released under NW Monsoon (summer) conditions are predicted to principally settle out along a north-south axis. A proportion of the lighter material (33% of total cuttings volume) that is transported northward is predicted to remain in the water column for a protracted period of time (beyond the 20 day period of simulation) as the water depth increases at a greater rate than the predicted rate of sinking under the influence of local currents. Heavier material is predicted to settle out up to 85 km from the well site (**Table 8-9**, and **Figure 8-3** and **Figure 8-4**) over a predicted footprint an area of approximately 3,750 km^2. The highest cumulative cuttings load and thickness at any location within the footprint are slightly higher than for the winter case at approximately 13.4 g/m^2 and 5.2 µm respectively (**Table 8-9**, and **Figure 8-3** and **Figure 8-4**).

Table 8-9 Predicted Spread of Cuttings under Different Environmental Conditions

Parameter	Discharge Conditions		
	Winter (high energy)	Summer (high energy)	Calm (low energy)
Maximum total sedimentation (g/m^2)	7.48	13.37	54.61
Maximum cumulative thickness (µm)	2.93	5.24	24.41
Maximum distance (km)	155	85	24
Area of coverage (km^2)	5245	3750	693

Modelling during the calm environmental conditions, which typically occur during the short transitional seasons between summer and winter, indicates that the drill cuttings will settle out over a much reduced footprint area (693 km^2) contained within 24 km of the discharge point. Consequently, predictions for the highest cumulative cuttings load and total thickness at any location are significantly higher at approximately 56.6 g/m^2 and 21.4 µm respectively (**Table 8-8** and **Figures 8-5 to 8-6**).

The discharge of cuttings during the transitional seasons is therefore likely to have a greater potential to smother seabed benthos. During winter and summer, any potential smothering is likely to occur within 100 m of the discharge point. Modelling indicates that cumulative loads and predicted total thickness of the settling of cuttings are very low and it is likely that such cutting and sediment loads would have negligible impact of the existing condition of benthic communities. Some habitat disturbance will occur due to the difference in particle characteristics (such as size and abrasiveness) to the existing sediment. However, this change may be temporary as sediment redistributes and disperses over time.

Turbidity generated from the discharge of cuttings and general drilling activities can affect photosynthetic activity; however, no significant impact is anticipated as existing benthic communities have adapted to low photosynthetic activity as a result of the large water depths surrounding the Sunrise Gas Project area. Modelling indicates that the nearest shallow waters to the southwest of the Sunrise Gas Project will receive an estimated maximum cumulative load of only 4g/m^2 during winter (**Figure 8-1**). These shallow areas will receive little or no load during summer or transitional seasons (**Figure 8-3** and **Figure 8-6**). Turbidity is unlikely to affect benthic communities in the vicinity of the drilling operations.

Formation materials retrieved from the well may also include heavy metals. The deposition of heavy metals on the seabed will create the potential for metal bioaccumulation which may possibly lead to toxicity. Marine organisms will be able to uptake metals; however, it is considered unlikely that this would result in toxic effects as the metals would be present in low concentrations and in a form not biologically available (Chandler *et al.*, 1990).

Summary of Drilling Impacts

The modelling of cuttings discharge has been presented to show the maximum extent of distribution of material. The modelling assumed a discharge at 28 m above mean sea level. Discharge above the sea surface leads to greater spatial distribution of material and a much larger footprint size. The modelled scenarios thus grossly over estimate the spread of cuttings. Cuttings generated during drilling for this project, if not discharged down well, would be released between 54 and 68 m below sea level. This would markedly reduce the spread of material.

The modelling also assumed over 50% of the material discharged was of a size fraction less than 60 µm (clay). This is also a over estimate which leads to significantly greater spreading of the cuttings by currents.

Figures showing the predicted spatial extend of cuttings discharge must take into account the significant over estimation built into the modelling by the very conservative assumptions of particle size and the point of cuttings discharge.

Modelling has shown that in most cases the material is of a concentration less than 10 g/m^2 and of a thickness of less than 10 µm (0.01 mm). In reality, this material would be practically undetectable during field investigations at distances of more than 2 km from the site of discharge. The drilling activities are therefore predicted to have a limited short-term impact on the ecology of the area.

Smothering of benthos is likely to be limited to within 100 m of the site of cuttings discharge and the effects of turbidity in the area is predicted to be minimal.

It is predicted that rapid biodegradability of the drilling fluids and their low toxicity would not impact on the biota present in the vicinity of the drilling operation. While some benthos would be smothered close to the discharge of the cuttings, recolonisation would take place. Studies undertaken in Australia and elsewhere in the world in similar habitats indicate that recolonisation would take place over a time scale of 6 months to 2 years (**Table 8-4**).

Other Discharges

A variety of waste products will be produced during the drilling programme and will have the potential to be discharged to sea. The discharge of waste may include:

- ❑ Discharge of drilling chemicals and hydrocarbons only attached to cuttings;
- ❑ Discharge of sewage and greywater;
- ❑ Oily water discharged to the environment during installation of drilling facilities; and
- ❑ Possible loss of fuel during refuelling at sea.

The potential environmental impacts that may result from the above discharges include:

- ❑ Potential accumulation of contaminants in seabed sediments leading to toxicity;
- ❑ Potential reduction in water quality in the area; and
- ❑ A potentially significant fuel spill.

The above discharges will be small in comparison to the discharges of cuttings. These discharges are common also to the construction and operation phases of the project (see **Sections 8.4** and **8.6**).

8.2.2.3 Noise, Vibration and Light

Potential exists for marine fauna to be disturbed by noise, vibration and light; a result of heavy construction work on site during installation of bucket foundations and mandatory industrial lighting. These activities and the potential impacts on marine fauna have been previously discussed in **Section 8.2.1.3**.

8.2.2.4 Waste to Shore

Wastes that will be generated during the drilling programme will be appropriately disposed of on shore. The potential environmental impacts associated with the disposal of waste onshore have been previously discussed in **Section 8.2.1.4**.

8.2.2.5 Other Impacts

Seabed disturbance, other than that caused by the routine discharge of drilling fluids and cuttings, will result from the establishment of up to eleven subsea production wells (spudding of the drilling unit) and the deployment and retrieval of the drilling rig's anchor. Each well will disturb an area of about 100 m^2 and an anchor is expected to occupy an area less that 10 m^2. Further information on mooring systems and anchoring is provided in Section 3.2.10.

The increase in turbidity and potential smothering of benthos from anchoring may result from the localised suspension of sediment from anchoring. Resuspended sediment is expected to settle following disturbance. Impacts to benthic communities are not considered to be significant due to the low diversity and low abundance of significant benthic communities and the absence of any hard substrate communities such as corals within the immediate vicinity of the Sunrise area.

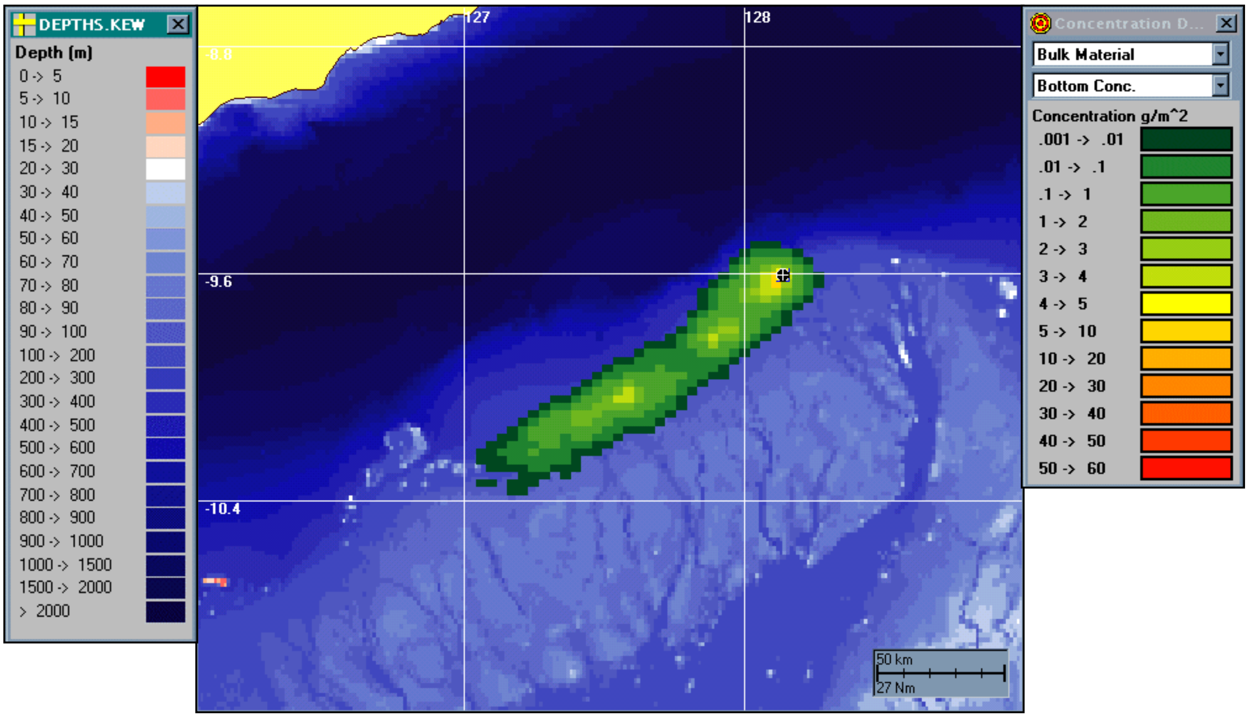


Figure 8-1 Predicted Cumulative Loads of Cuttings During a High-energy Winter Period.

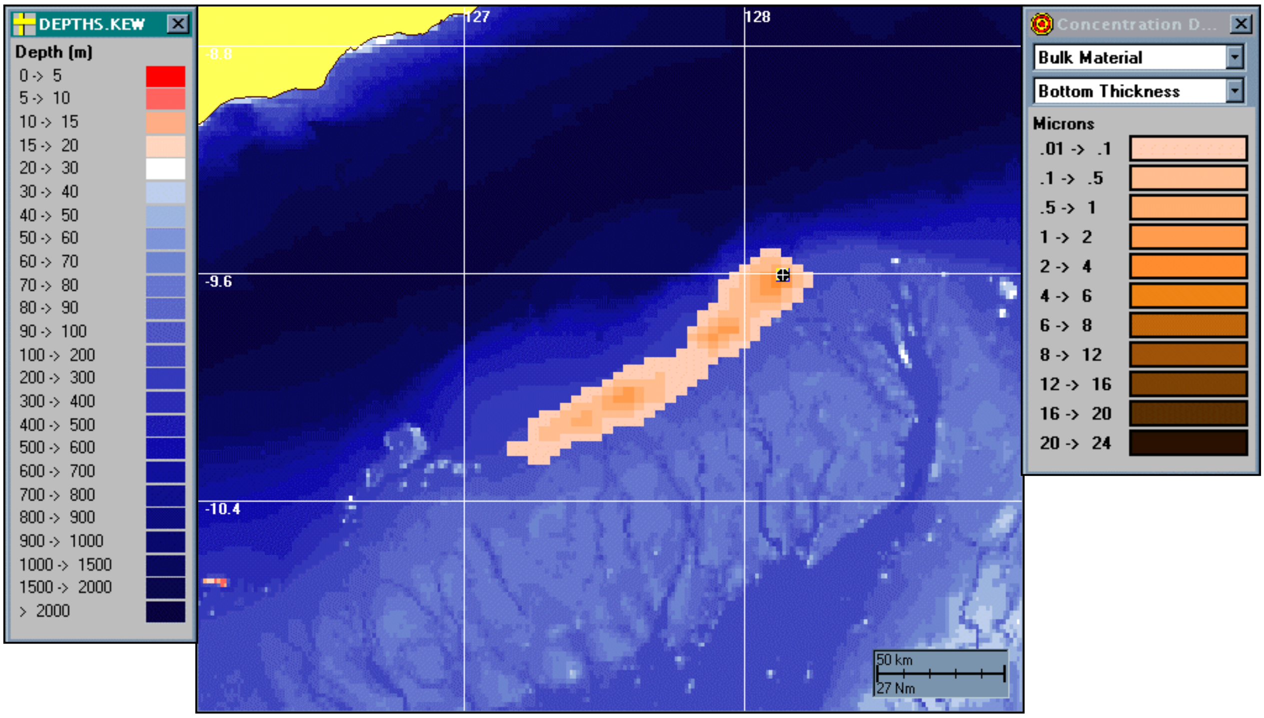


Figure 8-2 Predicted Thickness of Cuttings During a High-energy Winter Period

*Results are showing the predicted distribution of bulk material displayed over the bathymetry of the area (Source AGSO)

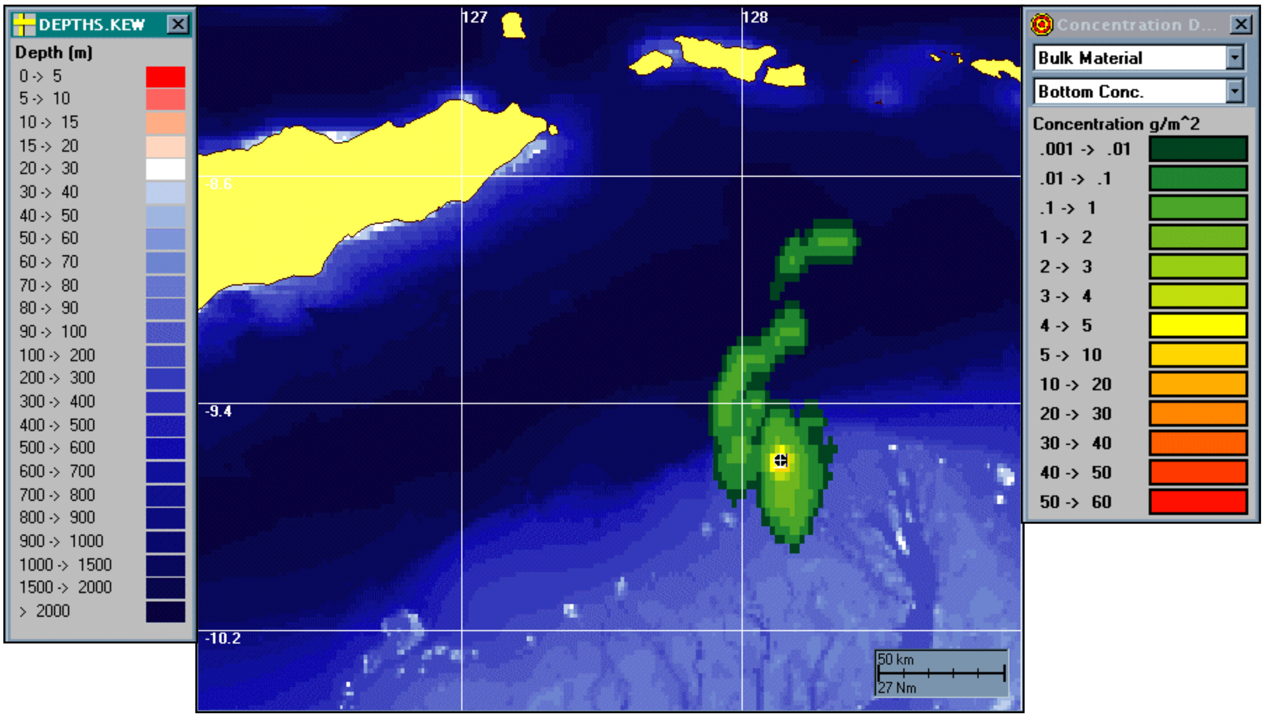


Figure 8-3 Predicted Cumulative Loads of Cuttings During a High-energy Summer Period

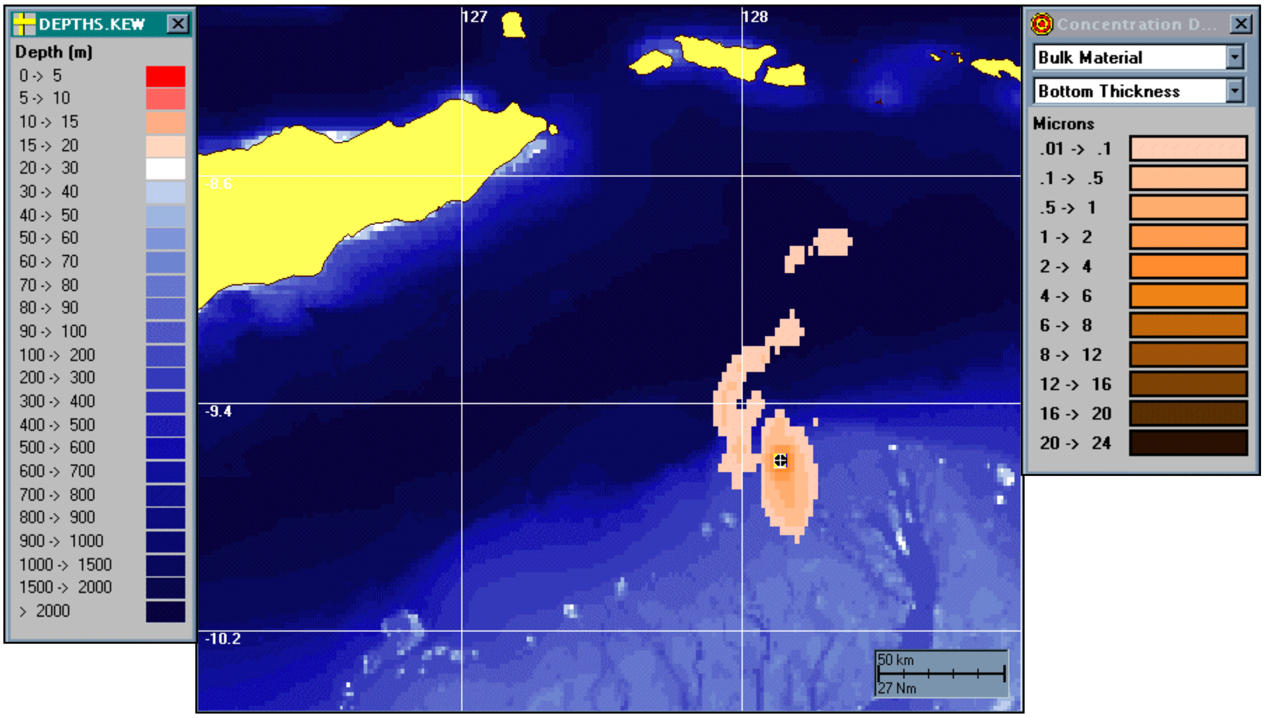
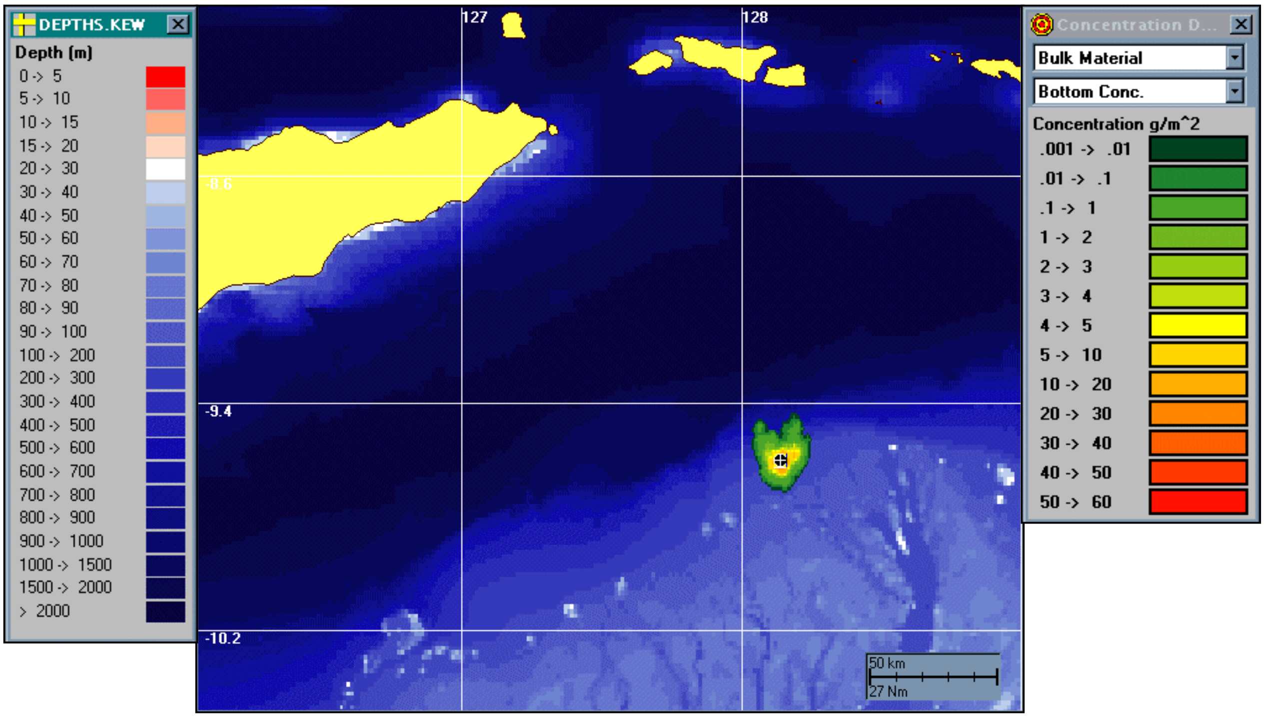


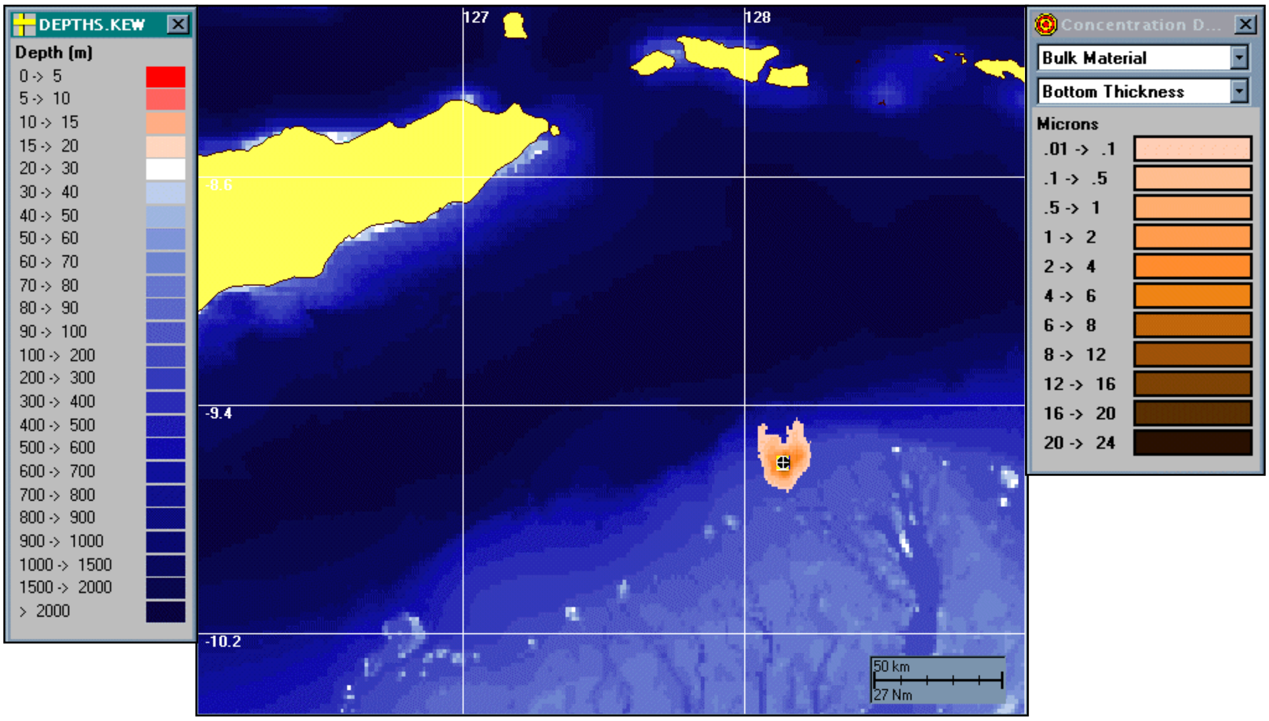
Figure 8-4 Predicted Thickness of Cuttings During a High-energy Summer Period



Bulk Material

Bottom Conc.

Figure 8-5 Predicted Cumulative Loads During a Low-energy Calm Period



Bulk Material

Bottom Thickness

Figure 8-6 Predicted Bottom Thickness During a Low-energy Calm Period

*Results are showing the predicted distribution of bulk material displayed over the bathymetry of the area (Source AGSO).

8.3 Mitigation Measures for Drilling and Associated Activities

During drilling operations Woodside will minimise or avoid wherever possible impacts on the surrounding environment and on marine/resource users as outlined below.

8.3.1 Drilling Rig

Drilling rig selection will ensure the operator's capacity for sound environmental management of drilling operations. Factors that will be taken account of will include:

- ☐ Ensure the drilling rig has adequate safety systems such as blow out preventers, alarms and automated shutdown devices which meet regulatory and industry standards and for which adequate maintenance and testing programs are in place;
- ☐ Ensure the drilling rig has safe operating procedures in place which meet regulatory and industry standards including chemicals and waste management aspects, etc;
- ☐ Ensure the drilling rig has efficient solids control and mud circulation systems which maximise recycling of drilling fluids; and
- ☐ Ensure the drilling rig has adequate comminution, containment, drainage and monitoring systems to prevent overboard discharges of unpermitted effluents (e.g. oil, or chemical contaminated effluents, whole food scraps and sewage, etc.

8.3.2 Drilling Muds

In selecting drilling fluids Woodside will take the following into consideration:

- ☐ Where practicable and possible low toxicity water-based drilling fluid formulations will be used;
- ☐ Oil-based formulations will only be used where absolutely necessary; and
- ☐ Where required lubricity or other fluid properties cannot be achieved using a water-based drilling fluid, a synthetic fluid which is of proven low toxicity will be used.

8.3.3 Crew Induction

An environmental and safety induction will be undertaken with crew members prior to commencement of any drilling-related operations. Items that will be covered include:

- ☐ Regulatory requirements for drilling operations;
- ☐ Environmental considerations and special procedures to be used for environment protection in the permit area; and
- ☐ Safety procedures with particular regard for appropriate conduct on vessels and safe use of equipment.

8.3.4 Wildlife Protection

Although no protected species are known to exist in the vicinity of the Sunrise Gas field, should such a situation arise in the future Woodside, will take all reasonable measures to ensure no adverse impacts on significant wildlife resources. These will include:

- ☐ Specifying routes and/or operating procedures for supply vessels and helicopters, which minimise impact on wildlife.

8.3.5 Spills Prevention

Procedures and systems to prevent accidental spills will be implemented throughout the drilling operations and these will include:

- ☐ Safety systems including blowout preventers;
- ☐ Contained oil and chemical, packaging and storage areas;

- Containment around oil and chemical use areas and equipment such as the pipe deck, mud tanks, pumps etc;
- Efficient oil/water separators in bilges (and ballast tanks where not segregated from containment sources); and
- Safe fuel transfer procedures from supply vessel to drilling rig eg checking product transfer hoses for leaks, monitoring tank levels etc.

8.3.6 Chemicals and Hazardous Materials

A chemicals and hazardous material management plan will be adopted taking into account relevant regulatory requirements and environmental considerations such as:

- Provision of Material Safety Data Sheets and handling procedures for hazardous chemicals and materials;
- Provision of appropriate absorbent material and spill clean-up equipment;
- Provision of segregated and contained storage areas; and
- Use of low impact chemicals and materials as far as practicable.

8.3.7 Emergency Response

The emergency response plan will be implemented to deal with all environmental incidents including:

- Oil and Chemical Spills;
- Fire prevention; and
- Diesel or bunker fuel spill.

8.3.8 Waste Management

A project-specific waste management plan will be adopted which will take in to account the regulatory requirements of the P(SL)A, maritime laws and legislation of the Northern Territory Government.

The waste management plan will address the following two areas:

- Discharges to Sea; and
- Solid and Hazardous Waste.

The release of contaminants to the sea from deck wash will be minimised by ensuring the following:

- Absorbents and containers are available in the rig to clean up small accumulations of oil and grease around work areas and decks;
- Accumulations of oil, grease and other contaminants are collected and removed from the deck prior to every washdown;
- Oil-contaminated deck drainage is diverted to a settling tank to allow separation of oil from water (URS, 2001).

8.3.9 Discharges to Sea

- No waste will be disposed overboard except for the following:
    - Comminuted sewage and food wastes;
    - Drilling cuttings and adherent water-based drilling muds;
    - Excess water-based drilling muds at the completion of a well or if different properties apply; and
    - Uncontaminated deck washdown wastes.
- The total volume of discharges will be minimised and recirculation of drilling fluids optimised;
- Drill cuttings and fluid discharges will be analysed to avoid oil contamination;
- Discharges from essential operations such as grouting of the conductor and surface casing strings for eg cement mixture circulation to seabed, surplus cement fluid and powder etc.;

- ☐ To achieve optimal dispersal stage discharges will be implemented eg disposal of excess fluid at the end of well; and
- ☐ Where small amounts of oil additives are added to drilling fluid on a one-off basis, consultation will take place with the Designated Authority on the disposal method – disposal to sea may be considered if concentrations are low, the site environment is suitable and or additional treatment (oil separation) is undertaken.

8.3.10 Air Emissions and Energy Use

- ☐ Minimise emissions from fired machinery and optimise fuel use efficiency;
- ☐ Minimise flaring and emissions from production tests; and
- ☐ Optimise flare burner characteristics to ensure maximum burning of all hydrocarbons produced during production test.

8.3.11 Solid and Hazardous Waste

Non-hazardous wastes may include paper, rope, cardboard, sacking, timbers, metal scrap, domestic packaging and plastic. Hazardous wastes generated during the drilling phases may include chemicals, paints, batteries, oil filters, drilling fluid additives/chemicals, fuel and lubricating oils. The following mitigation measures will be implemented to ensure no adverse impacts on the environment occur:

- ☐ Segregate waste as much as possible and ensure safe storage and labelling of maintenance, chemical packaging, batteries, waste lube oils and other industrial waste for return to shore, recycling and or treatment and disposal in an approved manner;
- ☐ Collection of all solid domestic waste for return to shore and approved disposal; and
- ☐ Retention of oil based drilling fluids and returned to shore for reuse and recycling if possible or alternatively treatment and approved disposal.

No adverse impacts on the environment are expected with the implementation of these mitigation measures.

8.3.12 Physical Presence of Rig

Measures to be implemented to ensure the least possible impact on mariners or other marine users will include:

- ☐ Advance notification of the presence of the rig to local fishermen and other relevant parties;
- ☐ Ensure radio watch on shipping traffic and fishing vessels; and
- ☐ Notification of the Australian Maritime Safety Authority of the rig location and anchor distances.
- ☐ Adequate lighting of the rig.

8.3.13 Commitments

- ☐ Prepare a Drilling Environment Plan;
- ☐ Minimise flaring where possible;
- ☐ Obtain approval for non-water based drilling fluids. An Environment Plan will be drawn up and approved for the drilling programme prior to commencement;
- ☐ Implement an Emergency Response Plan (ERP);
- ☐ Implement WEL existing Timor Sea Oil Spill Contingency Plan. Amend this plan if required;
- ☐ Induct all personnel with particular attention given to correct handling of chemicals and pollution prevention requirements; and
- ☐ Issue Notice to Mariners alerting them of development and associated activities.

8.4 Impacts During Installation and Construction

Table 8-10 overleaf summarises the source of impact, potential environmental impacts, their effect and duration for the Installation and Construction phase which includes:

- ☐ Subsea Facilties;
- ☐ PCUQ platform and FSO; and
- ☐ Subsea pipeline construction.

8.4.1 Subsea Facilities

The installation and construction of subsea facilities linking the wells to the Wellhead and PCUQ Platforms entails the construction of wellheads, manifolds, flow lines and risers. The subsea gas export pipeline from the Sunrise field to the Wye piece is discussed separately in **Section 8.4.3.** The activities associated with the installation and construction of subsea facilities and potential environmental impacts are discussed in the following sections. The sources of impacts identified during the impact assessment were as follows:

- ☐ Installation of subsea facilities;
- ☐ Anchoring of construction vessel(s);
- ☐ Discharge of sewage and greywater;
- ☐ Discharge of domestic waste including food scraps;
- ☐ Disposal of domestic waste including paper, packaging, plastics etc;
- ☐ Power generation; and
- ☐ Refuelling at sea.

In relation to these sources, the following potential impacts are discussed in **Sections 8.4.1.1** to **8.4.1.4**:

Atmospheric Emissions:

- ☐ Greenhouse gases produced by vessel power generation (primarily CO_2);
- ☐ Atmospheric pollutants (primarily NO_x, SO_x, VOCs and smoke/particulates);

Discharges to the Sea:

- ☐ Potential significant fuel spill.

Noise, Vibration, Light and Heat:

- ☐ Potential disturbance to marine organisms and birds.

Waste to Shore:

- ☐ Improper disposal.

8.4.1.1 Atmospheric Emissions

Power will be required to install and construct subsea facilities. Power will be produced from diesel generators that will result in the emissions of CO_2, NO_x and other gases, smoke and particulates to the atmosphere. The diesel consumption rates have been estimated at between 10 and 30 tonnes per day. The emissions will not result in a significant reduction in air quality as the project area is isolated and far from sensitive receptors.

Table 8-10 Summary of Potential Environmental Impacts for Installation and Construction

Project Component	Source of Impact	Potential Environmental Impact	Effect	Duration
Subsea Facilities (well heads, manifolds, flowlines, risers, etc.)	a) Installation of subsea facilities. b) Anchoring of construction vessel(s) c) Discharge of sewage and greywater. d) Discharge of domestic waste including food scraps. e) Disposal of domestic waste including paper and plastics etc. f) Power generation. g) Refuelling at sea.	**Atmospheric Emissions** ▪ Greenhouse gases produced by vessel power generation (primarily CO_2).	Negligible	Short-term
		▪ Atmospheric pollutants (primarily NO_x, SO_x, VOCs and smoke/particulates);	Negligible	Short-term
		Discharges to the Sea ▪ Potential significant fuel spill.	Minor	Temporary
		Noise, Vibration, Light and Heat ▪ Potential disturbance to marine organisms and birds.	Negligible	Temporary
		Waste to Shore ▪ Improper disposal.	Negligible	Temporary
PCUQ Platform and FSO	a) Transportation of the PCUQ Platform and FSO to site. b) Power generation. c) Installation of the PCUQ Platform and the FSO on site. d) Physical presence of PCUQ Platform and FSO. e) Installation of foundations of the PCUQ platform. f) Lighting. g) Presence of construction and support vessels. h) Installation of mooring for the FSO.	**Atmospheric Emissions** ▪ Greenhouse gases produced by vessel power generation (primarily CO_2)	Negligible	Short-term
		▪ Atmospheric pollutants (primarily NO_x, SO_x, VOCs and smoke/particulates).	Negligible	Short-term
		Discharges to the Sea ▪ Potential reduction in water quality in the area.	Negligible	Short-term
		Noise, Vibration, Light and Heat ▪ Potential disturbance to marine organisms and birds.	Negligible	Short-term
		▪ Potential attraction of marine organisms to the lights.	Negligible	Short-term
		Waste to Shore ▪ Improper disposal.	Negligible	Temporary
Subsea Pipeline	a) Potential pre-sweep along pipeline route b) Prelay with rock dump. c) Laying of pipeline on seabed. d) Hydrotesting	**Atmospheric Emissions** ▪ Greenhouse gases produced by vessel power generation (primarily CO_2) and vehicles	Negligible	Short-Term
		▪ Atmospheric pollutants (primarily NO_x, SO_x, VOCs & smoke/particulates).	Negligible	Short-Term
		Discharges to the Sea ▪ Smothering of benthos.	Negligible	Temporary
		Noise, Vibration, Light and Heat ▪ Potential disturbance to marine organisms and birds.	Negligible	Temporary
		Waste to Shore ▪ Improper disposal.	Negligible	Temporary
		Other Impacts ▪ Disturbance due to repositioning of anchors.	Negligible	Temporary
		▪ Temporary disruption of commercial, recreational fisheries and recreational areas.	Negligible	Temporary

8.4.1.2 Discharges to Sea

The discharge of wastewater, chemicals and domestic waste has the potential to reduce the quality of water surrounding the Sunrise area. A variety of waste products will be generated and a number of chemicals will be used during construction. These may include:

- ☐ Potential discharge of domestic waste including food scraps;
- ☐ Discharge of sewage and greywater; and
- ☐ Refuelling at sea.

The potential environmental impacts that may result from the above discharges include the potential occurrence of a significant fuel spill.

Sewage and Putrescible Waste

The workforce upon vessels required for the installation and construction of subsea facilities will generate sewage and putrescible wastes (refer to **Section 8.2.1.1**). The discharge of domestic waste may lead to the localised reduction in water quality, including increased nutrient availability. As a result, this routine discharge of waste to the sea is considered to have a negligible impact.

Fuel Spills

A fuel spill could occur during the transfer of fuel during the process of refuelling. Spills are likely to be small and result from handling losses rather than significant ruptures of hoses and tanks. The spills will be localised and expected to disperse and volatilise rapidly. It is very unlikely that small spills of lighter than water oils will reach the seabed or any of the shallow shoals located about 30 km to the south-west of the Sunrise Gas Project area. Fuel spills will result in a negative impact to the quality of surrounding waters; however, as a result of rapid dispersion and mixing the impact will be temporary. A description of the impacts associated with larger diesel spills is provided in **Section 8.6.1.2**.

8.4.1.3 Noise, Vibration and Light

Noise and Vibration

Noise and vibration associated with the installation and construction of subsea facilities will be minimal and of a much reduced level than emissions expected during the installation of the wellhead platform (**Section 8.2.1.3).** The effects of noise and vibration on marine fauna are discussed in **Section 8.2.1.3.** It is possible that marine fauna will be disturbed by the activities and emissions of noise and vibration from construction. Such disturbance is very unlikely to be harmful to marine fauna as they are highly mobile and will be expected to avoid the area. This impact is temporary and of a short duration.

Light

Industrial lighting will be required during the installation and construction of subsea facilities to comply with regulatory safety requirements. There is a potential that turtles may be attracted to the area by light falling on the sea surface; however, such an attraction is not considered to be adverse as turtles are able to move away from the area if they are disturbed (refer to **Section 8.2.1.3)**. Light is more of a concern for turtle hatchlings near shore (refer to **Section 8.2.1.3)**.

8.4.1.4 Waste to Shore

A variety of construction wastes will be generated during the installation and construction of subsea facilities. The disposal and resultant environmental impacts from construction wastes have been previously discussed in **Section 8.2.1.4**.

8.4.2 PCUQ Platform and FSO

The installation of the PCUQ Platform and FSO involves their transportation to site and fixing them into position. Both facilities are to be fabricated elsewhere. The activities associated with the installation of these facilities and potential environmental impacts are discussed in the following sections. The sources of impacts identified during the impact assessment were as follows:

- Transportation of the PCUQ Platform and FSO to site;
- Power generation;
- Installation of the PCUQ Platform and FSO on site;
- Physical presence of PCUQ Platform and FSO;
- Installation of foundations of the PCUQ Platform;
- Lighting;
- Presence of construction and support vessels; and
- Installation of mooring for the FSO.

In relation to these sources, the following potential impacts are discussed in **Sections 8.4.1.1** to **8.4.1.4**:

Atmospheric Emissions:

- Greenhouse gases produced by vessel power generation (primarily CO_2); and
- Atmospheric pollutants (primarily NO_x, SO_x, VOCs and smoke/particulates);

Discharges to the Sea:

- Potential reduction in water quality in the area

Noise, Vibration, Light and Heat:

- Potential disturbance to marine organisms and birds; and
- Potential attraction of marine organisms such as turtles to the lights.

Waste to Shore:

- Improper disposal.

8.4.2.1 Atmospheric Emissions

Power will be required to install and construct the PCUQ Platform and to connect the FSO. Power during installation will be produced from diesel generators that will result in the emissions of combustion gases, smoke and particulates. Atmospheric emissions associated with the operation of diesel generators and resultant environmental impacts will have a negligible impact on the environment.

8.4.2.2 Discharges to Sea

The discharge of wastewater and domestic waste has the potential to reduce the quality of water surrounding the Sunrise Gas Project area during the establishment of the PCUQ platform and the FSO on site. These are also generated during the installation and construction of other project facilities and may include:

- Potential discharge of domestic waste including food scraps; and
- Discharge of sewage and greywater.

These potential environmental impacts and discharges to sea have been previously discussed in **Section 8.4.1.2** and will have a negligible impact on the environment.

8.4.2.3 Noise, Vibration and Light

Noise and Vibration

Noise and vibration associated with the installation of the PCUQ Platform and the FSO will be generated from the establishment of foundations and vessel engines. Acoustical emissions are expected to be similar in magnitude as those generated during the installation of the wellhead platform (**Section 8.2.1.3)**. The effects of noise and vibration on marine fauna are discussed in **Section 8.2.1.3**.

It is likely that marine fauna will be disturbed by the activities and emissions of noise and vibration from construction. Such disturbance is very unlikely to be harmful to marine fauna as they are highly mobile and will be expected to avoid the area. Noise and vibration is, therefore, expected to have a negligible impact on the environment.

Light

There is a potential that turtles may be attracted to the area by the lights, however such an attraction is not considered to be adverse as turtles are able to move away from the area if they are disturbed. The impacts of lighting on marine fauna have been previously discussed in **Section 8.2.1.3**.

8.4.2.4 Waste to Shore

Only a small quantity of waste will be generated during the installation of the PCUQ Platform and the FSO. The disposal and resultant environmental impacts have been previously discussed in **Section 8.2.1.4**.

8.4.3 Subsea Pipeline Construction

The proposed subsea pipeline will extend along a 218 km route to the proposed location of the Bayu-Undan ‘Wye’ piece. Sections of the route may require preparation prior to the pipeline being laid on the sea bed which may include a pre-sweep and pre-lay with rock armour to provide stability and protection for the pipeline. The sources of impacts related to pipeline construction as identified during the impact assessment are as follows:

- ☐ Potential pre-sweep along pipeline route;
- ☐ Potential pre-lay with rock armour;
- ☐ Laying of pipeline on seabed; and
- ☐ Hydrotesting.

In relation to these sources, the following potential impacts are discussed in **Sections 8.4.1.1** to **8.4.1.4**:

Atmospheric Emissions:

- ☐ Greenhouse gases produced by vessel power generation (primarily CO_2) and vehicles; and
- ☐ Atmospheric pollutants (primarily NO_x, SO_x, VOCs and smoke/particulates);

Discharges to the Sea:

- ☐ Smothering of benthos.

Noise, Vibration, Light and Heat:

- ☐ Potential disturbance to marine organisms and birds.

Waste to Shore:

- ☐ Improper disposal.

Other Impacts:

- ☐ Temporary disruption of fisheries and recreational areas; and
- ☐ Disturbance due to repositioning of lay barge anchors.

8.4.3.1 Atmospheric Emissions

Atmospheric emissions, primarily CO_2 associated with the operation of the subsea pipelaying barge will result in negligible short term environmental impacts. The barge may also emit vapours containing VOCs and small quantities of other pollutants to the atmosphere during pipelaying. The potential environmental impact associated with these atmospheric emissions is a reduction of air quality. Release and venting of gases during operations will be minimal and negligible. Any impact that may occur to air quality will be localised. As a result, atmospheric emissions from the FSO are considered to have a negligible short term impact.

8.4.3.2 Discharges to Sea

Installation of the subsea pipeline will result in routine discharges to sea including sewage and putrescible waste. There is the potential for fuel spills to occur and water containing biocides, corrosion inhibitors and oxygen scavenger will be discharged following hydrotesting. The potential environmental impacts associated with each of these potential discharges have been previously discussed in **Sections 8.2.2.2** and **8.4.1.2**.

Disturbance to the seabed is unlikely to affect water quality and the associated increase in turbidity is likely to be minimal. The preparation of the seabed and the laying of the pipeline will have a direct impact on the seabed and the benthic communities it supports. Direct disturbance and loss of organisms will occur in areas that are directly impacted. These impacts are considered to be localised and of a short duration. The benthos present along the pipeline route is common and widespread and would quickly recolonise the impacted area.

8.4.3.3 Noise, Vibration and Light

Noise and vibration associated with the installation of the subsea pipeline will be minimal. The effects of noise and vibration on marine fauna are discussed in **Section 8.2.1.3.** Such disturbance is very unlikely to be harmful to marine fauna as they are highly mobile and will be expected to leave and avoid the area.

There is a potential that turtles may be attracted to the area by the lights, however such an attraction is not considered to be adverse as turtles are able to move away from the area if they are disturbed. The impacts of lighting on marine fauna have been previously discussed in **Section 8.2.1.3**.

8.4.3.4 Waste to Shore

A variety of construction wastes will be generated during the installation of the subsea pipeline. The disposal and resultant environmental impact from construction wastes has been previously discussed in **Section 8.2.1.4**.

8.4.3.5 Other Impacts

- Potential for Localised Scouring:

Evidence of sediment transport processes is seen in Beagle Gulf, where seabed currents are relatively high. In the waters of the subsea export pipeline route, currents are lower and scour and other transport phenomena are not expected nor have they been noted during the course of the surveys undertaken to date. Consequently, the stability of the pipeline is unlikely to be impacted from scouring by tidal movements within the vicinity of the pipeline. This aspect is presently being considered in the design of the pipeline and appropriate measures will be undertaken to ensure that the integrity of the pipeline is maintained at all times.

- Disruption to Commercial Fisheries:

During the installation of the subsea pipeline, commercial fishing along the route of the pipeline may be impacted by an anchoring exclusion zone. This zone will ensure that damage to the pipeline from vessels will be minimised. Consultation with all relevant fishery organisations and the Seafood Council will take place at an early stage to ensure a satisfactory agreement is reached.

8.5 Mitigation Measures During Installation and Construction

8.5.1 General Measures

Due to the fact that the wellhead and PCUQ platforms will not be constructed offshore but towed to site and assembled in place, there will be very little in the way of construction on site thereby ensuring minimal waste generation. Installation of the platforms will occur over a very short period of time thereby minimising any impacts on the surrounding environment. Mitigation measures will focus on issues such as waste management, air and noise emissions and restriction of the development to the defined project area.

During construction and installation Woodside will include the following mitigation measures to avoid any adverse impacts on the environment:

- Charts of the route and notification will be given to marine users prior to construction/installation;
- Navigation and safety lighting will be provided to ensure that any shipping or recreational activities are able to clearly identify the presence of activity;
- Woodside will confine activities to the minimum development area required to minimise the area impacted;
- Work areas will be kept to a minimum with pipeline laying restricted to at most a 10 km width corridor. Within this corridor pipe laying operations will occur with a 1 km corridor in as much as is possible. Any pre-lay rock armour that may be required, will be confined to a much smaller area usually 10 m in width;
- Woodside will endeavour to minimise all disturbance to marine life and fisheries. However, as no breeding areas are affected by the development impacts will be kept to a minimum;
- Minimise all air emissions and discharges. Efficient planning of vehicle and vessel movements will minimise fuel usage;
- All waste will be managed in accordance with a project–specific waste management plan and in accordance with current waste legislation;
- All chemicals will be managed in accordance with a project–specific chemicals management plan; and
- Any rock dumping along the pipeline route will be kept to a minimum.

8.5.2 Marine Support Vessels

All marine support activities must comply with maritime laws and implement good environmental working standards. These will include the following:

- All support services are conducted in accordance with relevant legislation and the operating companies requirements;
- Goods and materials are properly package, labelled for transportation and transfer;
- Refuelling and similar operations will be conducted in accordance with port authority requirements and all hoses, fittings and fail-safe devices will be fully operational;
- Efficient oil/water separation in bilges and disposal of clean bilge water in offshore areas, where permitted;
- No disposal of wastes en route from offshore facilities to shore base;
- Comminution of sewage and food waste and disposal in offshore areas only where permitted and containment of sewage and food wastes for onshore disposal when in nearshore waters; and

- The collection of own wastes for return to shore and correct disposal.

8.5.3 Commitments

Woodside, or any future operator, will adhere to the following commitments during the Installation and Construction Phase of the Project:

- Minimise flaring where possible; and
- Install breakaway self-sealing couplings on floating hoses that contain condensate.

8.6 Impacts During Commissioning and Operation

Table 8-11 summarises the source of impact, potential environmental impacts, their effect and duration for the Commissioning and Operation phase which includes:

- Wellhead and PCUQ Platforms including Subsea Facilities;
- FSO and Shuttle Vessels; and
- Subsea Pipeline.

8.6.1 Wellhead and PCUQ Platforms including Subsea Facilities

Once installed, the Wellhead, PCUQ Platforms and associated subsea facilities would be commissioned and then function for the lifetime of the Sunrise Gas Project which is expected to be in the order of 30 years. The sources of impacts resulting from the operation of the Wellhead and PCUQ platforms and the subsea facilities are as follows:

- Potential blowout of wellhead;
- Hydrotesting of facilities;
- Potential rupture of flowline or riser;
- Potential diesel spill;
- Potential condensate spill;
- Emergency shutdown of facility;
- Discharge of Produced Formation Water (PFW);
- Discharge of cooling water;
- Disposal of waste associated with maintenance of the platforms;
- Discharge of potentially contaminated stormwater from machinery, workshop, deck wash-down areas, oily water, waste oil and lubricants;
- Discharge of sewage and greywater;
- Disposal of domestic waste including food scraps;
- Potential collision of shuttle tanker or supply vessels with platforms;
- Operational noise;
- Power generation and compression turbines producing greenhouse gas emissions; and
- Hazardous materials.

In relation to these sources, the following potential impacts are discussed in **Sections 8.6.1.1** to **8.6.1.5**:

Atmospheric Emissions:

- Significant emission of greenhouse gases due to export compression;
- Significant emission of greenhouse gases due to power generation;
- Significant emission of greenhouse gases due to flaring; and
- Significant emission of smoke and particulates.

Discharges to the Sea:

- Potential significant hydrocarbon contamination from condensate spill;
- Potential significant hydrocarbon contamination from diesel spill;
- Potential significant impact from PFW discharge;

- Potential reduction in local water quality; and
- Potential reduction in water quality due to hydrotesting (biocides, scale and corrosion inhibitors and oxygen scavengers).

Noise, Vibration, Light and Heat:

- Potential disturbance to marine organisms and birds.

Waste to Shore:

- Improper disposal.

Table 8-11 Summary of Potential Environmental Impacts for Commissioning and Operation

Project Component	Source of Impact	Potential Environmental Impact	Effect	Duration
Wellhead Platform, Processing, Compression, Utilities and Quarters (PCUQ) and Subsea Facilities	a) Potential blowout of wellhead. b) Hydrotesting of facilities. c) Potential rupture of flowline or riser. d) Potential diesel spill. e) Potential condensate spill. f) Emergency shutdown of facility. g) Discharge of Produced Formation Water (PFW). h) Discharge of cooling water. i) Disposal of waste associated with maintenance of the platforms. j) Disposal of oily water, waste oil, etc. k) Discharge of sewage and greywater. l) Disposal of domestic waste including food scraps. m) Potential collision of shuttle tanker or supply vessels with platforms. n) Operational noise. o) Power generation and compression turbines producing greenhouse gases emission to air. p) Hazardous materials	**Atmospheric Emissions** ▪ Significant emission of greenhouse gases due to export compression. ▪ Significant emission of greenhouse gases due to power generation. ▪ Significant emission of greenhouse gases due to flaring. ▪ Significant emission of smoke and particulates. **Discharges to the Sea** ▪ Potential significant hydrocarbon contamination from condensate spill. ▪ Potential significant hydrocarbon contamination from diesel spill. ▪ Potential significant hydrocarbon from PFW discharge. ▪ Potential reduction in local water quality. ▪ Potential reduction in water quality due to hydrotesting **Noise, Vibration, Light and Heat** ▪ Potential disturbance to marine organisms and birds. **Waste to Shore** ▪ Improper disposal. **Other Impacts** ▪ Creation of hard substrate that could be colonised by marine pest species. ▪ Recolonisation of a different community to that originally found in the area.	Minor Minor Minor Negligible Moderate Minor Negligible Negligible Negligible Negligible Negligible Negligible Minor	Long-term Long-term Short-term Long-term Temporary Temporary Long-term Short-term Short-term Long-term Long-term Long-term Long-term
FSO and Shuttle Vessels	a) Potential spill during condensate transfer to shuttle tankers. b) Ballast water discharge from offtake tankers once on site. c) TBT and other antifoulant paints on tankers. d) Vessel hulls fouled with exotic marine organisms. e) Cargo tank venting to atmosphere. f) Potential collision with shuttle tankers or supply vessels. g) Power generation emissions. h) Discharge of sewage and greywater. i) Disposal of domestic waste including food scraps.	**Atmospheric Emissions** ▪ Cargo tank emissions from loading of FSO and shuttle tankers. **Discharges to the Sea** ▪ Contamination of marine environment by anti-fouling agents. ▪ Introduction of marine pest species from offtake tanker de-ballasting and hullfouling. ▪ Potential significant hydrocarbon contamination from condensate spill. ▪ Potential significant hydrocarbon contamination from diesel spill. **Othe Impacts** ▪ Interference with shipping.	Negligible Negligible Moderate Moderate Minor Negligible	Long-term Long-term Long-term Temporary Temporary Long-term
Subsea Pipeline	a) Potential rupture of pipeline. b) Hydrotesting of pipeline. c) Physical Presence of the pipeline.	**Atmospheric Emissions** ▪ Potential emissions of natural gas in the event of a leak. **Discharges to the Sea** ▪ Potential reduction in local water quality due to release of hydrotest water (biocides, corrosion inhibitors and oxygen scavengers).. **Othe Impacts** ▪ Physical presence of pipeline.	Significant Negligible Negligible	Long-term Temporary Long-term

Other Impacts:

- ☐ Creation of hard substrate that could be colonised by marine pest species;
- ☐ Recolonisation of a different community to that originally found in the area; and
- ☐ Attraction of seabirds and turtles to the production facility.

8.6.1.1 Atmospheric Emissions

During commissioning and operation, greenhouse gases and air pollutants will be emitted to the atmosphere as a result of the following activities:

- ☐ Export compression;
- ☐ Power generation for equipment, utilities and support;
- ☐ Routine flaring (eg flare line purging for safety purposes); and
- ☐ Flaring during emergency shutdown.

The former three activities will occur continuously. After a 3-month commissioning period, emergency flaring is only expected to occur on an infrequent basis. Minor atmospheric emissions will also be expected from venting.

The following environmental impacts will occur:

- ☐ Emissions of greenhouse gases due to compression (primarily CO_2);
- ☐ Emissions of greenhouse gases due to power generation (primarily CO_2);
- ☐ Emissions of greenhouse gases due to flaring (primarily CO_2); and
- ☐ Emissions of smoke and particulates.

Power Generation and Compression

Power generation will require ~12 MW of power on an ongoing basis. Compression (of export gas from Sunrise to Darwin) will require ~90 MW of power, also on an ongoing basis. The power generation and gas export compression turbines, combined, are expected to emit between 600,000 and 700,000 tonnes CO_2 per annum, and ~5000 tonnes NO_x per annum. The CO_2 emissions will contribute to the greenhouse inventory. Greenhouse emissions are expected to be one of the largest emissions associated with the facility. Woodside will minimise greenhouse emissions, through selection of energy efficient turbines and other equipment, and by making efforts to integrate waste heat recovery into facility designs.

The combustion processes will also emit NO_x, SO_x and CO, which are considered air pollutants. These emissions will not impact any nearby sensitive receptors, as the project area is isolated and far from sensitive receptors. The expectation is that no air quality standards, eg National Air Quality Protection Measures (NEPMs) will be exceeded for exposure to people outside the immediate area.

Flaring

Flaring will be minimised as the Wellhead and PCUQ Platforms can be started up once the pipeline to the Wye piece has been hydrotested. This will allow power generation (~12 MW) mostly using Bayu-Undan gas rather than imported diesel. Export gas compression (~90 MW) will only be applicable once Sunrise gas is being generated for export (in excess of Sunrise power generation requirements).

Baseload, sustained flaring is expected to be roughly 25 tonnes/day for line purging, etc. This rate is relatively low compared to other offshore facilities, as design efforts have been undertaken to minimise flaring which will reduce the loss of saleable export gas. Occasionally, upset flaring will occur for short periods (hours) during the project's 3-month commissioning period. Philosophically, Sunrise is a gas project rather than a liquids (oil/condensate) project. Therefore, the economics of the project are predicated on the successful export of essentially all the gas not needed for power generation and compression. The project's Joint Venture Partners (JVPs) will not allow sustained flaring of saleable gas product at significant rates (or inefficient power generation/compression turbines) as this would make the project uneconomic.

8.6.1.2 Discharges to Sea

The discharge or accidental spillage of condensate, diesel, solid wastes or chemicals has the potential to degrade the quality of water surrounding the facility. A variety of waste products will be generated and a number of chemicals will be used during operation.

The environmental impacts from discharges and spills to the ocean will be varied depending upon the nature of the waste, chemical or substance entering the marine environment and the quantity that is released. The potential environmental impacts associated with the discharge of produced formation water, deck drainage, sewage and putrescible wastes, chemicals and hydrocarbon spills and cooling water, and are discussed in detail below.

Produced Formation Water (PFW)

Treated Produced Formation Water (PFW) will most likely be discharged to the ocean. However, the potential exists for PFW to be reinjected into a dedicated shallow well. This option will be considered during the detailed design phase. PFW will be discharged at a rate of approximately 4,000 barrels/day over the life of the project and is likely to contain 20–30 mg/L oil-in-water following treatment. At these rates a maximum volume of entrained oil of 13–20 kg/day will be discharged. Produced formation water will disperse rapidly. The rate of dispersion will depend on the characteristics of the produced water (ie salinity and temperature), and the mixing energy of the receiving waters. It should be noted that the volume of PFW increases greatly for a few years after year 10 as the Troubadour wells come onstream. The volume decreases soon after, as some wells die or are shut in due to too much water production. Predicted PFW volumes are shown in **Table 8-12.**

Table 8-12 Predicted Produced Formation Water Volumes

Start Up	Year	PFW Volume (bpd)	No. of Wells
2005	0		4
2006	1	348	6
2007	2	376	7
2008	3	440	9
2009	4	443	10
2010	5	609	12
2011	6	695	12
2012	7	1029	13
2013	8	1287	14
2014	9	1816	16
2015	10	1696	18
2016	11	2220	19
2017	12	3011	20
2018	13	2923	20
2019	14	3629	21
2020	15	707	22
2021	16	763	22
2022	17	1060	22
2023	18	1706	22
2024	19	2833	22

Start Up	Year	PFW Volume (bpd)	No. of Wells
2025	20	5314	22
2026	21	11411	22
2027	22	16702	22
2028	23	18040	22
2029	24	9240	22
2030	25	9690	22
2031	26	6492	22
2032	27	4074	22
2033	28	5789	22
2034	29	9165	22
2035	30	8831	22
2036	31	3286	22
2037	32	3337	22
2038	33	3084	22
2039	34	2036	22
2040	35	2227	22
2041	36	2187	22
2042	37	2170	22
2043	38	2165	22
2044	39	2171	22
2045	40	2201	22

The potential environmental impacts associated with the discharge of PFW include:

- ☐ Potential oil-in-water exceedance;
- ☐ Potential change to water temperature, salinity and turbidity; and
- ☐ Chronic toxic effects on sensitive organisms and ecosystems.

Considering the discharge of PFW to the ocean as the 'base case', a high level of dilution and dispersion is expected to minimise the impacts on sensitive organisms and ecosystems. It has been estimated that sensitive species are unlikely to be affected by discharge of PFW at dilutions greater than 1:1,000 (Swan *et al.*, 1994) which is estimated to be within approximately 100 m of the discharge point.

Produced formation water is known to contain a combination of hydrocarbons, heavy metals, nutrients and naturally occurring radioactive materials. Whole effluent ecotoxicological investigations at the Buffalo Field have shown that a dilution of 1:33 was sufficient to reduce the toxicity of PFW to a level where the test organisms (marine algae, rock oyster and urchins) were unaffected (No Observed Effects Concentration). This dilution was achieved within 50 m of the production facility in worst-case conditions of no wind and neap tides (SKM, 2001).

Marine organisms likely to be impacted are those in the vicinity of the discharge outlet. Pelagic fish have the ability to avoid the produced water plume or only be exposed to it temporarily, however, documented evidence is not presently available. Planktonic species are known to be abundant and have rapid turnover rates (LeProvost Dames & Moore, 1997). The impact of produced formation water on planktonic organisms is considered to be potentially adverse locally but of no regional significance.

Deck Drainage

No wastes will be routinely discharged via deck washdown. Detergent washdown of the decks may result in minor quantities of chemical residues such as oil and grease and pipe dope entering the direct overboard drain. Drainage water with significant oil contamination is sent to the oil/water separator and oil is decanted. No significant impacts are anticipated because of the minor quantities of overboard discharges involved and the localised area of impact.

Sewage and Putrescible Wastes

Sewage and putrescible wastes will be disposed of in accordance with Clauses 222 and 616 of the schedule of the *Petroleum (Submerged Land) Act – Schedule 1995*, which requires that food scraps and sanitary effluents be passed through a grinder or comminuter so that final product will pass through a screen <25 mm diameter prior to disposal to the sea. Discharges will occur on a more or less continual basis. There will be a temporary increase in nutrient availability; however, it is expected that considerable dilution and dispersion will occur ensuring that any increase will be negligible.

Increased nutrient availability may result in the attraction of marine organisms. This is not considered to lead to any adverse impacts. Marine organisms will be able to move away and avoid the area if the proposed activities disturb them.

Diesel Spill

Facilities will be designed to minimise the risk of any diesel spill. An Oil Spill Contingency Plan (OSCP) already exists for the area which will be updated if necessary to include the Sunrise Gas Project.

Modelling undertaken by Asia-Pacific ASA for a diesel spill scenario at the production facility indicates that it is unlikely that diesel fuel will make contact with any shorelines or exposed reefs prior to evaporation or decay. Diesel spills may result from the potential rupture of storage tanks, leakage or damage to hoses and overfilling of storage tanks. A simulation was carried out for a diesel spill of 50 m^3 at the surface over a period of 6 hours using the three dimensional oil spill trajectory and fates model, SIMAP. Diesel spills are expected to be moderately volatile and have a high proportion of residual oil, which will resist evaporation after loss of approximately 80% of the initial volume. This residual oil will have a relatively high density and will thus be easily entrained where it may not be detectable to an observer. The residue would continue to disperse and decay over time.

The probability of surface exposure and the highest predicted concentration of diesel at surface locations surrounding the production facility during summer conditions is provided in **Figure 8-7** and **Figure 8-8.** The spill disperses to the north-east over the Timor Trench with highest worst case maximum surface oil masses of 13 g/m^2 at the production facility that rapidly disperses to surface masses between 0.1 and 1.0 g/m^2. Corresponding winter conditions are provided in **Figure 8-9** and **Figure 8-10** which illustrates spill dispersion in a southwest direction and corresponding transitional season conditions are provided in **Figure 8-11** and **Figure 8-12**. The spill disperses to the south-west along the continental shelf with highest worst case maximum surface oil masses of 14 g/m^2 at the production facility that rapidly disperses to surface masses between 0.1 and 1.0 g/m^2. Diesel spills occurring in the transition season are subject to less dispersion across the surface and are contained closer the production facility. These differences between the seasons largely reflect the seasonal differences in the wind patterns.

Maximum mean concentrations of dissolved aromatic hydrocarbons resulting from a diesel spill do not exceed 6.0 ppb at any location within the water column during summer conditions. These concentrations are comparable to the interim guideline (ANZECC/ARMCANZ 2000) which stipulates acceptable criteria of 7 µg/L (ppb). Spills will not impact on the island of Timor nor the Indonesian Archipelago. Entrainment of oil from a spill is not predicted to reach shallow water environments or to deeper water banks in the area.

Condensate Spills and Blowouts

A well or other subsea blowout such as a complete flowline rupture is a major emergency scenario that could result in uncontrolled discharges to sea. A blowout occurrence is highly unlikely and requires a systems failure to result in loss of well control, usually beginning with loss of formation pressure control with the fluid system. In Australia, there have been six well blowouts since offshore drilling operations commenced in the 1960's. Oil was spilled to the sea in only one case and the volume spilt was small. As a result of technological and procedural improvements, there has not been a blowout since 1984 (Woodside, 1998). The likelihood of a blow-out is therefore deemed a low risk.

Product spill from a potential blow-out was modelled by Asia Pacific ASA for a release scenario of 1,113 m^3 of condensate at the seabed (162 m below mean sea level) over a period of about 12 hours. This scenario represents the expected loss of condensate from the full-flow release potential of one of the production flow lines leading to the platform. The full-blown release potential for a typical well case is 350 mmcf/day, of which the condensate to gas ratio would be 40 bbl/mmcf. Thus, an estimated 14,000 bbl (2,226 m^3) of condensate will be lost per day. Spill modelling was undertaken for an inventory of 1,113 m^3 over 12 hours on the basis that the well would be isolated over this period. Entrainment of oil from a spill is not predicted to reach shallow water environments or to deeper water banks in the area.

Hydrotesting

The potential environmental impacts that may result from the discharge of chemicals & water during and after hydrotesting of flowlines and risers include the reduction in water quality and the use of biocides, scale and corrosion inhibitors and oxygen scavengers.

Hydrotesting of flowlines and risers involves the injection of filtered seawater comprising small quantities of additives including biocide, corrosion inhibitors and oxygen scavenger. Hydrotesting will be undertaken immediately following the construction and connection of the lines to ensure that no leakages occur, the lines are clean and capable of carrying the product at high pressure.

To ensure that the entire lengths of all flow lines and risers are treated with hydrotest water, a slightly greater volume of hydrotest water to the capacity of all lines will be injected. A small volume will be allowed to escape from the downstream end (at the wells and manifolds). At the conclusion of hydrotesting, during the commissioning phase when hydrocarbons are first flowed from the wells to the platforms, the hydrotest water will be discharged to the sea, from the PCUQ platform.

The concentrations of the chemical additives in hydrotest water will be carefully determined. For example, with oxygen scavenger, the plan is to add just enough to remove the oxygen normally present in the volume of seawater needed, adjusting for the seawater's temperature (which determines oxygen content, in mg/L). For biocide, the plan is to add just enough to kill the bacteria in the filtered seawater without overdosing. Normally, the biocides selected also degrade quickly with time, so as to to make any residual biocide in the hydrotested line as environmentally non-impacting as possible upon discharge. The additives will be in a diluted form in hydrotest water and when discharged to the sea will be further diluted to extremely low concentrations that are expected to be harmless to sensitive communities and marine organisms in the area. The discharge of hydrotest water is considered to result in a negligible impact.

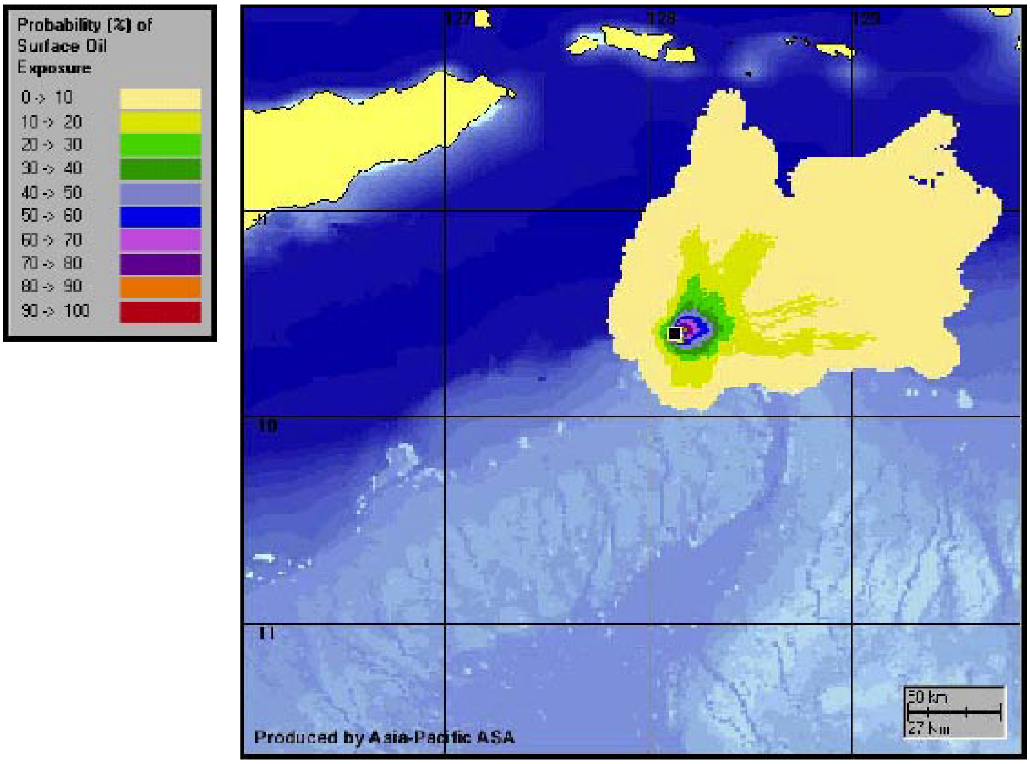


Figure 8-7 Probability of Surface Exposure to Diesel During Summer Conditions

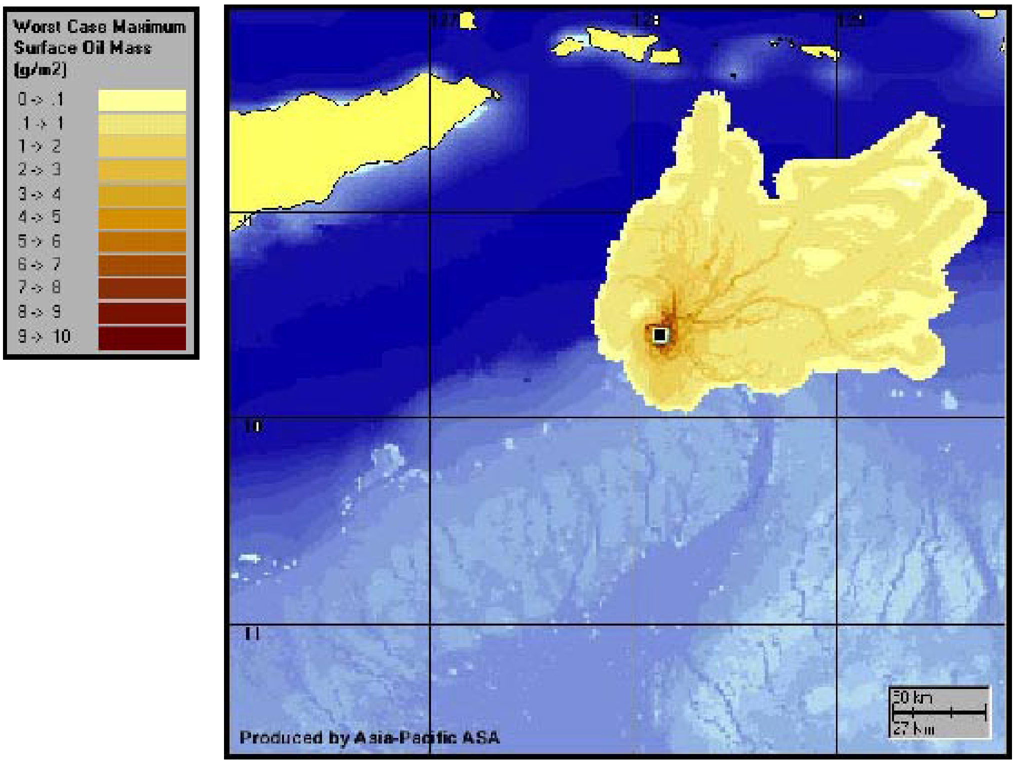


Figure 8-8 Predicted Surface Diesel Concentration During Summer Conditions

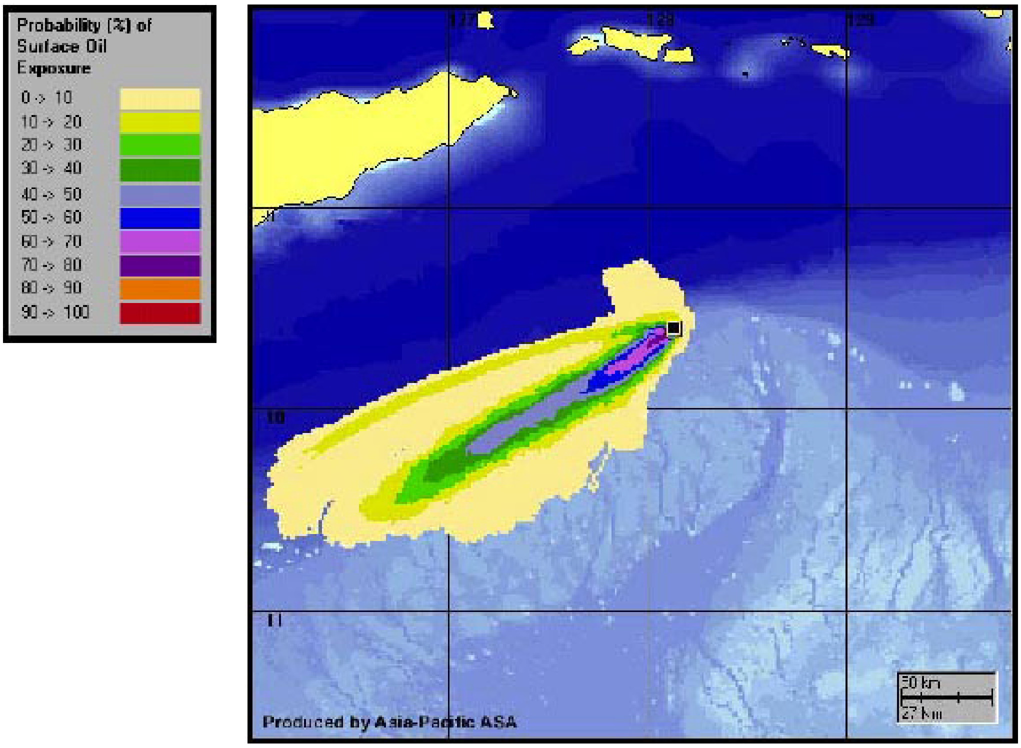


Figure 8-9 Probability of Surface Diesel Exposure During Winter Conditions

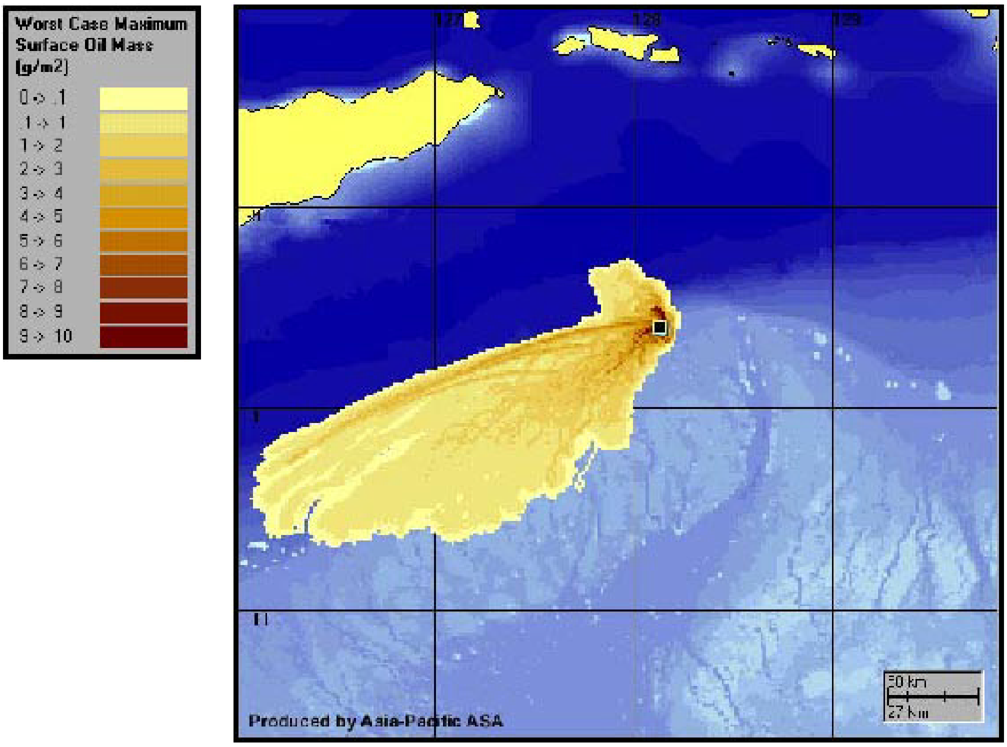
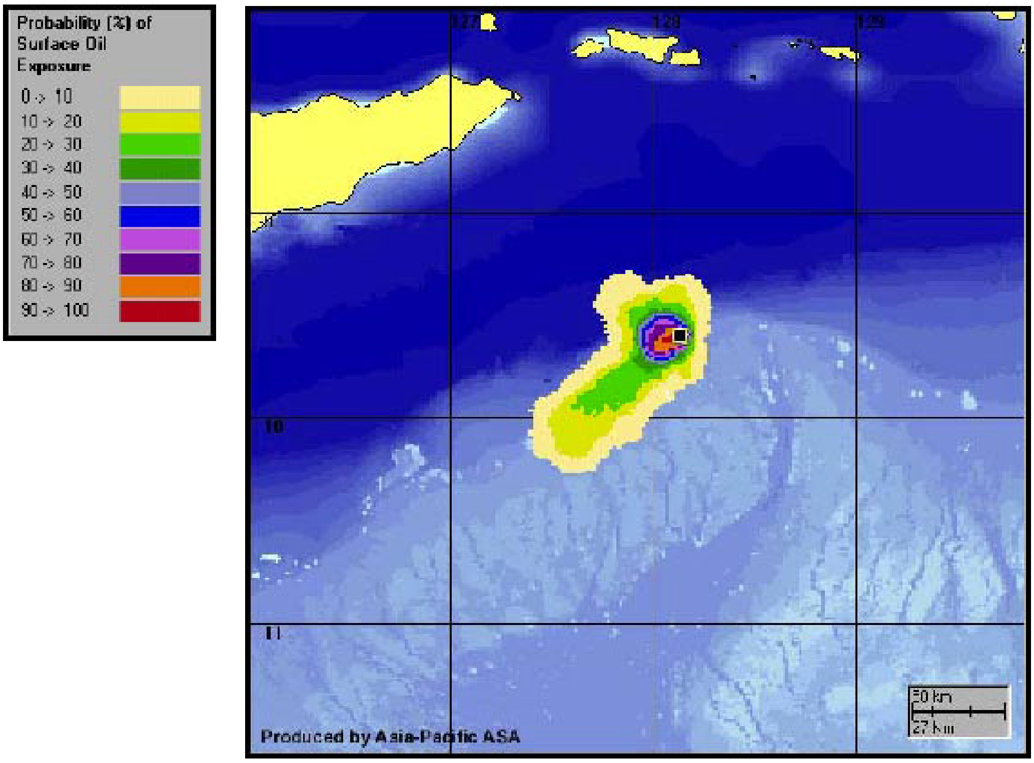
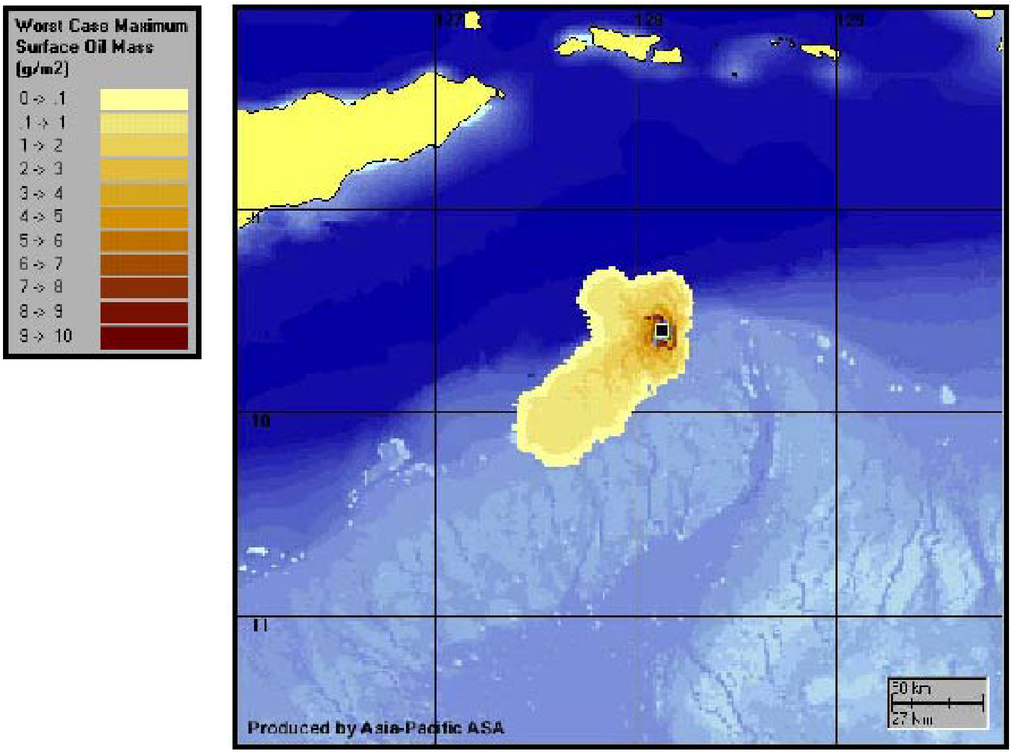


Figure 8-10 Predicted Surface Diesel Concentration During Winter Conditions



Produced by Asia-Pacific ASA

Figure 8-11 Probability of Surface Diesel Exposure During Transitional Season Conditions



Produced by Asia-Pacific ASA

Figure 8-12 Predicted Surface Diesel Concentration During Transitional Conditions

Similar to diesel spills, condensate is unlikely to make contact with any shorelines or exposed reefs prior to evaporation and decay. Simulations carried out for a dispersion period of 10 days indicates no exposure to coastlines under conditions representative of any season. Condensate discharge would be largely evaporated within 48 hours at sea-surface temperatures experienced in the Timor Sea. The condensate is expected to contain only a small proportion of residual components (~3%) that would resist evaporation.

Modelled simulations of rising and expanding plume of condensate indicates that relatively low loads (mass per unit area) would be generated at any location on the surface (below 8 x 10^{-4} g/m^{2}). However the area affected by the plume could experience concentrations of entrained oil up to 2,000 ppb (equivalent to 2 ppm) and dissolved aromatic concentrations up to 300 ppb (**Table 8-13**). Maximum sediment loads are predicted to be relatively low (<0.05 g/m^{2}).

Table 8-13 Summary of Highest Predicted Loads for Any Condensate Spill Scenario

Scenario	Surface		Aromatic		Entrained		HC_Sediment	
	Mean (g/m)	Max (g/m)	Mean (ppb)	Max (ppb)	Mean (ppb)	Max (ppb)	Mean (g/m)	Max (g/m)
Summer	1.6x10^{-5}	7.1x10^{-4}	257.9	988.6	2,008.3	11,725.1	1.4x10^{-5}	1.2x10^{-3}
Winter	8.4x10^{-6}	5.1x10^{-4}	200.12	838.7	1,951.6	7,582.4	9.3x10^{-3}	5.2x10^{-2}
Transitional	2.0x10^{-5}	7.3x10^{-4}	294.9	810.9	2,004.7	8,418.9	1.7x10^{-2}	4.7x10^{-2}

The probability of surface exposure and highest predicted concentration of condensate at surface locations during summer conditions is illustrated in **Figure 8-13** and **Figure 8-14**. The spill disperses to the north-east over the Timor Trench with highest worst case oil masses of 7.1 x 10^{-4} g/m^{2} (**Table 8-13**). Maximum concentrations of dissolved aromatic hydrocarbons are predicted to reach 989 ppb at any location within the water column during summer conditions (**Table 8-13**). Predicted maximum concentrations of total hydrocarbons at sea bed locations during summer conditions will also be very low, typically <0.0001 g/m^{2} (**Table 8-13**). The deposition of hydrocarbons on the seabed sediment will be confined within a 20 km radius of the platform and will avoid the shallow shoals located approximately 30 km to the southwest of the platform.

Corresponding winter conditions are provided in **Figure 8-15** and **Figure 8-16** which illustrate condensate dispersion and hydrocarbon deposition and corresponding transitional season conditions are provided in **Figure 8-17** and **Figure 8-18**. **Table 8-9** provides a summary of the highest predicted loads for any location in each of the seasonal scenarios.

The potential environmental impacts associated with diesel and condensate spills may include (Apache Energy, 2001):

- Lethal toxic effects – where death of an organism results from direct interference of a component of the diesel or condensate;
- Sub-lethal effects – chronic, biological effects of hydrocarbons through disruption of physiological and/or behavioural responses, but not resulting an immediate death;
- Bioaccumulation – where hydrocarbons may be transferred through the food web;
- Tainting – uptake of oil or certain fractions of hydrocarbons;
- Direct smothering and suffocation;
- Physical or chemical alteration to a habitat resulting in a change in population; or
- Changes to local community structure.

Numerous studies have been undertaken to determine the effects and toxicity of hydrocarbon spills on marine organisms. A summary of the likely impacts on marine organisms from diesel and condensate spills is provided below (Apache Energy, 2001):

- ☐ *Plankton*
  Plankton occurring in the immediate vicinity of the discharge point is likely to suffer high mortality. The repopulation of plankton is known to be rapid due to high reproductive rates and immigration from areas outside of the impacted areas (Davenport, 1982). In open waters such as that of the Sunrise Gas Project area plankton populations are very low; however, it is expected that they would return to normal within a number of days of a spill.
- ☐ *Benthic Communities*
  Numerical modelling has indicated that the deposition of hydrocarbons on the seabed will be restricted within a 20 km radius of the platform. A spill would result in local damage to communities and organisms inhabiting the seabed. Heavier oils have the potential to reside in sediment for several years however the characteristics of the condensate of the Sunrise Gas Project indicates that a high proportion will evaporate and the remainder will rapidly decay and disperse over time. Sediment resuspension from tide, current, storm activities and bioturbation from organisms will assist in the recovery of the benthic communities that would be impacted.
- ☐ *Fish*
  Fish stocks would be less affected due to their mobility and ability to avoid contaminated water and thus impacts would be short-term. However, in severe cases there may be effects of toxicity as a result of entrained hydrocarbons in the water column. Previous studies have indicated that deaths of adult fish have been attributed to toxic effects of water or tainted food, ingestion and to suffocation by clogging of the gills (Clark, 1982; Jones, 1989).
- ☐ *Seabirds*
  Although seabirds are highly mobile and capable of avoiding polluted areas they may dive into oil slicks. The covering of the birds plumage with oil may result in drowning or hypothermia as birds rely on the air trapped between their feathers to provide insulation and buoyancy. Oiled feathers lose their water repellency and become matted down. Lightly oiled birds are able to clean themselves but will ingest oil in the process. This may in turn lead to liver, kidney and other tissue damage. Some bird populations will be able to recovery rapidly from the impacts of diesel and hydrocarbon spills, however, the rate of recovery will be largely dependent on:
  - the existence of a reservoir of young breeding adults from which breeding colonies can be replenished; or
  - a high reproductive rate.
- ☐ *Turtles*
  Similar to fish, turtles will be expected to avoid areas of contaminated water. In the event that they come into contact with diesel or condensate they may experience eye infections. Little else is known about the direct impacts of hydrocarbons on turtles.
- ☐ *Marine Mammals*
  Marine mammals will be expected to avoid areas of contaminated water; however, like turtles, they may experience eye infections if contact is made with hydrocarbons. Whales and dolphins have been observed to avoid surface oil slicks (Baker *et al*., 1989).

Cooling Water

Approximately 10,000 cubic metres per hour of cooling water from the production facility will be discharged to the ocean surface under the PCUQ Platform on a continual basis at an approximate temperature of 45°C, approximately 18°C above ambient. Seawater will be used for cooling water and is unlikely to require the addition of chemicals. The cooling water discharged will not contain any hydrocarbon. The discharge of cooling water will have a localised effect on water temperature restricted to the vicinity of the discharge point.

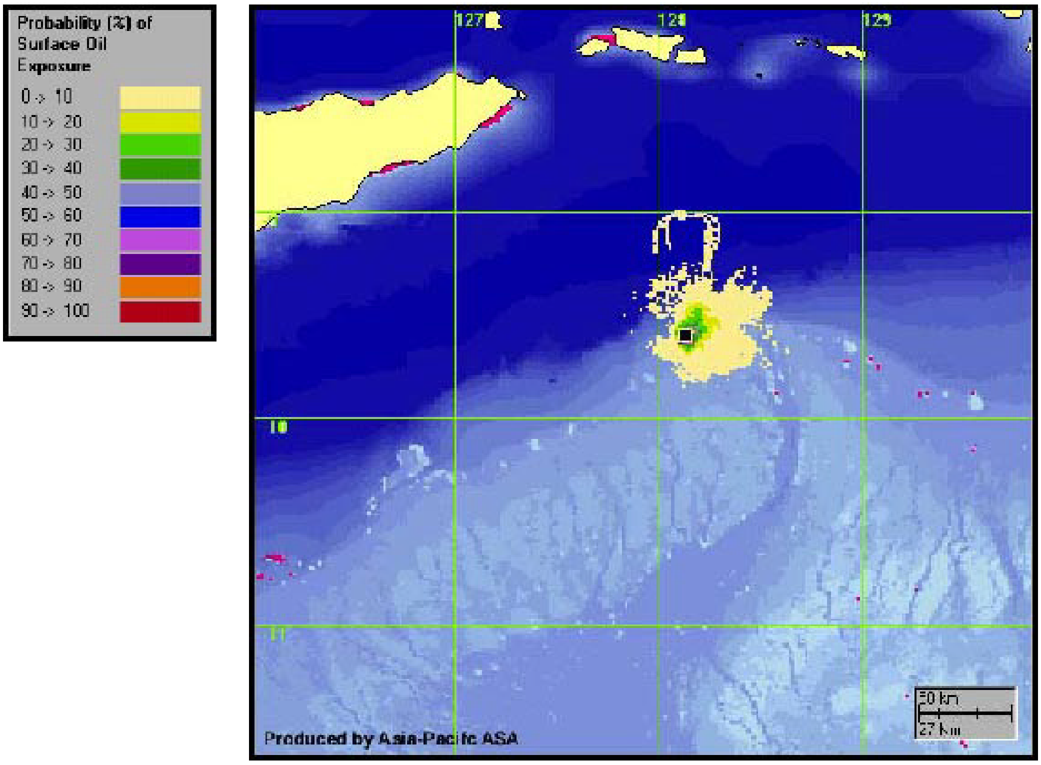


Figure 8-13 Probability of Surface Condensate Exposure During Summer Conditions

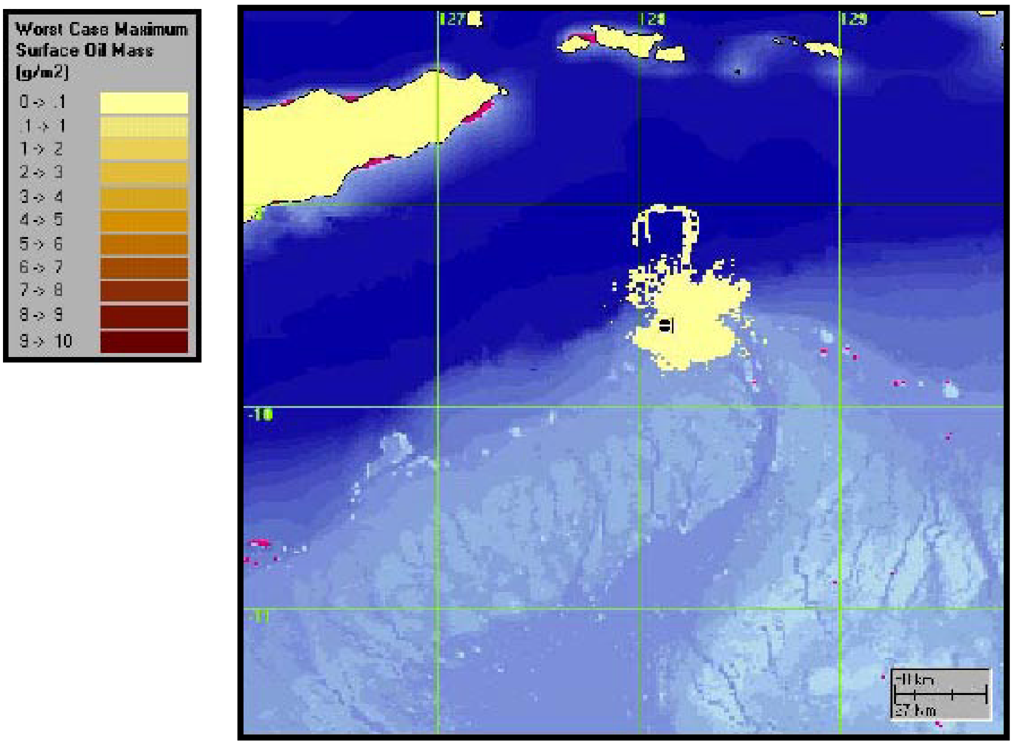


Figure 8-14 Predicted Surface Condensate Concentration During Summer Conditions

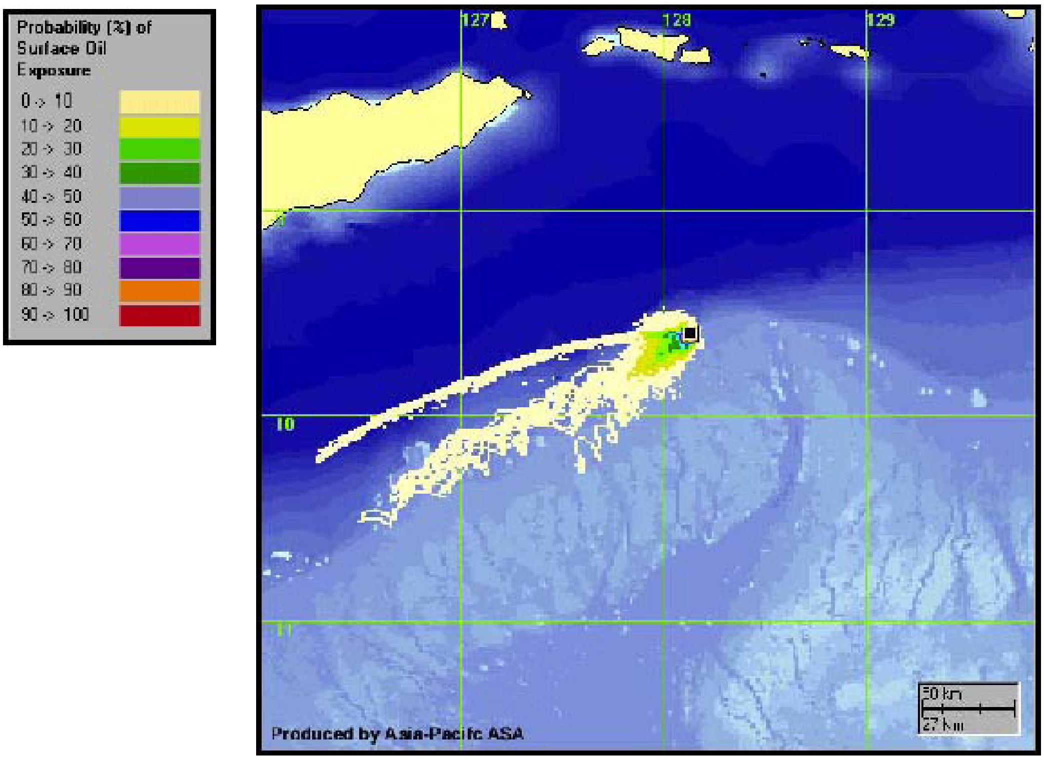


Figure 8-15 Probability of Surface Condensate Exposure During Winter Conditions

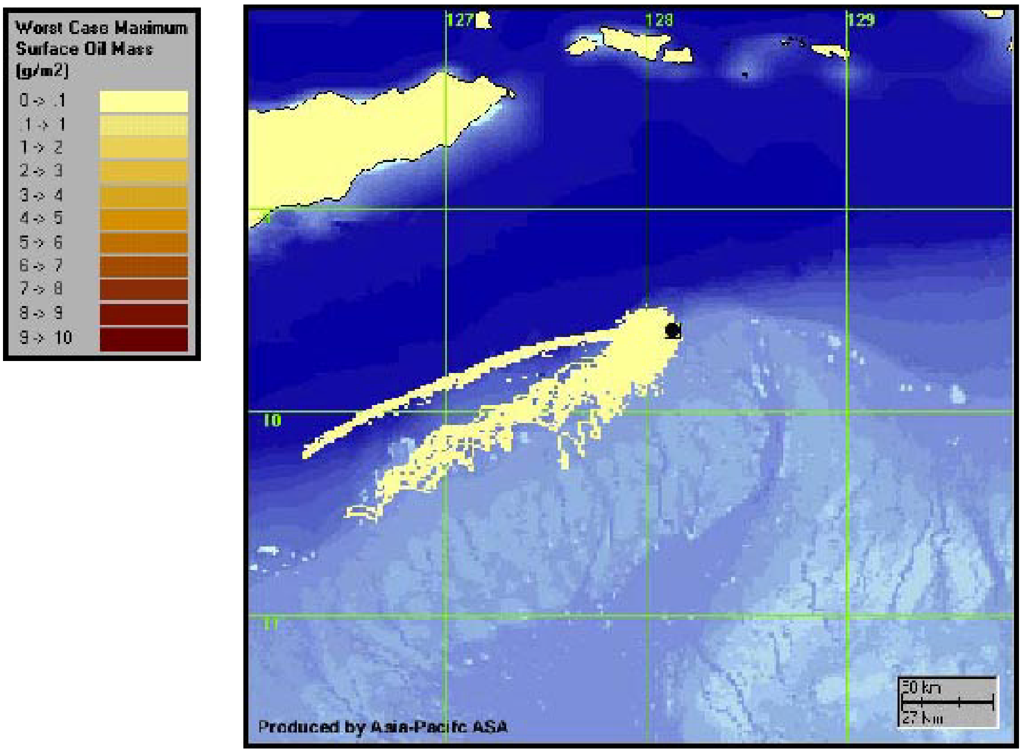


Figure 8-16 Predicted Surface Condensate Concentration During Winter Conditions

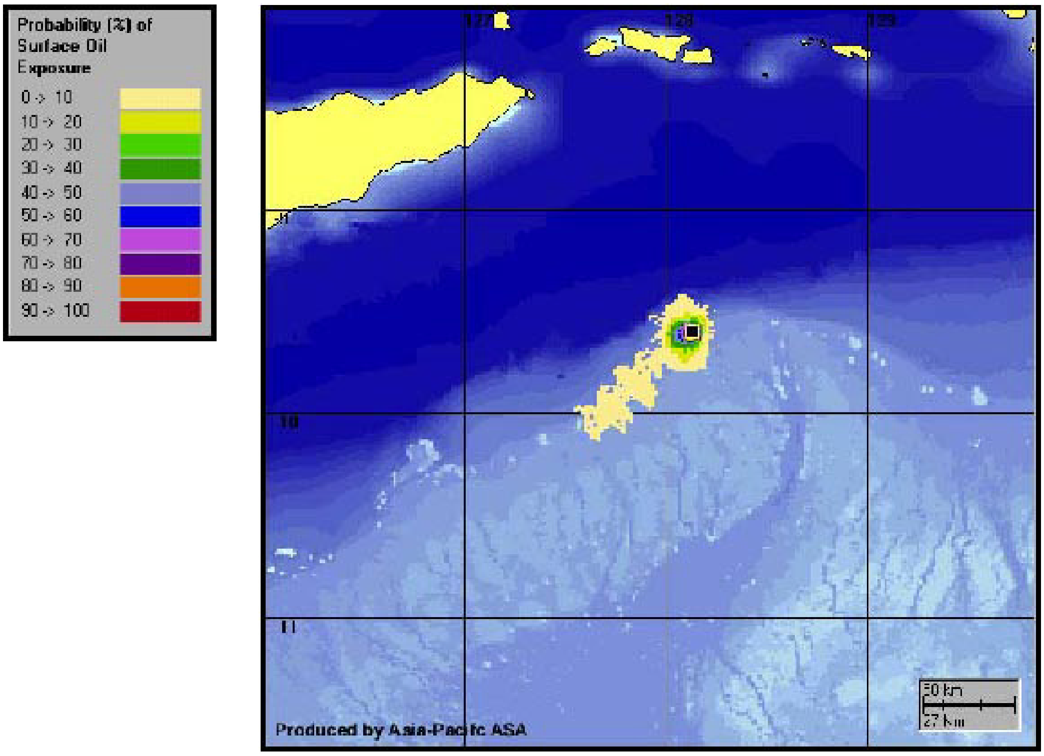


Figure 8-17 Probability of Exposure to Condensate Spill during Transitional Season Conditions

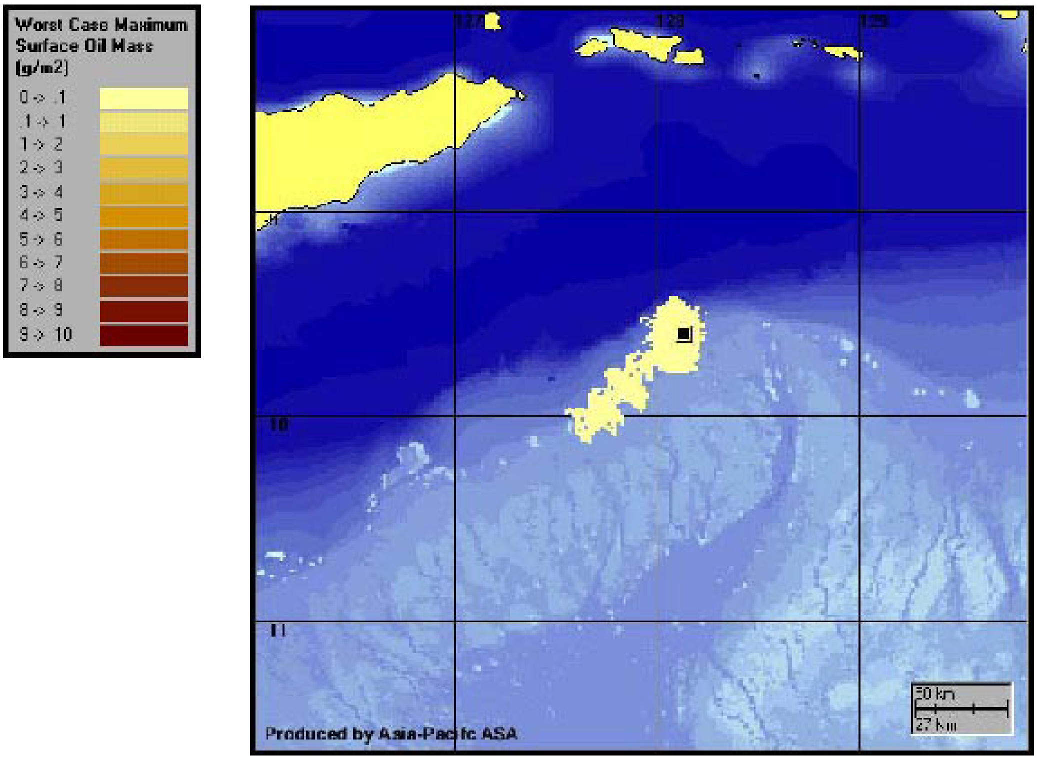


Figure 8-18 Predicted Surface Condensate Concentration During Transitional Conditions

8.6.1.3 Noise, Vibration, Light and Heat

Noise and vibration during the commissioning and operation of the subsea facilities, wellhead and PCUQ platforms will be generated from flaring and operation of equipment. Light will be generated from lighting and flaring with the latter also emitting heat. The potential impacts associated with the generation of noise, vibration, light and heat include:

- Potential disturbance to marine organisms and birds; and
- Potential attraction of marine organisms, in particular turtles as a result of flaring and industrial lighting.

Noise and Vibration

Marine fauna may be disturbed from the operation of the production facility and vessel movements. The impact of acoustical emissions on fauna has been previously discussed in **Section 8.2.1.3**. Operational noise is not considered to have either a negative or positive impact on fauna. There will be some disturbance, however, this will not result in any beneficial or adverse impact. It is concluded that noise and vibration generated during operation will have a neutral and negligible effect on marine fauna.

Light

Lighting will be required on the production facility to comply with regulatory safety requirements. Routine flaring and in particular emergency flaring will also generate light that may attract turtles to the production facility. This attraction is not considered to result in an adverse impact.

Heat

Heat generated from flaring has the potential to be harmful to birds that may fly over the production facility. It is likely that the heat generated from the flare will deter birds away from the flare stack, thus preventing direct harm that may occur from direct contact with the flare.

8.6.1.4 Waste to Shore

The disposal of waste to shore has the potential to reduce the quality of the environment if the waste is not disposed of in an approved manner. There is the potential to reduce the quality of surface, ground and marine waters through leachate contaminants.

During operation it is likely that the following wastes will be disposed to shore:

- Waste oil;
- Waste lubricants;
- Chemical drums and other storage containers;
- Scrap metal, piping and other solid waste materials generated from periodic maintenance; and
- Packaging materials (plastic, cardboard, paper and pellets).

These wastes will be disposed of in an approved manner. A project-specific waste management policy will be followed consistent with Woodside's corporate waste minimisation policy. Where possible waste will be reused, recycled, recovered or returned to the supplier for treatment, as an alternative to being disposal at landfill. However, in the event that improper disposal does occur, the potential environmental impacts are considered to be negligible due to the relatively small quantities of waste being disposed, and the likelihood is that the impact will be localised.

8.6.1.5 Other Impacts

Presence of Facilities

The presence of large areas of hard substrate will provide a substrate for the colonisation of encrusting organisms present in the plankton. There is a potential that a different community, to that originally found in the area may become established and may include exotic marine species. The colonised communities are likely to attract a variety of fish that may utilise the newly formed habitat as a source of food and refuge. The reef-like nature of the submerged structures will cause a localised increase in the diversity and abundance of marine life, although this cannot be assigned either a positive or negative overall effect. If the option to remove the submerged structures during decommissioning is exercised, thereby removing the artificial habitat and associated communities, then the overall environmental impact will be negligible. This issue will be further addressed in the Decommissioning Plan that will be submitted in accordance with DBIRD guidelines.

The reef effect of submerged structures is believed by some to promote or increase the dominance of predatory species. However, this has not been adequately demonstrated. Perhaps the best case study for Australia is the biological monitoring of the HMAS Swan (Morrison 2001). A very large fish and encrusting invertebrate community has established over a four year period on a scuttled vessel in 30 m of water. The initial colonisation was dominated by prey species during the first year and subsequently the presence of predatory species has stabilised the community structure approximating that of local natural reefs. Predatory species have not been promoted above that of natural reefs and prey species appear not to be any more vulnerable. The effect of the artificial reef was localised and surrounding habitat was not effected.

The presence of the submerged structures should not be considered beneficial nor should they be considered harmful. Hard structures in deep water provide a habitat which may otherwise not be present. The colonisation of new habitat would stabilise over time and any ecological effects would be localised.

Commercial and Recreational Fishing

The presence of the platforms and associated facilities will represent a potential navigational hazard to commercial vessels. Species of importance to the fishing industry are unlikely to be impacted by the operations of the Sunrise Gas Project. A 500 m exclusion zone will apply around the facility although little fishing effort is focussed in water depths greater than 100 m. The Sunrise Gas Project area is located in water depth of about 140–400 m. Minor effects on commercial fishing activities could result from restriction of access to fishing grounds and loss or damage to fishing gear. This impact is highly unlikely to occur as no trawling is undertaken in the area and it is believed that only one licensed fishing boat uses the area on a very occasional basis. Taking into consideration the current usage of the area for fishing, the proposed activities associated with the Sunrise Gas Project are considered to have a neutral long-term impact on fishing activities.

8.6.2 FSO and Shuttle Vessels

The FSO, once installed and commissioned, would serve as a storage and offloading facility for condensate. Periodically, shuttle vessels from either Australia or overseas will arrive to take on condensate and transport it to its intended market. The sources of impacts identified during the impact assessment were as follows:

- ☐ Potential spill during condensate transfer to shuttle tankers;
- ☐ Ballast water discharge from offtake tankers once on site;
- ☐ TBT and other antifoulant paints on tankers;
- ☐ Vessel hulls fouled with marine organisms;
- ☐ Cargo tank venting to atmosphere;
- ☐ Potential collision with shuttle tankers or supply vessels;
- ☐ Power generation emissions;
- ☐ Discharge of sewage and greywater; and

- Disposal of domestic waste including food scraps.

In relation to these sources, the following potential impacts are discussed in **Sections 8.6.2.1** to **8.6.2.4**:

Atmospheric Emissions:
- Cargo tank emissions from loading of FSO and shuttle tankers.

Discharges to the Sea:
- Contamination of marine environment by anti-fouling agents;
- Introduction of marine pest species from offtake tanker de-ballasting and hull fouling;
- Potential significant hydrocarbon contamination from a condensate spill; and
- Potential significant hydrocarbon contamination from a diesel spill.

Other Impacts:
- Interference with shipping.

8.6.2.1 Atmospheric Emissions

The FSO and offtake tankers will emit cargo tank vapours containing VOCs and small quantities of other pollutants to the atmosphere when loading. The VOC release rate is estimated at ~10 tonnes/day for the FSO and ~8 tonnes/day (on average) for the offtake tankers. The FSO will release cargo tank vapours at a steady rate as condensate is filled into it from the PCUQ Platform. In contrast, the offtake tankers will release much larger quantities when loading, but loading will only take a fraction of a day every ~3 weeks.

The potential environmental impact is the reduction of air quality. Any impact that may occur to air quality will be localised. As a result, atmospheric emissions from the FSO are considered to have a local negative impact. Under current Kyoto Protocol definitions, cargo tank venting of VOCs is not a significant issue since VOCs currently have a global warming potential of zero. The cargo tank vapours are expected to contain very low levels of methane.

8.6.2.2 Discharges to Sea

The discharge of wastewater, chemicals, domestic waste and ballast water from the FSO and offtake tankers has the potential to degrade the quality of water surrounding the FSO. A variety of waste products will be generated during the operation of the FSO. The activities that may lead to this include:
- Ballast water exchange;
- The use of antifouling paints on tankers;
- Discharge of sewage and greywater;
- Tank washing;
- Potential condensate spills during transfer to shuttle tankers; and
- Potential collision between vessels.

The potential environmental impacts associated with the above discharges are discussed below.

Ballast Water
Ballast water from coastal waters elsewhere in Australia or overseas has the potential to impact upon marine communities through the introduction of exotic organisms. Shuttle vessels arriving to offtake condensate from the FSO will need to de-ballast and supply vessels may arrive with hull biofouling.

A range of marine organisms may be transported in large numbers within ballast water and some of these organisms may be capable of invading new ecosystems and upsetting the ecological balance.

Vessels that have biofouling on their hulls as a result of poor maintenance or ageing antifouling paint may introduce exotic marine organisms to the area.

The potential impact is related to the origin of the vessels that could potentially introduce marine pest species. Ballast water or hull fouling organisms from habitats with similar environmental conditions to that of the Sunrise Gas Project area have a much higher success rate for colonisation. Those organisms that are isolated by great distances or geographical barriers are even more prone to be a problem of introduction.

AQIS mandatory procedures would normally allow vessels passing through the Sunrise Gas Development Area to undertake ballast water exchange as it is classified as open ocean. However, vessels arriving at the Sunrise Gas Project area will be required to carry out deballasting in open ocean waters away from the nearby banks, platforms and FSO, preferably over the Timor trench where possible. In addition, there will be a requirement for the shipping company to demonstrate to Woodside that the vessel hulls have been adequately maintained and free of biofouling organisms. This will minimise the risk for such organisms being introduced into an area where they may become colonised on new hard substrates and potentially being transported to Australian ports via vessels travelling between the Australian mainland and the Sunrise Gas Project area.

Antifoulant Contamination

The leaching of antifouling paints containing tributyltin (TBT) from vessels has the potential to adversely impact upon marine organisms. TBT is highly toxic at very low concentrations and causes imposex in marine gastropod molluscs at sublethal levels. TBT is relatively quickly broken down in the presence of oxygen while in the water column; however, in sediments it can persist for periods of years, particularly in anoxic conditions.

In November 1999, the International Maritime Organisation (IMO) directed the Marine Environment Protection Committee to develop an instrument, legally binding throughout the world, to address the harmful effects of antifouling systems used on ships. The objective was to institute a global ban on the application of TBT paints on ships by 1 January 2003 and a complete prohibition on the presence of TBT paints on ships by 1 January 2008. The 5-year gap allows for ships legally coated with TBT before 1 January 2003 to operate until their next dry-docking for maintenance. These conditions will apply to all vessels, including the FSO and offtake tankers, related to the Sunrise Gas Project.

Given that marine organisms and benthic communities in the Sunrise Gas Project area are common and widespread the potential impact of TBT on the marine ecology of the area is considered to be localised and negligible. With reference to the EPA classification criteria, the potential impact of TBT contamination is considered to be a negative, long term impact; however, this is generally only the case in areas of high accumulation such as ports.

Drainage Systems

The FSO will be equipped with a suitable drainage system to collect stormwater and where possible to separate clean stormwater from potentially contaminated stormwater. Potentially contaminated stormwater and other oily waste streams produced during the operation of the FSO will be contained in suitable storage ‘slops’ tanks. Clean stormwater will be discharged to the sea without the need for treatment. There is the potential for contained oily wastewater to be discharged to sea in the event of an overflow or leakage of the storage basin.

The potential reduction of water quality is considered to be a negligible impact as the potential discharge will be small, localised and diluted as a result of dispersion and mixing and is unlikely to reach the seabed in sufficient quantities or concentrations to impact on the benthos.

Sewage and Putrescible Wastes

Sewage and putrescible wastes will be produced by the workforce on the FSO. The environmental impacts associated with the discharge of such waste to the sea has been previously discussed in **Section 8.2.1.1**. The FSO will comply with P(SL)A – Schedule 1995 requirements.

Oil Spills and Collisions

Any spills and leaks of diesel and condensate would result in the localised reduction of water quality. Dispersion and mixing of any hydrocarbons spilled would reduce the concentrations of the contaminants in the water column hence reducing the significance of the impact. Modelling of larger diesel and condensate spills has been undertaken and these have been previously discussed in **Section 8.6.1.2**.

8.6.2.3 Waste to Shore

The FSO will generate wastes including paper, plastic, bottles, cans that will be required to be disposed onshore. The disposal of waste onshore has the potential to reduce the quality of the surrounding environment if the waste is not disposed of properly. The potential impacts associated with this have been previously discussed in **Section 8.2.1.4**.

8.6.2.4 Other Impacts

The presence of the FSO and the movement of associated vessels have the potential to disrupt other ships travelling along designated shipping routes. However, the proposed facilities are unlikely to impact on any shipping activities as they are not located near to any designated shipping lanes.

8.6.3 Subsea Pipeline

The subsea pipeline, once installed and commissioned, would conduct compressed gas for the lifetime of the Sunrise Gas Project which is expected to be in the order of 30 years. The sources of impacts identified during the impact assessment were as follows:

- ❑ Hydrotesting of pipeline;
- ❑ Potential rupture of pipeline; and
- ❑ Physical presence of the pipeline.

In relation to the above listed sources of impacts, the following potential impacts are discussed in following subsections.

Atmospheric Emissions:

- ❑ Potential emissions of natural gas in the event of a leak.

Discharges to the Sea:

- ❑ Potential reduction in local water quality due to release of hydrotest water (biocides, corrosion inhibitors and oxygen scavengers)

Other Impacts:

- ❑ Physical presence of pipeline.

8.6.3.1 Atmospheric Emissions

Atmospheric emissions would only occur in the unlikely event of a pipeline rupture.

8.6.3.2 Discharges to Sea

- ❑ Hydrotesting:

During the operation of the pipeline there will be no routine discharges to sea.

During the commissioning phase, hydrotest water, comprising filtered seawater and additives including biocide, corrosion inhibitors and oxygen scavenger, will need to be displaced from the pipeline. As discussed in **Section 8.4.3.1,** hydrotest water is injected into the pipeline following the completion of construction to ensure that the pipeline is constructed intact and that no leakages occur. During commissioning, hydrotest water will be displaced from the pipeline and discharged to the sea. The discharge will most likely occur to the sea surface at the PCUQ Platform if Bayu Undan gas can be used to start up the Sunrise facility by back-flowing from the WYE piece. However, if Bayu Undan gas is not available, the hydrotest water will most likely be displaced to the sea floor at the WYE piece.

The hydrotest water discharges will have negligible impact on the marine environment because hydrotest water will contain very low concentrations of additives and when discharged will be substantially diluted. Furthermore, as discharges will not occur in the nearshore area.

8.6.3.3 Other Impacts

- Physical Presence of Pipeline:

The presence of the hard substrate of the pipeline is likely to provide a suitable substrate for the colonisation of encrusting organisms. There is a potential that a different community, including exotic species, to that originally found in the are may become established. The colonised communities are likely to attract a variety of fish that may utilise the newly formed habitat as a source of food and refuge. The reef-like nature of the subsea pipeline will cause a localised increase in the diversity and abundance of marine life. For this reason the environmental impact is considered to be beneficial on a local scale.

8.7 Mitigation Measures for Commissioning and Operation

8.7.1 Commissioning

During commissioning of the facility and pipelines, care will be taken to ensure that no adverse impacts on the environment occur.

Consideration will be given to controlling and minimising where possible the use of biocides and toxic chemicals contained within the hydrotest water. The chemicals used in the pressure testing will be carefully selected with regard to toxicity.

Woodside will ensure that appropriate collection, treatment and discharge options are identified and approved by regulatory authorities to avoid adverse environmental impacts at the point of discharge. In this regard pipeline hydrotest water will be discharged in offshore waters, where an adequate hydrographic regime will ensure rapid and sufficient dilution, so that there is no impact on nearshore areas.

8.7.2 Operation

8.7.2.1 General Operation and Maintenance procedures

Woodside will ensure that the facility will implement sound operating procedures for operation and maintenance procedures. In this regard Woodside will implement the following measures:

- Good house-keeping measures will be implemented and maintained.
- All fittings and equipment will be routinely checked and maintained.

- Any areas of spillage and leakage will be promptly reported and necessary maintenance works and control measures undertaken immediately.
- All monitoring devices and alarms will be operative.
- Adequate process surveillance will be undertaken.
- Personnel will be adequately informed of procedures.
- Oil Spill Prevention.
- Navigation and safety lighting will be provided to ensure that any shipping or recreational activities are able to clearly identify the presence of activity.

8.7.2.2 Spills

The following measures are recommended to minimise spill of oil, diesel or chemicals and minimise impact if a spill were to occur.

- Hoses for diesel/ oil/ chemical transfer to be fitted with high reliability breakaway self-sealing couplings;
- Mooring hawser to be fitted with quick release hook and load monitoring cell;
- Consider designing all flowlines for 1 in 10,000 year storms - provided with shutdown valves and HP/LP sensors;
- Spill kits available for clean-up of minor spills;
- Process spill and leak detection, alarm, shutdown and isolation devices will be maintained in good operating conditions;
- Efficient containment and separation of contaminated run-off decks, machinery areas and oil/chemical storage areas; and
- An Oil Spill Contingency Plan (OSCP) has been prepared by Woodside for the Timor Sea. If necessary this OSCP will be amended to meet the specific requirements of the field development.

8.7.2.3 Emergency Response

Woodside will ensure that the ERP are tested and reviewed at regular intervals and the operational personnel are appropriately informed of emergency procedures and trained to effectively implement them.

8.7.2.4 Hydrocarbon Loading

Transportation of condensate, as well as diesel for fuelling etc, to and from the offshore facilities will require vessel transfers. In this regard consideration will be given to the following procedures:

- All regulatory requirements will be observed including standards for design and application of hardware eg flanges, valves, couplings, fittings etc;
- Marine operating procedures define acceptable ocean conditions for the tanker to be connected to the transfer hose and for the export of condensate to take place;
- The transfer hose will be flushed with seawater prior to disconnecting in the event of rough weather;
- Pressure sensors will be installed to detect and trigger alarms for stopping the transfer of condensate to the tanker in the event of a high or low pressure trip;
- Flowlines and hoses are certified and tested prior to use;
- Dry break couplings will be fitted to hoses;
- All fittings and hoses will be routinely inspected and maintained;
- All spillages, leaks or points of excessive wear will be properly reported and the necessary maintenance work and control measures undertaken without delay;
- All monitoring devices and alarm systems will be fully operative; and
- Development and adoption of hydrocarbon loading procedures to minimise the possibility of spillage.

8.7.2.5 Chemicals and Hazardous Materials Management

In summary all chemicals that will need to be discharged into the marine environment will be tested for toxicology and bio-accumulation/ biodegradation. The following approaches will be adopted to minimise chemical usage:

- ❑ *Hydrate Inhibitor Chemical Use*

An evaluation of flowline insulation vs. hydrate inhibition will be conducted. In certain flowline configurations, avoidance of hydrate formation may not be effectively guaranteed with flowline insulation alone due to low seabed temperatures and low water production. It may be necessary to inject hydrate inhibitors continuously under such circumstances. If continuous mono ethylene glycol (MEG) injection is used for hydrate inhibition, the MEG will be recovered on the topsides and recirculated. Hydrate inhibition requirements will consider start-up, shutdown scenarios.

- ❑ *Self-Equalising Subsea Shutdown Valve (SSSVs)*

All wellheads will be provided with methanol or MEG injection for pressure equalisation and hydrate prevention on start-up. Self-equalising SSSVs will be considered such that methanol injection will not be required. Quantities of chemicals used for such operations are relatively small. These chemicals are highly soluble in water and will be partitioned into produced water phase and a relatively small fraction will get mixed with the product gas and condensate with no significant impact on product quality.

- ❑ *Scale Inhibitor Injection*

Available data do not show scale formation tendency but with onset of water production, scale forming potential may occur and scale inhibition may be required. Selection of scale inhibitor will take into account its environmental suitability and compatibility with other chemicals used.

- ❑ *Minimise need to dose demulsifier/anti-foam agent in separator*

All separator internals will be selected to achieve minimum breakdown of droplet size and minimising foaming. Proper selection of separator inlet device and internals have shown to greatly improve separation efficiency and minimise consumption and cost of defoaming agent / demulsifier chemicals. A review of the existing state of the art separator internals will be conducted to determine best separator internals for each case to achieve this objective. These chemicals will be mainly discharged with produced water.

- ❑ *Minimise need to dose anti-foaming agent in dehydration and stabiliser*

Selection of high-efficiency separator internals will also result in minimisation of condensate carryover with gas and thereby reduce potential for foaming in the Tri Ethylene Glycol (TEG) contactor thereby reducing likelihood of anti-foam agent use in the TEG contactor. A filter coalescer will be provided at the inlet to the stabiliser to minimise foaming in the stabiliser.

- ❑ *Minimise continuous corrosion inhibitor injection*

The gas export pipeline may be designed for wet operation for a certain number of days over the design life for start-up and upset conditions. Small quantities of corrosion inhibitor injection may be required during such periods, which will pass on with the product gas stream with no significant impact on product specification.

- ❑ *Minimise environmental impact of biocide, corrosion inhibitor, chemical scavenger and dye use in hydrotest water*

It is a common practice to use sea water treated with chemicals such as biocide, corrosion inhibitor, chemical scavenger and dye for flooding and hydrotesting of subsea flowlines and pipelines. This water is ultimately discharged to sea during pre-commissioning. This is a one-off operation and does not constitute continuous discharge. Chemicals with low toxicity, low bio-accumulation potential and high biodegradability will be selected for this purpose. Type of chemicals used will need to be approved by relevant authorities and DBIRD prior to use.

- *Minimise environmental impact of release of hydraulic fluid from subsea control systems.*

Hydraulic fluid which is a proprietary mixture, typically consisting of a 25:75 mixture of glycol and water and certain inhibitor chemicals, are released subsea in small quantities during subsea valve actuation. This system will be similar to that used in recent subsea developments including Wannea Cossack and Laminaria subsea production systems.

More information is contained in **Section 8.3.6.**

8.7.2.6 Waste Management

A project-specific waste management plan will be adopted which will take into account the regulatory requirements of the P(SL)A, maritime laws and legislation of the Northern Territory Government.

The waste management plan will address:
- Discharges to Sea; and
- Solid and Hazardous Waste.

All solid wastes will be stored appropriately and will not be released to sea. The use of licensed disposal sites at Darwin further reduces the risks of environmental impacts. The following mitigation measures will ensure that solid and hazardous waste will not adversely impact on the environment.

- As much as possible waste will be segregated into distinct waste streams eg packaging, chemicals, industrial waste, batteries etc and stored in appropriate locations;
- Waste will be labelled appropriately for return to shore where disposal at landfill, or if possible reuse, recycling or recovery will take place;
- Solid domestic waste will be returned to shore and disposed at an approved landfill; and
- Woodside will ensure, as much as possible, that care is taken to avoid accidental release of synthetic materials to the sea, for eg plastic bags, to avoid adverse impacts on the environment especially marine life.

8.7.2.7 Discharges to Sea

During operation of the facility the following measures will be applied:
- No waste will be disposed overboard except for the following:
  - Comminuted sewage and food wastes;
  - PFW;
  - Ballast water;
  - Cooling water; and
  - Uncontaminated wastewaters eg separated deck drainage, bilge water etc
- Discharges will meet oil –in-water standards;
- Treatment facilities will be of sufficient design capacity to handle PFW, and other oily waters from dirty work areas (deck area drainage, machinery space drainage etc;
- The effluent discharges from treatment facilities will be monitored by appropriate techniques prior to discharge, and monitoring equipment will undergo periodic checking in accordance with statutory requirements;
- All treatment methods will be suitable for the physical and chemical characteristics of the water discharge eg emulsified wastewater may require demulsification facilities;
- Cooling water releases will be controlled to minimise thermal effects; and

- As a minimum sewage and food scraps will be comminuted prior to discharge in offshore waters and in accordance with P(SL)A requirements.

Produced formation water will be separated from the oil using an approved oil separation system and will be discharged overboard during routine operations. The overboard stream will be monitored for oil content and will be discharged under the rules laid down in the P(SL)A. An approved oil in water monitoring system will be used to record oil levels and to ensure that the concentration does not exceed permitted levels. The 'Oil In Water' meter will be regularly tested and calibrated to maintain its accuracy.

Good house-keeping and spills procedures are critical to prevent contamination of the storm run-off water. Deck areas will be kept clean and free of contaminated material. Any spills of chemicals or oil are cleaned up using absorbent material. Contaminated absorbent material will be stored in approved covered containers and transported to shore for disposal. It is also important that all spills are cleaned up prior to the next rainfall event.

Bunds around equipment and process areas will ensure that any runoff potentially carrying contamination is directed to the slops tank. Chemicals or oils in drums will preferably be stored inside the bund areas. If any storage is required outside the bunds then trays will be placed under the drums so that runoff is diverted to the bund or slops tank.

8.7.2.8 Air Emissions/Energy Use

- Flaring will be minimised;
- Emissions from fired machinery will be minimised and fuel use optimised.

The following five options are considered for mitigating environmental impact of venting hydrocarbon vapour from the FSO cargo tanks:

- Base case - the hydrocarbon containing inert gas is directly vented;
- Vent recovery option –the gas is compressed and cooled/ dehydrated and condensate recovered is returned to FSO;
- Vent absorption – in this option the vent gas is compressed and scrubbed with cold condensate to recover non-methane VOCs and the offgas is vented;
- Flare - this option requires flaring of vent gas; and
- Hydrocarbon inert gas – in this case fuel gas is used as blanketing gas instead of inert gas. Displaced gas from FSO is compressed and returned to process. A pipeline to supply and return fuel gas will be required between production platform and the FSO.

For the shuttle tanker, any process to either return the inert gas to the FSO or any process such as recovery or flaring will primarily depend on facilities available on the tanker. The gas is primarily inert gas with a certain percentage of LPG. The venting occurs primarily while loading condensate from the PCUQ, as cargo tank gases are displaced by the liquids.

8.7.2.9 Noise, Vibration, Light and Heat

Woodside will attain occupational health standards for noise emissions by installing silencers, cladding and other appropriate noise attenuation controls where practicable. Due to the distance of the facility offshore noise will not be a major issue.

Methods for minimising noise, vibration, light and heat impacts are included in the following table.

Table 8-14 Alternatives for Minimising Impacts of Noise, Vibration, Light and Heat

Aspect	Alternatives
Noise	Acoustic Enclosures Low Noise Electric Drives/Generators Elimination of Gear Boxes Low Noise Valves
Vibration	Use Centrifugal Compressors Vibration Dampeners Vibration Monitoring
Light	Low Intensity Flare Tips Enclosed Flare
Heat	Waste Heat Recovery Units (WHRU)

8.7.2.10 Marine Support Vessels

Refer to Section 8.5.2.

8.7.2.11 Physical Presence

A 500 m safety exclusion zone will be maintained around the facility and no vessels are allowed to enter or anchor within the zone without the permission.

To reduce the risk of collision with vessels using the area, fisheries and shipping will be made aware of the presence of facility, flowlines and 500 m exclusion zone. The facility will be marked on the Australian navigational charts. Notices will be issued to shipping and appropriate navigation marker lights will be displayed.

8.7.3 Commitments

Woodside will implement the following commitments throughout the operation and commissioning phase of the Project:

- Prepare a Facility Environment Plan to ensure efficient power generation, planning of vehicle and vessel movements and overall optimal operation;
- Minimise flaring where possible;
- Prohibit the use of ozone depleting substances-CFCs and halons;
- Undertake regular inspections/maintenance of the subsea pipeline in accordance with DNV OS F101 (2000);
- Induct all personnel with particular attention given to correct handling of chemicals and pollution prevention requirements;
- Continuously monitor the quantity and hydrocarbon content of Produced Formation Water;
- Monitor cooling water for temperature and hydrocarbon content;
- Restrict ballast water exchange to deep, ocean waters; and
- Continuously monitor and supervise the transfer of product and diesel between vessels.

8.8 Impacts During Decommissioning

Table 8-15 summarises the source of impact, potential environmental impacts, their effect and duration for the Commissioning and Operation phase which includes:

- Wellhead Platform, Wells and Associated Subsea Facilities;
- PCUQ Platform and FSO; and
- Subsea Pipeline.

8.8.1 Wellhead Platform, Wells and Associated Subsea Facilities

The sources of impacts associated with the decommissioning of the wellhead platform, subsea wells and associated subsea facilities are as follows:

- ❑ Plugging and abandonment of wells;
- ❑ Removal of well heads;
- ❑ Removal of flowlines, manifolds and risers; and
- ❑ Vessel and rig movements.

In relation to these sources, the following potential impacts are discussed in **Sections 8.8.1.1** to **8.8.1.4**:

Discharges to the Sea:

- ❑ Potential discharge of residual hydrocarbons.

Noise, Vibration, Light and Heat:

- ❑ Disturbance to noise sensitive marine life.

Waste to Shore:

- ❑ Improper disposal.

Other Impacts:

- ❑ Disruption of benthic communities that have established on and adjacent to the facilities.

8.8.1.1 Discharges to Sea

It is likely that residual hydrocarbons, and potentially other oily wastes, will remain within storage basins and containers, flowlines and risers. The inventory of residual hydrocarbons may be discharged to the sea resulting in a reduction of water quality and the bioaccumulation and toxicity to marine ecology. Appropriate mitigation measures (as discussed in the following Section) will be outlined in a Decommissioning Plan. However in the event that such a discharge occurs the magnitude of the environmental impact will be a negative short term but negligible impact for the following reasons:

- ❑ Relatively small potential release volumes for residual hydrocarbons;
- ❑ Mixing and dispersion will dilute any leaks to concentrations that are not harmful; and
- ❑ Marine organisms and benthic communities that could be impacted by the plume are common and widespread in the region.

8.8.1.2 Noise and Vibration

Noise from decommissioning will be generated from cutting activities and the movement of vessels. These disturbances will be temporary, of short duration and localised. Marine mammals, turtles and fish are highly mobile and if within the vicinity of the Sunrise Gas development during decommissioning they are likely to move away. It is unlikely that there will be any direct impact on marine organisms thus the generation of noise and vibration is considered to be a potential negative, short term but negligible impact.

8.8.1.3 Waste to Shore

Wastes will most likely be disposed of onshore. This may include large quantities of subsea piping, storage drums, metal sheets, concrete and steel. The disposal of waste to shore has the potential to reduce the quality of the environment and create hazardous conditions for fauna if the waste is not disposed of properly.

The potential environmental impact from inappropriate disposal will be negligible, as Woodside will ensure that all waste be disposed in accordance to regulatory requirements. With reference to EPA classification criteria the potential environmental impact of improper disposal will be a negative but short-term impact.

8.8.1.4 Other Impacts

The removal of the wellhead platform and subsea facilities will result in the removal of benthic communities that have encrusted on the hard stand surfaces of the platform and subsea facilities. These communities are likely to have developed over the duration of the operation and the removal of such communities will also impact the fish and other organisms that rely on such communities as a food source. The removal of the platforms will result in the direct loss of these communities and the reduction of fish populations in the area. The environmental impact will be permanent one and is considered to be a minor impact. It is accepted industry practice that all facilities and associated infrastructure be removed to at least 55 m below the sea surface, such that an appropriate level of safeguard is provided for potential future activities in the area.

Table 8-15 Summary of Potential Environmental Impacts for Decommissioning

Project Component	Source of Impact	Potential Environmental Impact	Effect	Duration
Wellhead Platform, Wells and Associated Subsea Facilities	a) Plugging and abandonment of wells. b) Removal of well head. c) Removal of flowlines, manifolds and risers. d) Vessel and rig movements.	**Discharges to the Sea**		
		▪ Potential discharge of residual hydrocarbons.	Negligible	Short-term
		Noise, Vibration, Light and Heat		
		▪ Disturbance to noise sensitive marine life.	Negligible	Short-term
		Waste to Shore		
		▪ Improper disposal.	Negligible	Short-term
		Other Impacts		
		▪ Disruption of benthic communities that have established on and adjacent to the facilities.	Negligible	Permanent
PCUQ Platform and FSO	a) Removal of Wellhead Platform components and equipment. b) Jackup and removal of the PCUQ. c) Disconnection of FSO from flowlines. d) Movement of FSO offsite.	**Discharges to the Sea**		
		▪ Potential hydrocarbon contamination by oil spillage.	Negligible	Short-term
		Noise, Vibration, Light and Heat		
		▪ Disturbance to noise sensitive marine life.	Negligible	Short-term
		Waste to Shore		
		▪ Improper disposal.	Negligible	Short-term
		Other Impacts		
		▪ Disruption of benthic communities that have established on and adjacent to the facility.	Negligible	Permanent
Subsea Pipeline	a) Abandonment of subsea pipeline. b) Removal of subsea pipeline. c) Potential discharge of residual hydrocarbons	**Discharges to the Sea**		
		▪ Potential hydrocarbon contamination by oil spillage.	Negligible	Short-term
		Noise, Vibration, Light and Heat		
		▪ Disturbance to noise sensitive marine life and terrestrial fauna.	Negligible	Short-term
		Waste to Shore		
		▪ Disposal (abandonment of subsea pipeline)	Negligible	Short-term
		▪ Disposal (removal of subsea pipeline)	Moderate	Permanent
		Other Impacts		
		▪ Disruption of benthic communities and habitats that have been established on and adjacent to the pipeline.	Negligible	Medium Term

8.8.2 PCUQ Platform and FSO

The PCUQ Platform will be removed from the site at decommissioning for possible reuse elsewhere. The facility will be removed by a reverse floatover technique. Essentially the structures will be placed on vessels and shipped off site for reuse/recycling.

The FSO and all mooring systems above the seabed will be completely removed with only anchor piles remaining. The sources of impacts identified from the above activities associated with the decommissioning of the PCUQ Platform and FSO are as follows:

- Removal of Wellhead Platform components and equipment;
- Jackup and removal of the PCUQ;
- Disconnection of FSO from flowlines; and
- Movement of FSO offsite.

In relation to these sources the following impacts are expected, as discussed in **Sections 8.8.2.1** to **8.8.2.4**:

Discharges to the Sea:

- Potential hydrocarbon contamination by oil spillage;

Noise, Vibration, Light and Heat:

- Disturbance to noise sensitive marine life.

Waste to Shore:

- Improper disposal.

Other Impacts:

- Disruption of benthic communities that have established on and adjacent to the facilities.

8.8.2.1 Discharges to Sea

Minor spills of oil and the release of residual hydrocarbons from the uncoupling of connections, used storage containers and general handling may lead to the potential reduction of water quality. The environmental impacts associated with minor spills have been previously discussed in **Section 8.8.1.1**. It is concluded that this potential environmental impact will be a negative short-term but negligible impact.

8.8.2.2 Noise and Vibration

Noise from decommissioning will be generated from cutting activities and the movement of vessels. The environmental impacts associated with the generation of noise and vibration has been previously discussed in **Section 8.8.1.2**. It is unlikely that there will be any direct impact on marine organisms thus the generation of noise and vibration is considered to be a potential negative, short-term but negligible impact.

8.8.2.3 Waste to Shore

All wastes will be disposed onshore. This may include storage drums, metal sheets, concrete and steel. The disposal of waste to shore has been previously discussed in **Section 8.8.1.3**. The potential environmental impact of improper disposal will be a negative but short-term impact.

8.8.2.4 Other Impacts

It is accepted industry practice that all facilities and associated infrastructure be removed to at least 55 metres below the sea surface, such that an appropriate level of safeguard is provided for potential future activities in the area.

8.3.3 Subsea Pipeline

A number of options for the decommissioning of the subsea pipeline will be considered by Woodside including full removal, deep burial, leave in-place (after flushing and cleaning) or a combination of these. At this stage no decision has been made on the abandonment policy, however, a Decommissioning Plan will be prepared by Woodside and approved, prior to decommissioning commencing. The ultimate decommissioning undertaken at the conclusion of the Sunrise Gas Project will be subject to the legislative requirements of the day. The sources of impacts identified from the above activities associated with the decommissioning of the sections of the subsea pipeline:

- Abandonment of subsea pipeline;
- Removal of subsea pipeline; and
- Potential discharge of residual hydrocarbons/chemicals.

Discharges to the Sea:

- Potential hydrocarbon contamination by oil spillage;

Noise, Vibration, Light and Heat:

- Disturbance to noise sensitive marine life.

Waste to Shore:

- (Improper) Disposal.

Other Impacts:

- Disruption of benthic communities that have established on and adjacent to the pipeline.

8.3.3.1 Discharges to Sea

Residual hydrocarbons are likely to be encountered during cleaning and flushing of the pipeline whilst decommissioning. Potential contaminants are likely to be similar to that contained in hydrotest water used during commissioning. Small concentrations of biocides and corrosion inhibitors will be contained in wastewater. Wastewater from cleaning and flushing will be discharged offshore such that impacts to sensitive receptors are avoided. The presence of residual hydrocarbons, biocides and corrosion inhibitors will have the potential to reduce water quality. The environmental impacts associated with the discharge of hydrocarbons and other contaminants to the sea have been previously discussed in **Section 8.8.1.1**. It is concluded that this potential environmental impact will be a negative short term but negligible impact.

8.3.3.2 Noise and Vibration

In the event that the subsea pipeline will be completely removed, cutting activities will generate acoustical emissions. The subsea pipeline will need to be cut into sections to allow the transport of the pipeline onshore. The lay barge and support vessels will also generate acoustical emissions however these are expected to be much lower than those produced from cutting.

In the event that the pipeline will be buried, acoustical emissions will be generated by vessels and equipment used to transport and dump fill over the pipeline.

The potential environmental impacts on marine fauna from noise and vibration have been previously discussed in **Section 8.8.1.2**. It is unlikely that there will be any direct impact on marine organisms from noise and vibrations generated by decommissioning activities of the subsea pipeline. Therefore the generation of noise and vibration is considered to be a potential negative, short-term but negligible impact.

8.8.3.3 Waste to Shore

If the pipeline is removed, disposal onshore will be necessary. This may include materials such as concrete and steel in quantities of at least 0.5 million tonnes. This impact is considered permanent in duration but minor. If feasible Woodside will investigate alternative options to disposal at landfill. The disposal of waste to shore has been previously discussed in **Section 8.8.1.3**. In the event that the pipeline will be buried, there will be no requirement to dispose of waste onshore.

8.8.3.4 Other Impacts

A decommissioning plan will be prepared by Woodside and approved by the relevant regulatory authorities prior to initiation of decommissioning.

If the pipeline is to be removed it will result in a loss of benthic communities and increased turbidity within the vicinity of disturbance. The increase in turbidity and potential smothering of benthos from either removing the pipeline or dumping of fill is likely to occur as result of the localised suspension of sediment. Resuspended sediment is expected to settle following disturbance. The environmental impact on benthic communities is considered to be minor as the communities are generally resilient and are expected to recolonise the area soon after disturbance. On the other hand, if the pipeline remains in place, following cleaning and flushing, the impact would be deemed negligible and neutral.

8.9 Mitigation Measures for Decommissioning Phase

8.9.1 General

A decommissioning plan will be developed by Woodside in accordance with the guidelines currently being drawn up by the DBIRD. This plan will take into account the concerns and views of other marine users as well as the current and future values of the area. The disposal or reuse/recycling of structures and equipment and the safe decommissioning of wells will also be considered.

A number of options will be considered by Woodside for the decommissioning of the wellhead platform. The ultimate decommissioning undertaken at the conclusion of the Sunrise Gas Project will be subject to the legislative requirements of the day. The options to be considered include:

- Complete removal of jacket;
- Toppling of jacket on side and leaving as artificial reef;
- Cutting of the jacket at seabed and towing to deep water for disposal as an artificial reef; and
- Removing of the top bays of the jacket.

Equipment and facilities no longer required for production will be decommissioned safely taking the following into consideration:

- All wells developed by the project will be permanently sealed off below the seabed and abandoned in accordance with industry standard and legislation of the day;
- Intrafield pipelines and manifolds will most likely be cleared of hydrocarbons, depressurised, cleaned and left in place;
- Risers will also be cleaned but will be removed; and
- All waste materials will be managed in accordance with the project-specific Waste Management Plan.

At present it has not been decided exactly how the pipeline will be dealt with at the end of its working life. The potential options will be considered in the Decommissioning Plan, which will be drawn up in accordance with DBIRD guidelines and relevant legislation.

8.9.2 Commitments

- Prepare and Implement a Decommissioning Plan.

8.10 Preliminary Hazard Analysis

This section summarises Woodside's objectives in the management of safety, hazards and risks during the course of the Sunrise Project. The information below has been summarised from Woodside's 'Concept Health, Safety and Environment (HSE) Case' Woodside (2001) which brings together the methodologies, results and conclusions of hazard analysis conducted for the Project to date. Reference should be made to this document for such details.

The governing legislation *Petroleum (Submerged Lands) (Management of Safety on Offshore Installations) Regulations* requires a Safety Case to be in force for an offshore facility. The primary objective of the HSE Case is to demonstrate to the Regulator, stakeholders, shareholders, workers and the public that essential controls are in place such that the major HSE risks arising from the operations are both tolerable and reduced to as low as reasonably practicable (ALARP). Major HSE risks are defined as those associated with major ('high risk') hazards and are illustrated in a risk matrix.

The objectives of the concept HSE Case (Woodside 2001) at this early stage of the development are:

- To demonstrate that the design option creates an acceptable major accident and environmental risk that is as low as reasonably practicable;
- To demonstrate that the adequacy of the concepts have been considered to achieve the lowest reasonably practicable level of risk for personnel on the installation;
- To evaluate the Project's understanding of the inherent risk in the concept and operation and identify the requirement for controls through the Develop and Execute phases to ensure operational phase risks are as low as reasonably practicable (ALARP). The resulting documentation can be used to demonstrate that:
    - All major potential hazards applicable to the Sunrise Project concept design have been identified and are controlled;
    - The risks have been identified, evaluated and measures taken to reduce the risks to a level of ALARP; and
    - Recovery systems will be put in place for the unlikely event of loss of control.

The Project activities will be guided by the requirements of Woodside's 'Guideline for HSE Management During Opportunity and Project Realisation' which provides guidance for HSE hazard management activities within the four phases of the 'Opportunity and Project Realisation Process' (OPREP), ie. Assess, Select, Develop and Execute.

These requirements will ensure the identification and understanding of all known hazards and their associated risks; and mishap risk eliminated or reduced to acceptable ALARP levels. The overall objective is to achieve acceptable mishap risk through a systematic approach of hazard analysis, risk assessment and risk management.

Design of the Sunrise Gas Facilities safety systems will be based upon the requirements and guidance of the following (where applicable) main reference systems, documents and Regulations:

- Woodside HSE Management System;
- API RP 14 C Analysis, Design, installation and Testing of Basic Surface Safety Systems for Offshore Production Platforms;
- API RP 14 J, Design and Hazard Analysis for Offshore Production Facilities;
- API 521, Guide for Pressure Relief and Depressurising Systems;

- ❑ Petroleum (Submerged Lands) Act 1967, Commonwealth of Australia, and the associated schedules "*Specific Requirements as to Offshore Petroleum Exploration and Production – 1999* and "*Management of Safety on Offshore Installations – Regulations 1996*; and
- ❑ *Navigation Act 1912* and Amendments and Regulations pursuant to the Act (which includes requirements of the International Convention for the Safety of Life at Sea (SOLAS) as called up by P(SL)A).

Sunrise project philosophies have been prepared, based upon the above reference sources to guide safety systems design. These include:

- ❑ Safety Systems Design Philosophy;
- ❑ Flare Relief and Blowdown Philosophy;
- ❑ Hazardous Area Classification Philosophy;
- ❑ Fire and Explosion Protection Philosophy; and
- ❑ Philosophy for Escape, Temporary Refuge and Evacuation.

These documents provide guidance on design aspects to be considered in the control of hazards and on application of different hardware systems for recovery. The documents outlined above will be upgraded to reflect design maturity in the Design Phase of the Sunrise Project. A number of studies will be undertaken to provide additional checks on the design integrity including:

- ❑ HAZID Studies/Reviews: - to be held at various stages to identify the major hazards, which must be removed or managed.
- ❑ Base Case Review: A HAZID was performed in May 2001 on field and facility layouts. This study reviewed at a high level all known field activities for the design case.
- ❑ HAZOPs (Hazard and Operability Studies): are a safety study seen as being a valuable tool for design review. A HAZOP is a systematic review of the entire process and utility systems for a facility with the aim of identifying potential hazard or operability "deviations" from design or operational intent. For Sunrise HAZOP studies have been conducted as follows:
    - Select Phase: A coarse HAZOP of Process Flow Diagrams was conducted at the end of the Select Phase of the Project (May 2001) when concept drawings and documentation were available.
    - Coarse Quantitative Risk Assessment (QRA) studies have been initiated to determine risk levels of options and as an aid to management decisions on project development. Coarse QRA studies have been progressed for the above purpose in the Select Phase and will be preformed in the Basis of Design (BOD) /Project Specification phases. The select phase preliminary QRA results are presented in the 'Concept HSE Case' Woodside (2001).

The objectives of the hazard analysis concepts conducted to date are to demonstrate:

- ❑ That all major health, safety and environmental risks will be identified and assessed;
- ❑ That the control, mitigation and recovery measures that will be put in place to manage these hazards are adequate; and
- ❑ That identified risks will be reduced to as low as reasonably practicable (ALARP).

In the Project Select phase, health and safety-related activities are concentrated on the identification and comparison of major hazards and the selection of options to minimise total project life-time risks both in terms of potential loss of life, voluntary and when applicable involuntary, individual risk.

There has been a number of Hazard Identification exercises QRA's undertaken to evaluate different options and to demonstrate ALARP risk levels throughout the Project development. Safety has been a major driver in concept and option selection.

9. Environmental Management

9.1 Environmental Management Strategy

The Sunrise Project's Environmental Management Plans (EMPs) will be managed through Woodside's Health Safety and Environmental Management System (HSE-MS). Central to this system is the Environmental Policy which seeks to ensure that planning and performance of all Company activities are undertaken so that adverse effects are either avoided or kept to within acceptable standards, and all statutory requirements are observed.

The Woodside HSE-MS is based on the AS/NZS/ISO 14000 series. The Sunrise environmental management performance will be audited externally. The system will contain a two-tiered system of inspection and internal audits on specific activities or facilities.

Environmental issues will be further identified as part of Project planning as an internal *Register of Environmental Effects* enabling Project management to ensure they were addressed, along with other business priorities, in the early screening and design stages. Progress will continue to be periodically reviewed and documentation updated during project design and execution.

Environmental issues relevant to contractors will be managed through the requirements of Woodside's tendering and contracting procedures. These procedures require tenderers to pre-qualify, amongst other things, on the basis of their environmental management capabilities. Each tenderer is required to submit details on its Environmental Management Policy and Environmental Management System and provide a preliminary EMP. Each external EMP will be further developed if the Tenderer is successful.

Environmental inductions will be provided to all employees involved in all major phases of the project. These inductions will involve input from professional environmental staff.

For activities identified as potentially impacting on the environment, a detailed EMP will be prepared to Woodside's and where appropriate, regulatory agency requirements.

9.2 Environmental Management Plans

Environmental aspects of the Sunrise Gas Project will be managed primarily through development and implementation of EMPs for the 4 phases of the development:

- Drilling;
- Construction and Installation;
- Commissioning and Operation; and
- Decommissioning

Tables 9.1 through **9.4** provide preliminary lists of component tasks to be developed further in the 4 EMPs. The components are organised by Facility/System Sub-Elements, Environmental Sources and Potential Impacts, Management Measures, and supporting Management Plans (on specific issues such as Waste Management, Oil Spill Contingency Management, and Emergency Response).

The EMPs will be developed further following the completion of the environmental assessment and finalisation of project design.

The EMPs will establish management and monitoring plans to minimise actual and potential impacts associated with the four phases of the Sunrise Gas Project, and ensure compliance with all relevant environmental regulations.

The EMPs will identify the timing and scope of individual components and serve as a compliance document – recording the progress of management commitments and their conformity with requirements set by authorities and expectations of the public.

9.2.1 Structure and Scope

Each EMP will contain information covering: corporate environment policy, environment legislation, description of an activity, description of the environment, assessment of environmental risks and effects, performance objectives, standards and criteria, implementation strategy, reporting arrangements and consultations. Full details of consultation with both statutory and non-statutory bodies will be recorded as part of the EMP process.

Corporate Environmental Policy
Woodside's Environmental Policy is contained in **Appendix B**.

Environment Legislation
Each EMP will identify all Commonwealth and State/Territory legislation that must be complied with relevant to the environment and the proposed upstream operations. A table or list identifying the legislation, specific requirements, guidelines or codes of practice and how the operator proposes to address each specific document or legislative requirement would be included.

Description of the Activity
The EMPs will contain sufficient information about each activity to enable identification of potential interactions with the environment. They will contain, at a minimum:

- The location or locations of the proposed activity;
- General construction and layout details of any facility or other structure;
- An outline of the proposed operations (eg, production drilling, production, etc) and proposed timetables; and
- Additional information relevant to consideration of the environmental risks and effects of the activity.

Description of an activity may be made by reference to existing documents prepared for other purposes, if the description is adequate.

Description of the Environment
The EMPs will contain a description of the environment that will be affected or potentially affected by an activity, covering:

- Existing environment;
- Cultural environment; and
- Socio-economic environment.

The description will identify particular values and sensitivities of that environment (eg, cultural and heritage sites, marine protected areas, coral reefs and endangered flora and fauna).

Description and Assessment of Environmental Risks and Effects

Each EMP will contain a detailed assessment of the environmental impact of normal operations and possible non-routine operations (whether accidental or otherwise) that are not normal operations for an activity for the life of the proposal. At a minimum, the following will be included, where relevant:

a) An identification and evaluation of the environmental risks and effects and their significance arising directly or indirectly from the normal and non-routine operations of an activity including those arising from the:

- ☐ Construction and installation of facilities;
- ☐ Presence of fixed, mobile or temporary facilities;
- ☐ Marine operations including:
  - Transport to and from facilities;
  - Standby vessels;
  - Air operations including;
  - Transport to and from facilities;
  - Production drilling operations;
  - Production and pipelining operations; and
  - Storage, transfer and transport of petroleum and other materials.
- ☐ Discharges to land or water including:
  - Drilling muds and fluids;
  - Formation water;
  - Domestic wastes; and
  - Other discharges.
- ☐ Emissions to air including:
  - Flaring;
  - Venting;
  - Fugitive emissions; and
  - Other emissions.
- ☐ Waste management;
- ☐ Noise;
- ☐ Decommissioning; and
- ☐ Rehabilitation.

relative to the:

- ☐ The natural environment;
- ☐ Cultural environment; and
- ☐ Socio-economic environment.

b) An assessment of the confidence in predicting the environmental effects, risks and significance.

Where possible, risk to the environment will be expressed in a quantitative manner. Where uncertainty exists the best possible semi-quantitative or qualitative measures should be provided. A precautionary approach should be adopted in the consideration of risk to the environment.

Performance Objectives, Standards and Criteria

The EMPs will contain environmental performance objectives, standards and measurement criteria, to determine if an activity is meeting its environmental objectives and standards.

The performance objectives, standards and criteria must be consistent with reducing environmental risks and effects to 'as low as reasonably practicable' (ALARP).

Implementation Strategy

Woodside will develop an implementation strategy that will include operational systems and procedures that:

1) Ensure that the agreed environmental performance objectives and standards are met;
2) Identify specific systems, practices and procedures to be used to ensure that environmental risks and effects are reduced to as low as reasonably practicable and that environmental performance objectives and standards are met;
3) Establish a clear chain of command that sets out the roles and responsibilities of personnel;
4) Ensure that each employee or contractor working on, or in connection with, the activity is aware of their responsibilities in relation to the environment and has the appropriate skills and training;
5) Monitor, review and audit environmental performance and the implementation strategy (IS);
6) Maintain quantitative records of emissions and discharges to the air, marine, seabed and sub-seabed environment, that are accurate and can be monitored and audited against environmental performance standards and measurement criteria;
7) Maintain an up-to-date emergency response manual (including an oil spill contingency plan) that includes detailed response and investigative arrangements;
8) Provide for appropriate consultation with relevant government authorities and other interested persons or organisations; and
9) Comply with the P(SL)A and corresponding regulations and any other environment legislation applying to the activity.

Reporting Arrangements

Each EMP will include arrangements for recording, monitoring and reporting information about the activity (including information required to be recorded under the P(SL)A and its corresponding regulations or any other environment legislation applying to the activity) that will enable the relevant regulatory authority to determine whether the environmental performance objectives and standards in the EMP have been met.

Consultations

Each EMP may include a report on consultations between the operator and the relevant authority, and other interested persons and organisations (eg, fishing cooperatives and tourism operators, local community and environment Non-Government Organisations) in the course of developing the EMP. It will also include details of ongoing consultation arrangements to be adopted during the operational phase with other marine users and interest groups.

Consultations will begin at an early stage of project development to ensure all concerns are addressed prior to commitment to a preferred option. The level and nature of consultations should be appropriate to the level and nature of the proposed activity.

The Report on Consultations prepared for the various EMPs will identify:

- ☐ Relevant government authorities, interested persons and organisations (such as other marine users and interest groups that were consulted);
- ☐ Concerns and interests raised during the consultations; and
- ☐ Actions or other arrangements to address those concerns, including any ongoing consultation arrangements.

9.3 Monitoring

A detailed environmental monitoring programme will be developed an implemented. The programme will be designed to:

- Provide information on the nature of potential impacts which cannot be precisely predicted;
- Ensure that safeguards are appropriate;
- Ensure that the potential environmental effects are minimised;
- Ensure that the facility complies with any regulations governing particular activities; and
- Enable the implementation of contingency measures, if required.

The monitoring programme will be developed following completion of the environmental assessment and finalisation of project design and will be subject to regulatory approval prior to implementation.

9.4 Management Commitments

Woodside is committed to achieving a level of environmental management and performance consistent with national and international standards and statutory obligations during its pursuit of sound business and financial objectives. The most economically effective, environmentally sound technology and procedures will be incorporated into the design of the project. The adoption of such a strategy will ensure optimal management of all emissions, discharges and waste. Furthermore, Woodside is committed to ensuring that the development of the Sunrise Gas Project will be undertaken in a manner that minimises impacts on the surrounding biophysical and social environments. Accordingly, Woodside proposes numerous management commitments. As the project concept advances it will be possible to refine further a full list of these commitments. These commitments are summarised in **Table 9.5.**

Table 9-1 Draft Environmental Management Plan for Drilling and Associated Activities

TOPIC/SUB-ELEMENT	SOURCES AND POTENTIAL IMPACTS	ENVIRONMENTAL MANAGEMENT MEASURES	SUPPORTING MANAGEMENT PLANS
Wellhead Platform Installation	**Source of Impact** Physical Presence of Wellhead Platform ▪ Lighting ▪ Disposal of construction wastes ▪ Presence of construction and support vessels ▪ Discharge of sewage and greywater ▪ Discharge of domestic waste including food scraps **Impacts** ***Discharges to the Sea*** ▪ Potential localised reduction in water quality ***Noise, Vibration, Light and Heat*** ▪ Potential disturbance to marine species ***Waste to Shore*** ▪ Improper disposal	***Discharges to Sea*** ▪ Strict adherence to regulations for discharges to sea ***Noise, Vibration, Light and Heat*** ▪ Design to minimise, noise, vibration, light and heat ***Waste to Shore*** ▪ Develop and implement a Waste Management Plan ▪ Ensure that Waste Management Plan is audited to ensure compliance ▪ Solid waste produced during construction will be stored, contained, separated where appropriate and disposed onshore at an approved facility ***Other*** ▪ Navigation and safety lighting will be provided to ensure that any shipping or recreational activities are able to clearly identify the presence of the facility. ▪ Notice to mariners will be issued alerting them of the development and associated activities prior to construction and charts will be amended to show the location of the facility.	Facility Environment Plan Waste Management Plan
Drilling of Platform and Subsea Wells	***Discharges to the Sea*** ▪ Smothering effects of accumulated drilling cuttings on marine biota ▪ Increased turbidity in the area if cuttings discharged at the surface ▪ Potential accumulation of metal and hydrocarbon concentrations in seabed sediments leading to toxicity ▪ Potential bioaccumulation/bioconcentration by marine biota of contaminants in non-water based drilling fluids ▪ Potential anoxia of sediment due to natural degradation of drilling muds ▪ Potential reduction in water quality in the area ▪ Potential of a significant fuel spill ***Noise, Vibration, Light and Heat*** ▪ Potential disturbance to marine species ***Waste to Shore*** ▪ Improper disposal ***Other*** ▪ Disturbance to seabed and potential changes to seabed characteristics from drilling unit spud cans.	***Atmospheric Emissions*** ▪ Use of efficient power generation equipment during drilling campaigns ▪ Efficient planning of vehicle and vessel movements will minimise fuel usage ***Discharges to Sea*** ▪ Strict adherence to regulations for discharges to sea Solid waste products from drilling will be monitored ▪ Hydrocarbon content in cuttings will be monitored ▪ Cuttings may be either directed to seafloor via chute or disposed down hole. ▪ Recolonisation of drill cutting occurs rapidly within the first 6–24 months if directed to the seabed ▪ Non-water-based fluids must be approved for use by regulatory bodies ▪ Where possible the selection of drilling fluids will give preference to low toxicity ▪ Non-water based drilling fluids can be reused and recycled after use ▪ Government guidelines will be used for management of drilling fluids ▪ Equipment such as shale shakers and centrifuges to be used to separate cuttings from mud and other contaminants. Solids control equipment will be routinely checked ▪ Modelling of cuttings discharge has been undertaken by Asia Pacific ASA ▪ Prepare and implement an Emergency Response Plan and Oil Spill Contingency Plan ***Noise, Vibration, Light and Heat:*** ▪ Design to minimise emissions of noise, vibration, light and heat. ***Waste to Shore*** ▪ Develop and implement a Waste Management Plan. ▪ Ensure that Waste Management Plan is audited to ensure compliance. ▪ Drainage from workspace areas will be separately bunded and drained to a central collection system. ▪ Oily waste and potentially contaminated liquid wastes will be collected and contained separately from clean stormwater. ***Other*** ▪ Areas impacted by anchoring are likely to be recolonised within 6 months of disturbance ▪ Sensitive habitats would be avoided as a result of site selection studies ▪ Baseline surveys of seabed characteristics/communities have been undertaken to facilitate future monitoring ▪ Ongoing monitoring and inspections during the construction phase will ensure that impacts are minimised wherever possible	Drilling Environment Plan Waste Management Plan Emergency Response Plan Oil Spill Contingency Plan

Table 9-2 Draft Environmental Management Plan for Installation and Construction

TOPIC/SUB-ELEMENT	SOURCES AND POTENTIAL IMPACTS	ENVIRONMENTAL MANAGEMENT MEASURES	SUPPORTING MANAGEMENT PLANS
Subsea Facilities (well heads, manifolds, flowlines, risers, etc)	**Source of Impact** ▪ Installation of subsea facilities ▪ Anchoring of construction vessel(s) ▪ Discharge of sewage and greywater ▪ Discharge of domestic waste including food scraps ▪ Disposal of domestic waste including paper and plastics etc ▪ Power generation ▪ Refuelling at sea **Impacts** ***Atmospheric Emissions*** ▪ Greenhouse gases produced by vessel power generation (primarily CO_2) ▪ Atmospheric pollutants (primarily NOx, SOx, VOCs and smoke/particulates ***Discharges to the Sea*** ▪ Potential significant fuel spill ***Noise, Vibration, Light and Heat*** ▪ Potential disturbance to marine species and birds ***Waste to Shore*** ▪ Improper disposal	***Atmospheric Emissions*** ▪ Efficient planning of vehicle and vessel movements will minimise fuel usage ***Discharges to Sea*** ▪ All Contractors personnel will receive induction training on correct handling and pollution prevention requirements. ▪ Strict adherence to regulations for discharges to sea. ▪ Prepare and implement an Emergency Response Plan (ERP) and Oil Spill Contingency Plan (OSCP). ▪ Bunding of areas that contain chemicals. ***Noise, Vibration, Light and Heat*** ▪ Design to minimise emissions of noise, vibration, light and heat. ***Waste to Shore*** ▪ Develop and implement a Waste Management Plan. ▪ Ensure that Waste Management Plan is audited to ensure compliance. ▪ Solid waste produced during construction will be stored, contained, separated where appropriate and disposed onshore at an approved facility. ▪ Offsite fabrication and modularised construction will ensure minimal waste generation on site. ***Physical Presence of Facilities*** ▪ Selection of the pipeline routes has been optimised to take into account potential environmentally sensitive areas. ▪ Baseline surveys have been undertaken identifying benthic communities during EIA to minimise placement on sensitive marine habitats. ▪ Pipelines will be laid directly on seabed: no trenching, backfilling, dredging or blasting required.	Facility Environment Plan Waste Management Plan

Table 9-2 Draft Environmental Management Plan for Installation and Construction (Continued)

TOPIC/SUB-ELEMENT	SOURCES AND POTENTIAL IMPACTS	ENVIRONMENTAL MANAGEMENT MEASURES	SUPPORTING MANAGEMENT PLANS
PCUQ Platform and SO	**Source of Impact** ▪ Transportation of the PCUQ Platform and FSO to site ▪ Installation of the PCUQ Platform and FSO on site ▪ Physical presence of PCUQ Platform and FSO ▪ Installation of foundations of the PCUQ Platform ▪ Disposal of construction wastes ▪ Presence of construction and support vessels ▪ Installation of mooring for the FSO ▪ Power generation ▪ Lighting **Impacts** ***Atmospheric Emissions*** ▪ Greenhouse gases produced by vessel power generation (primarily CO_2); ▪ Atmospheric pollutants (primarily NO_x, SO_x, VOCs and smoke/particulates); ***Discharges to the Sea*** ▪ Potential reduction in water quality in the area ***Noise, Vibration, Light and Heat*** ▪ Potential disturbance to marine species ▪ Potential attraction of marine species ***Waste to Shore*** ▪ Improper disposal.	***Atmospheric Emissions*** ▪ Efficient planning of vehicle and vessel movements will minimise fuel usage. ***Discharges to Sea*** ▪ Strict adherence to regulations governing discharges to sea ***Noise, Vibration, Light and Heat*** ▪ Design to minimise emissions of noise, vibration, light and heat ▪ Light is a mandatory requirement for safety; however, it can be controlled such that lighting of the sea surface is minimised. ***Waste to Shore*** ▪ Develop and implement a Waste Management Plan. ▪ Ensure that Waste Management Plan is audited to ensure compliance. ▪ Solid waste produced during construction will be stored, contained, separated where appropriate and disposed onshore at an approved facility. ▪ Offsite fabrication and modularised construction will ensure minimal waste generation on site. ***Other*** ▪ Navigation and safety lighting will be provided to ensure that any shipping or recreational activities are able to clearly identify the presence of activity. ▪ Notice to mariners will be issued alerting them of the development and associated activities prior to construction and charts will be amended to show the location of the facility.	Facility Environment Plan

Table 9-2 Draft Environmental Management Plan for Installation and Construction (Continued)

TOPIC/SUB-ELEMENT	SOURCES AND POTENTIAL IMPACTS	ENVIRONMENTAL MANAGEMENT MEASURES	SUPPORTING MANAGEMENT PLANS
Subsea Pipeline	**Source of Impact** ▪ Potential prelay with rock dump ▪ Power generation ▪ Hydrotesting **Impacts** ▪ Power generation ▪ Vehicle operation ***Atmospheric Emissions*** ▪ Significant emissions of greenhouse gases produced by vehicles and power generation (primarily CO_2); ▪ Significant emissions of atmospheric pollutants (primarily NO_x, SO_x, VOCs and smoke/particulates); and ▪ Dust generation and significant emissions of particulate matter. ***Discharges to the Sea*** ▪ Smothering of benthos. ▪ Potential exposure of acid sulfate soils resulting in acid generation. ***Noise, Vibration, Light and Heat*** ▪ Potential disturbance to marine fauna. ▪ Potential disturbances of marine species from lights ***Waste to Shore*** ▪ Improper disposal. ***Other*** ▪ Potential spillage of fuel and hydrocarbons. ▪ Temporary disruption of commercial and recreational fisheries and recreational areas.	***Atmospheric Emissions*** ▪ Internal coating to maximise hydraulic efficiency of pipeline in order to minimise future compressor power requirements. ▪ Efficient planning of vehicle movements will minimise fuel usage. ▪ Contractor to maintain engines to ensure optimal operation. ***Discharges to Sea*** ▪ Ensure minimal use of hydrotest chemicals such as oxygen scavenger and biocide. ▪ Relevant regulatory authorities to be notified of requirement to abstract & discharge water. ***Noise, Vibration, Light and Heat*** ▪ Emissions of the noise and vibration will be minimised where practicable. ***Waste to Shore*** ▪ Solid waste produced will be stored, contained, separated where appropriate and disposed at an approved landfill facility. ***Other*** ▪ Develop and implement an Emergency Response Plan.	Facility Environment Plan Waste Management Plan Rehabilitation Plan Weed Management Plan Emergency Response Plan

Table 9-3 Draft Environmental Management Plan for Commissioning and Operation

TOPIC/SUB-ELEMENT	SOURCES AND POTENTIAL IMPACTS	ENVIRONMENTAL MANAGEMENT MEASURES	SUPPORTING MANAGEMENT PLANS
Well head Platform, Processing, Compression, Utilities and Quarters (PCUQ) and Subsea Facilities	**Source of Impact** ▪ Potential condensate spill ▪ Emergency shutdown of facility ▪ Discharge of Produced Formation Water (PFW) ▪ Disposal of waste associated with maintenance of the platforms ▪ Discharge of cooling water ▪ Disposal of oily waste, waste oil, etc. ▪ Discharge of potentially contaminated stormwater from machinery, workshop etc ▪ Discharge of sewage and greywater ▪ Disposal of domestic waste including food scraps ▪ Increased shipping movements in the area ▪ Potential collision of shuttle tanker or supply vessels with platforms ▪ Operational noise ▪ Power generation producing greenhouse gas emissions to air ▪ Hazardous materials ▪ Potential prelay with rock dump ▪ Rock armouring ▪ Power generation ▪ Hydrotesting **Impacts** ***Atmospheric Emissions*** ▪ Comminute or grind food scraps to particle sizes of less than 25 mm prior to discharge ▪ Significant emission of greenhouse gases due to export compression Significant emission of greenhouse gases due to power generation ▪ Significant emission of greenhouse gases due to flaring ▪ Significant emission of smoke and particulates ***Discharges to the Sea*** ▪ Potential significant hydrocarbon contamination from condensate spill ▪ Potential significant hydrocarbon contamination from diesel spill ▪ Potential significant contamination from PFW discharge ▪ Potential elevation of water temperature may affect marine organisms ▪ Potential reduction in local water quality ▪ Potential reduction in water quality due to hydrotesting (biocides, scale and corrosion inhibitors and oxygen scavengers) ***Noise, Vibration, Light and Heat*** ▪ Potential disturbance to marine species and birds ▪ Potential attraction of marine species	***Atmospheric Emissions*** ▪ Selection of efficient power generation and compression equipment ▪ The production facility will be equipped with an Emergency Shut Down (ESD) system and numerous isolation valves. The automated ESD will also be back-up via a manual system ▪ Equipment and fuel selection will be undertaken such that emission characteristics will be minimised ▪ Routine maintenance on combustion equipment will be undertaken ▪ Flaring will be minimal ▪ Banned substances including, CFC, halon and HFC's will not be permitted in facility design ▪ Chemical selection to avoid ozone depleting substances where practicable ▪ Refrigerants will be recovered during maintenance of equipment ***Discharges to Sea*** ▪ Prepare and implement an Emergency Response Plan and Oil Spill Contingency Plan ▪ PFW may be reinjected to dedicated wells ▪ The quantity and hydrocarbon content of PFW discharged to the sea will be monitored continuously ▪ The PFW system will be designed and managed such that oil in water content is maintained below 30 mg/L (24hr-average) and 50 mg/L (instantaneous) ▪ Alarm on PFW system will be raised when oil in water exceeds 30 mg/L. Water system will alarm when oil-in-water exceeds 50 mg/L ▪ Periodic sampling of PFW discharges will be undertaken ▪ Selection of low toxicity corrosion and scale inhibitors will be given preference ▪ Drainage from process and workspace areas will be separately bunded and drained to a central collection system ▪ MSDSs will be made readily available for all chemicals kept on the platforms ▪ Chemicals having minimal environmentally toxicity and bioaccumulation characteristics but which meet safety requirements will be used ▪ Comminute or grind food scraps to particle sizes of less than 25 mm prior to discharge ***Noise, Vibration, Light and Heat*** ▪ Emissions of the noise and vibration will be minimised where practicable ▪ Silencers, cladding and other appropriate noise attenuation controls will be installed where practicable ▪ Lighting will be designed to Australian Standards and regulatory requirements that ensure that excess lighting that may result in light overspill is avoided	

Table 9-3 Draft Environmental Management Plan for Commissioning and Operation (Continued)

TOPIC/SUB-ELEMENT	SOURCES AND POTENTIAL IMPACTS	ENVIRONMENTAL MANAGEMENT MEASURES	SUPPORTING MANAGEMENT PLANS
	Waste to Shore ▪ Improper disposal ***Other*** ▪ Potential loss of access to fishing grounds with a large exclusion zone around development area ▪ Creation of hard substrate that could be colonised by marine pest species ▪ Recolonisation of a different community to that originally found in the area **Comment:** The probability of a spill is very low. No major spills from exploration activity have occurred to date in Australia. Condensate evaporates rapidly and loses toxicity relatively quickly.	***Waste to Shore*** ▪ Develop and implement a Waste Management Plan ▪ Ensure that Waste Management Plan is audited to ensure compliance ▪ Solid waste produced during construction will be stored, contained, separated where appropriate and disposed onshore at an approved facility ▪ Personnel will be appropriately trained to ensure safe handling procedures and approved disposal of waste ▪ Oil and chemical drums will be stored in bunded areas capable of storing 110% capacity of stored volume ▪ Dip trays will be used under all machinery ***Other*** ▪ Platform design will incorporate features allowing for segregation of clean and dirty areas ▪ Baseline monitoring will be undertaken to facilitate future monitoring programs ▪ Ongoing monitoring and inspections during the operation phase will ensure that impacts are detected and minimised wherever possible	Facility Environment Plan Emergency Response Plan Oil Spill Contingency Plan
Subsea Pipeline	**Source of Impact** ▪ Hydrotesting of pipeline ▪ Potential rupture of pipeline ▪ Presence of the pipeline **Impacts** ***Atmospheric Emissions*** ▪ Potential emissions of natural gas or condensate in the event of a leak ***Discharges to the Sea*** ▪ Potential reduction in water quality offshore due to release of hydrotest water (biocides, scale and corrosion inhibitors and oxygen scavengers) ***Other*** ▪ Physical presence of pipeline ▪ Restriction of commercial fishing, recreation or other practices along the pipeline route ▪ Occurrence of fires ▪ Potential spills may contaminate important breeding, nesting and foraging habitats ▪ Potential spills may directly and fatally impact fauna and vegetation ▪ Potential spill resulting in soil contamination	***Atmospheric Emissions*** ▪ The pipeline will be designed to minimise risks of damage from any anticipated storm and cyclonic activities with a 100 year return period. ▪ Prepare and implement a Pipeline Rupture Contingency Plan ▪ Design will incorporate automatic Emergency Shut Down, with back-up allowing for manual shutdown ▪ Regular inspection of subsea pipeline - checking for damage, spans and objects) ▪ Flow rates will be continuously monitored and will detect the occurrence of any leaks along the line. Any drop in flow rate will activate a warning system. ▪ Cathodic protection of the pipeline to mitigate against external corrosion ▪ Continuous monitoring of rate of corrosion and where necessary adjustment of dosage rate ▪ The number of potential leak/ rupture points along the pipeline will be minimised by reducing the number of connection points, valves and flanges to as few as possible ***Discharges to Sea*** ▪ Selection of low toxicity corrosion inhibitors will be given preference. ▪ Prepare and implement a Pipeline Rupture Contingency Plan addressing the risk to the marine environment	Facility Environment Plan Pipeline Rupture Contingency Plan

Table 9-3 Draft Environmental Management Plan for Commissioning and Operation (Continued)

TOPIC/SUB-ELEMENT	SOURCES AND POTENTIAL IMPACTS	ENVIRONMENTAL MANAGEMENT MEASURES	SUPPORTING MANAGEMENT PLANS
FSO and Shuttle Vessels	**Source of Impact** ▪ Potential spill during condensate transfer to shuttle tankers ▪ Ballast water discharge from offtake tankers once on site ▪ TBT and other antifoulant paints on tankers ▪ Vessel hulls fouled with marine organisms ▪ Cargo tank venting to atmosphere ▪ Potential collision with shuttle tankers or supply vessels ▪ Power generation emissions ▪ Discharge of sewage and greywater ▪ Disposal of domestic waste including food scraps **Impacts** ***Atmospheric Emissions*** ▪ Cargo tank emissions from loading of FSO and shuttle tankers ***Discharges to the Sea*** ▪ Contamination of marine environment by anti-fouling agents. ▪ Introduction of marine pest species from off-take tanker de-ballasting and hull fouling ▪ Potential significant hydrocarbon contamination from condensate spill ▪ Potential significant hydrocarbon contamination from diesel spill ***Other*** ▪ Interference with shipping.	***Atmospheric Emissions*** ▪ Losses associated with loading and storage will be minimised as far as is practical ***Discharges to Sea*** ▪ Prepare and implement an Emergency Response Plan (ERP) and implement current Oil Spill Contingency Plan (OSCP) ▪ Ships to comply with AQIS guidelines with respect to de-ballasting ▪ Ballast water exchange restricted to deep ocean waters ▪ FSO and shuttle tanker to have segregated ballast tanks ▪ By 2003 new vessels will be required to use an alternative antifoulant to TBT. Existing vessels are required to have TBT removed by 2008 ▪ Transfer of product and diesel between vessels will be continuously monitored and supervised ▪ The drainage on the deck of the FOS will be designed to prevent spills going over the side ▪ Floating hoses containing condensate will be fitted with breakaway self-sealing couplings ▪ MSDSs will be made readily available for all chemicals kept on FOS ***Other*** ▪ Shipping movements will be co-ordinated according to accepted industry standards	Facility Environment Plan Emergency Response Plan Oil Spill Contingency Plan

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Table 9-4 Draft Environmental Management Plan for Decommissioning

TOPIC/SUB-ELEMENT	SOURCES AND POTENTIAL IMPACTS	ENVIRONMENTAL MANAGEMENT MEASURES	SUPPORTING MANAGEMENT PLANS
Wellhead Platform and Wells and Associated Subsea Facilities	**Source of Impact** ▪ Plugging and abandonment of wells ▪ Removal of well heads ▪ Removal of flowlines, manifolds and risers ▪ Vessel and rig movements **Impacts** ***Discharges to the Sea*** ▪ Potential discharge of residual hydrocarbons ***Noise, Vibration, Light and Heat*** ▪ Disturbance to noise sensitive marine life ***Waste to Shore*** ▪ Improper disposal **Other:** ▪ Disruption of benthic communities that have established on and adjacent to the facilities	***Discharges to Sea*** ▪ All flow lines will be flushed thoroughly to minimise oily waste discharges. ***Noise, Vibration, Light and Heat*** ▪ Emissions of the noise and vibration will be minimised where practicable. ***Waste to Shore*** ▪ All wastes will be collected and contained for disposal or recycling onshore. ***Other*** ▪ At the time of decommissioning, an investigation into the marine habitats surrounding the facilities will be undertaken to ensure that optimum abandonment philosophy is adopted. ▪ Decommissioning to be conducted in accordance with industry standards and legislation of the time.	Facility Environment Plan Decommissioning Plan
PCUQ and FSO	**Source of Impact** ▪ Removal of Wellhead Platform components and equipment ▪ Jackup and removal of the PCUQ ▪ Disconnection of FSO from flowlines ▪ Movement of FSO offsite **Impacts** ***Discharges to the Sea*** ▪ Potential hydrocarbon contamination by oil spillage ***Noise, Vibration, Light and Heat*** ▪ Disturbance to noise sensitive marine life ***Waste to Shore*** ▪ Improper disposal ***Other*** ▪ Disruption of benthic communities that have established on and adjacent to the facility	***Discharges to Sea*** ▪ Potential sources of hydrocarbon emission to the sea will be thoroughly flushed to minimise discharges ***Noise, Vibration, Light and Heat*** ▪ Emissions of the noise and vibration will be minimised where practicable ***Waste to Shore*** ▪ All wastes will be collected and contained for disposal or recycling onshore ***Other*** ▪ At the time of decommissioning, an investigation into the marine habitats surrounding the facilities will be undertaken to ensure that optimum abandonment philosophy is adopted ▪ Decommissioning to be conducted in accordance with industry standards and legislation of the time	Facility Environment Plan Decommissioning Plan
Subsea Pipeline	**Source of Impact** ▪ Abandonment of subsea pipeline ▪ Removal of subsea pipeline ▪ Potential discharge of residual hydrocarbons **Impacts** ***Discharges to the Sea*** ▪ Potential hydrocarbon contamination by oil spillage ▪ Discharge of pipeline cleaning and flushing chemicals ***Noise, Vibration, Light and Heat*** ▪ Disturbance to noise sensitive marine life ***Waste Production*** ▪ Improper disposal ***Other***: ▪ Disruption of benthic communities established on/by the pipeline	***Discharges to Sea*** ▪ The pipeline will be flushed thoroughly to minimise oily waste discharges ***Noise, Vibration, Light and Heat*** ▪ Emissions of the noise and vibration will be minimised where practicable ***Waste to Shore*** ▪ All wastes will be collected and contained for disposal or recycling/reuse to an approved facility ***Other*** ▪ At the time of decommissioning, an investigation into the marine habitats, surrounding the pipeline will be undertaken to ensure that optimum abandonment philosophy is adopted ▪ Decommissioning to be conducted in accordance with industry standards and legislation of the time	Facility Environment Plan Decommissioning Plan

Table 9.5 Summary of Woodside's Commitments for the Sunrise Gas Project

No.	Management Commitment	Objective	Timing
	Atmospheric Emissions		
1	Prepare a Drilling Environment Plan to ensure efficient power generation and planning of vehicle and vessel movements.	Minimise emissions of greenhouse gases in accordance to Commonwealth policies and accepted industry practice.	Pre-drilling
2	Prepare a Facility Environment Plan to ensure efficient power generation, planning of vehicle and vessel movements and overall optimal operation.	Minimise emissions of greenhouse gases in accordance to Commonwealth policies and accepted industry practice.	Pre-construction and pre-commissioning
3	Minimise flaring where possible.	Minimise emissions of greenhouse gases in accordance to Commonwealth policies and accepted industry practice.	Design and operation
4	Prohibit the use of ozone depleting substances-CFCs and halons.	Minimise emissions of greenhouse gases in accordance to Commonwealth policies and accepted industry practice. Meet ozone depleting substances legislation.	Design, drilling, construction and operation.
5	Undertake regular inspections/maintenance of the subsea pipeline in accordance with DNV OS F101 (2000).	Provide adequate protection to the pipeline.	Operation
	Discharges to Sea		
6	Obtain approval for non-water based drilling fluids. An Environment Plan will be drawn up and approved for the drilling programme prior to commencement.	Minimise potential for water quality reduction and subsequent impacts on marine biota.	Pre-drilling
7	Implement an Emergency Response Plan (ERP).	Minimise potential for water quality reduction and subsequent impacts on marine biota from non-routine events. The potential for pipeline rupture would be included in the ERP and drawn up in consultation with Emergency organisations etc.	Detailed Design
8	Implement WEL existing Timor Sea Oil Spill Contingency Plan. Amend this plan if required.	Minimise potential for water quality reduction and subsequent impacts on marine biota from oil spills.	Pre-drilling
9	Induct all personnel with particular attention given to correct handling of chemicals and pollution prevention requirements.	Minimise potential for water quality reduction and subsequent impacts on marine biota. Compliance with Emergency Response Plan and Oil Spill Contingency Plan.	Pre-drilling, pre-commissioning and appointment of new personnel
10	Continuously monitor the quantity and hydrocarbon content of Produced Formation Water.	Minimise potential for water quality reduction.	Operation
11	Monitor cooling water for temperature and hydrocarbon content.	Minimise potential for water quality reduction and subsequent impacts on marine biota.	Operation
12	Restrict ballast water exchange to deep, ocean waters.	Minimise potential for water quality reduction.	Operation
13	Continuously monitor and supervise the transfer of product and diesel between vessels.	Minimise risk on water quality from potential spills during product and diesel transfer.	Operation

No.	Management Commitment	Objective	Timing
14	Install breakaway self-sealing couplings on floating hoses that contain condensate.	Minimise risk on water quality from potential ruptures or leakages of floating hoses.	Design and Construction
15	Design an adequate stormwater drainage system to allow oily waste and potential contaminated liquid waste to be collected and contained separately from clean stormwater.	Minimise potential for surface water contamination	Design
	Noise, Vibration, Light and Heat		
16	Install appropriate noise attenuation controls including silencers cladding where practicable.	Minimise impacts on fauna and maintain species abundance.	Design
	Waste to Shore		
17	Prepare and implement a Waste Management Plan.	Avoid adverse impacts on the environment.	Design
	Other		
18	Issue Notice to Mariners alerting them of development and associated activities.	To ensure risk to fisheries is as low as reasonably practicable and complies with acceptable standards.	Pre-drilling and on a regular basis thereafter
19	Prepare and Implement a Decommissioning Plan.	Minimise potential impacts and risks on the environment.	Pre-decommissioning
20	Prepare and implement greenhouse gas strategy to minimise emissions of greenhouse gas	Minimise atmospheric pollution	Design
21	Design and implement operational measures to minimise flaring and venting	Minimise atmospheric pollution	Design
22	The reduction of methane emissions to negligible levels through the combustion of regeneration offgas;	Minimise atmospheric pollution	Design
23	Maximise the use of waste heat from gas turbines:	Minimise atmospheric pollution	Design

10. Public Involvement and Consultation

Preliminary consultations with numerous Darwin and East Timor based stakeholders have been undertaken by Woodside during the Project Development Phases and have continued throughout the process of preparing the EIS document. The following community stakeholders have been consulted to discuss the project and associated environmental factors:

Northern Territory

- Environment Centre;
- Marine and Coastal Community Network;
- World Wide Fund for Nature;
- Environmental Defenders Office;
- Threatened Species Network;
- Top End Native Plant Society;
- Field Naturaliste Club;
- Planning Action Network;
- Greening Australia;
- General public;
- NT Amateur Fishermen's' Association;
- NT Shooters' Council;
- Northern Land Council;
- Larrakia Nation Aboriginal Corporation;
- Larrakia Association Aboriginal Corporation;
- Acacia Larrakia Aboriginal Corporation;
- Tiwi Land Council;
- Tree Point Aboriginal Community; and
- Litchfield Shire Council.

East Timor

- United Nations Transitional Administration in East Timor
- East Timor Transitional Administration
- Universitas Nationale de Timor Loro Sae
- East Timorese National Council
- Partido Socialista Timor
- Apodeti (Popular Democratic Association)
- KOTA (Veterans Party)
- Trabalhista (Timor Labour Party)
- UDT (Timorese Democratic Union
- FRETILIN (Frente Revolucionara do Timor Leste Independente)
- PSD (Social Democratic Party)
- Chinese Business Association; and
- Dili Chamber of Commerce.

A communications plan has been developed specifically for the Sunrise Gas Project to:

- Increase community awareness and understanding of the oil and gas industry;
- Increase the Northern Territory and East Timor public awareness and participation in the community consultation process, prior to the formal release of the EIS document for public comment;
- Provide information about the Sunrise Gas Project into East Timor; and
- Address community and stakeholder concerns during the preparation of the EIS.

As part of the communications strategy the following information has been distributed to community stakeholders prior to and concurrent with the release of the EIS document for public comment:

- Two advertorials placed in the Northern Territory News, Palmerston Sun, Litchfield Times, Timor Post and Suara Timor Loro Sae newspapers;
- A Project Information Pack with ongoing updates; and
- Project information and updates on the Proponent's website – www.woodside.com.au

A public information session to be attended by Woodside representatives will proceed during the public review period at a shopping centre in Darwin to keep the public and any other interested parties informed on the project.

A free-call telephone number (1800 638 710) has also been established by Woodside to provide the community a readily accessible contact number to obtain further information. This telephone number is also open during the public review period for the community to obtain information. Since the telephone number was set up in August 2000, thirteen calls have been received, including two from East Timor, requesting information or commenting on the project.

In East Timor, information is provided in Bahasa Indonesia, Portuguese and English and specific mobile telephone numbers have been provided with relevant language speakers taking calls.

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12. Glossary

12.1 Glossary of Abbreviations:

2D	2 Dimensional seismic: recorded as broadly spaced lines (1 – 5km)
3D	3 Dimensional seismic: recorded as a finely spaced lines (15 – 30m)
APPEA	Australian Petroleum Production and Exploration Association
AS	Australian Standard
BTEX	Benzene Toluene Ethylene Xylene
Capex	Capital expenditure
DCQ	Daily Contracted Quantity
DES	Derrick Equipment Set
DISR	Department of Industry, Science and Resources
DNV	Det Norske Veritas
EBM	Ester Based Mud
EIS	Environmental Impact Statement
ERD	Extended Reach Drilling
ESD	Emergency Shut-Down
ESDV	Emergency Shut-Down Valve
FBHP	Flowing Bottom Hole Pressure
FPSO	Floating Production, Storage and Offtake vessel
FTHP	Flowing Tubing Head Pressure
FSO	Floating Storage and Offtake vessel
HAZID	Hazard Identification
HAZOP	Hazard Operation
HP	High Pressure
IMO	International Maritime Organisations
JV	Joint Venture
JVP	Joint Venture Partners
LNG	Liquefied Natural Gas
LoI	Letter of Intent
LP	Low Pressure
LPG	Liquified Petroleum Gas
LTOBM	Low Toxicity Oil Based Mud
MDQ	Maximum Daily Quantity
NAGV	North Australia Gas Venture
NOI	Notice of Intent
NWS	North-West Shelf
OBM	Oil Based Mud
PAWA	Power And Water Authority
P(SL)A	Petroleum (Submerged Lands) Act (1967)
PCUQ	An offshore platform containing Processing, Compression, Utilities and accommodation Quarters
RFSU	Ready For Start Up
RVP	Reid Vapour Pressure
SETA	Self Erecting Tender Assist rig
SETR	Self Erecting Tender Rig
SBM	Synthetic Based Mud
SR-1	Sunrise-1 well
SR-2	Sunrise-2 well
SS-1	Sunset-1 well

SSETR	Semi-Submersible Self Erecting Tender Rig
SSIV	Sub-Sea Isolation Valve
TAD	Tender Assisted Drilling
TEG	Tri-Ethylene Glycol
WBM	Water Based Mud
WEL	Woodside Energy Limited
ZOCA	Zone Of Cooperation – zone A

12.2 Glossary of Units:

%	percent
‰	parts per thousand
bar	absolute pressure in bars
bara	bar absolute
barg	bar gauge
bbl	barrel (1 barrel = 159 L)
cm	Centimetre
cm/s	centimetres per second
dB re 1 µPa-m	decibels re 1 micro Pascal of pressure at 1 metre
Hz	Hertz
kg	Kilogram
kg/m^3	kilogram per cubic metre
kl	Kilolitre
km	Kilometre
km^2	square kilometres
km/day	kilometres per day
km/hr	kilometres per hour
kts	knots or nautical miles per hour
L/s	litre per second
m	Metre
MD	MilliDarcy
Mm	Millimetre
m/s	metres per second
m^3	cubic metre
M^3/s	cubic metres per second
mg/l	milligram per litre
ml	Millilitre
Ml	million litre
mL/d	million litres per day
MMbbl	million barrels
Mss	metres subsea
MMscf/d	Million standard cubic feet per day
ppm	parts per million
psia	absolute pressure in pounds per square inch
Scf	standard cubic feet
Tcf	Trillion cubic feet
TJ/d	TeraJoules per day
ug/g	microgram per gram
ug/L	microgram per litre
Mm	micrometres
T	tonne (1 tonne of oil = 1,500 L)
tpa	tonne per annum

12.3 Glossary of Terms:

Abandonment	Final plugging of wells, and/or permanent dismantling, etc. of a production platform or other installation.
Annulus	The space between the drill string and well bore.
Anoxic	Lacking oxygen.
Australian Standard (AS)	An Australian Standard which provides criteria and guidance on design, materials, fabrication, installation, testing, commissioning, operation, maintenance, re-qualification and abandonment.
Barrel/Barrelage	42 US Gallons (approximately 159 litres). The traditional unit of measure of oil volume.
Bathymetry	Measurement of the changing ocean depth to determine the sea floor topography.
Benthic	Bottom dwelling.
Benthos	All biota living upon or in the sediment of an aquatic habitat.
Bioaccumulation	The accumulation of contaminants in organisms at levels above that of the ambient environment.
Bioavailability	A substance in a chemical and physical form that allows it to affect organisms or be accumulated by them.
Biodiversity	The variety of all life forms the different biota, the genes they contain and the ecosystems they form.
Biota	The plants, animals and micro-organisms of a region.
Bit	A drilling bit. Those chiefly in use are the steel roller-cutter, and the diamond-insert bit and PDC bit for hard formations, which penetrates by scratching or abrading the rock rather than by crushing or pulverising like the roller bit. There is also the annular diamond-insert core bit, for cutting and retrieving rock samples (in conjunction with a core barrel).
Blowout	Uncontrolled or uncontrollable release of downhole pressure upward through the well-bore or casing. Although the main danger is fire, the gases are also toxic, and in floating operations a gas blowout may include a threat to the stability of the rig itself. (See Mud)
Casing	The steel pipe that is cemented into a well to prevent the wall from caving in and to stop unwanted fluids from entering the hole from the surrounding rocks.
Cetaceans	The group containing whales, dolphins and porpoises.
Christmas Tree	The manifold, or arrangement of pipework connections and valves which is installed on the wellhead prior to production. As well as outlets for production, the tree will provide for the injection of mud to "kill" the well, and for the insertion of downhole maintenance tools and wirelines.
Condensate (Gas Condensate)	Light hydrocarbon fractions produced with natural gas which condense into liquid at normal temperatures and pressures associated with surface production equipment.
Contaminant	Any physical, chemical or biological substance or property which is introduced into the environment.
Crustacea	The group of animals containing crabs, prawns and shrimps.
Cuttings	The small chips or flakes of rock retrieved from a well by the circulation of the mud. They are studied and logged by the well-site geologist.
DNV OS-F101 (2000)	An international standard which provides criteria and guidance on design, materials, fabrication, installation, testing, commissioning, operation, maintenance, re-qualification and abandonment.
Deviated Well/Hole	A well whose path has been deliberately diverted from the vertical.

	Although relatively costly to drill, they are used particularly offshore to reach distant parts of a reservoir from a single platform. Deviated, or directional drilling up to 60º to 70º from the vertical is now fairly common. Greater deviation is possible with special equipment.
Ec_{50}	The concentration of a given contaminant that will cause a sublethal effect in a 50% of a collection of organisms over a given period of time. Effects can be larval abnormalities, reproductive impairment, growth inhibition or fertilisation success.
Environment	The surroundings of an organism including the other biota with which it interacts.
Environmental Management Plan	A procedure that identifies potential impacts and methodologies necessary to prevent or mitigate them.
Environmental Management System	A set of procedures incorporated into a documented framework that defines the environmental policy and organisational responsibility for planning, recording, auditing, and resolving non-conformances through a process of review leading to continual improvement of an organisations environmental management.
Epicentre	The location on the surface of the Earth directly above the focus, or place where an earthquake originates.
Epifauna	Benthic animals that move about on the sea bed or are firmly attached to it.
Exploration/Exploration Well	Exploration is the process of identifying a prospective hydrocarbon region and structure, mainly by reference to regional, and specific, geochemical, geological and geophysical (seismic) surveys. An Exploration Well is a well drilled to test a potential but unproven hydrocarbon trap or structure where good reservoir rock and a seal or closure combine with a potential source of hydrocarbons.
Fauna	Collectively, the animal life of any particular region.
Flora	Collectively, the plant life of any particular region.
Formation	A rock deposit or structure of homogeneous origin and appearance.
Grey Water	Water resulting from washing or cooking.
Habitat	The specific place where a particular organism lives.
Infauna	Animals that live within the sediments of aquatic environments.
Invertebrate	Collective term for all animals which do not have a backbone or spinal column.
Lc_{50}	The concentration of a given contaminant that will result in a 50% mortality of a collection of organisms over a given period of time.
Macrofauna	Animals whose shortest dimension is greater than or equal to 0.5 mm.
Macrophyte	An individual alga large enough to be seen easily with the unaided eye.
Mud	Mud is the name given to drilling fluid which is mainly a mixture of water, or oil distillate, and 'heavy' minerals such as Bentonite or Barites. Mud is pumped into a well at densities calculated to provide a hydrostatic pressure sufficient to overcome downhole formation pressures. (See eg Gas Kick). In addition, the mud is continuously circulated down to the bit, and returns in the annular space outside the drill-string, bringing with it rock cuttings for inspection and keeping the well clean. It is also engineered to maintain a thin protective layer of filter-cake on the bore hole wall, without excessive weight which would decrease the weight on the bit and hence penetration (see Drill String), and also possibly lead to differential sticking and formation damage. Mud is pumped from the mud pit (or tank) via the standpipe, rotary hose and gooseneck to the swivel, and into the drill stem. On return from down hole it is recovered and rock cuttings removed by the shale shakers before re-circulation. A Mud Log is the record of mud make-up and analysis of cuttings recovered.

Organism	Any living entity.
Pelagic	Pertaining to marine organisms which belong to the open seas living free from direct dependence on the bottom or the shore.
Phytoplankton	The planktonic organisms capable of photosynthesis.
Pollution	Degradation or impairment of the purity of the environment by causing a condition that is hazardous to public health, safety aesthetics or welfare, or to biota.
Polychaete	Segmented marine worms of the class Polychaeta.
Production Tubing String	The string of pipe installed inside the casing of a production well, to a point just above the reservoir through which the fluids are produced. It may be 2 inch to 5 inch diameter or more, depending on the production flow and pressures anticipated.
Production Well/Producer	A development well specifically for the extraction of reservoir fluids.
Production Wellhead And Tree	The assembly of casing head, tubing head, connections and well-control valves fitted to a producing well. The "Christmas Tree" is the name given to the complete assembly of valves, connecting flanges etc.
Reserves/Recoverable Reserves	Oil or gas that it is anticipated can be produced. Technical Reserves are theoretically producible at a gross operating margin by eg. normal primary or secondary recovery methods, while Commercial Reserves are restricted to volumes recoverable at an acceptable profitability. The detailed definitions are important in oil and gas financial and other information.
Reservoir	A porous, fractured or cavitied rock formation with a geological seal forming a trap for producible hydrocarbons. A common exploration maxim is that a prospective target must possess a related Source rock, Structure and Seal.
Separator	A process vessel used to separate gases and various liquids in a hydrocarbon stream. A Wellhead Separator is the first process vessel in a production operation, operating at or near wellhead pressures.
Shale Shakers	See Mud. Screens for extracting rock cuttings from circulating drilling mud.
Spud	To commence the actual drilling of the well.
String	See Joint, Drill-string, Casing, etc. Any number of connected joints of tubulars run in the well.
Tie-In	The action of connecting one pipeline to another or to equipment. Hence "pipeline tie-in" commonly describes the connection itself.
Toxicity	The quality or degree of being poisonous, or harmful, to humans or biota.
Turbidity	Measure of the clarity of a water body.
Wastewater	Domestic, industrial and municipal effluent.
Well Testing	Testing in an exploration or appraisal well is directed at estimation of reserves in communication with that well, in addition to well productivity.
Wellhead	"Wellhead" is descriptive of a location or function rather than a specific item of equipment. See Production Wellhead.
Zooplankton	Animal members of the plankton.

13. Study Team & Acknowledgments

This study was carried out by Sinclair Knight Merz, who were responsible for the overall formulation and production of the Environmental Impact Statement. The EIS was undertaken on behalf of Woodside Energy Limited, the operator of the Sunrise Gas Project.

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Guidelines for an Environmental Impact Statement on the Proposed Sunrise Gas Project (Northern Australian Gas Venture)

APPENDIX A

GUIDELINES FOR AN

ENVIRONMENTAL IMPACT STATEMENT

ON THE PROPOSED SUNRISE GAS PROJECT (NORTHERN AUSTRALIAN GAS VENTURE)

TABLE OF CONTENTS

INTRODUCTION

These Guidelines have been developed to assist Woodside Energy Limited (WEL) in preparing a draft Environmental Impact Statement (EIS) for the Sunrise Gas Project, (formerly known as the Northern Australian Gas Venture), in accordance with Clause 8 of the Administrative Procedures of the *Environmental Assessment Act (1982)* of the Northern Territory and Paragraph 4.1 of the Administrative Procedures under the *Environment Protection (Impact of Proposals) Act 1974* of the Commonwealth.

The Sunrise Gas Project comprises:

construction and operation of offshore production facilities, production wells and subsea infrastructure in the Timor Sea;
construction and operation of a pipeline from the offshore facilities to a new gas processing facility in the vicinity of Glyde Point, on the Gunn Point Peninsula, 35 km north east of Darwin, NT;
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 of materials; and
an area for pipe preparation during the construction phase of the project.

The draft EIS aims to provide:

a source of information from which individuals and groups may gain an understanding of the proposal, the need for the proposal, the alternatives, the environment that it would affect, the impacts that may occur and the measures taken to minimise those impacts;
a basis for public consultation and informed comment on the proposal; and
a framework against which decision makers can consider the environmental aspects of the proposal, set conditions for approval to ensure environmentally sound development and recommend an environmental management and monitoring programme.

In accordance with the principles contained in the “Intergovernmental Agreement on the Environment” and the Australian and New Zealand Environment and Conservation Council (ANZECC) “Basis for a National Agreement on Environmental Assessment”, the proposal will be jointly assessed by the Northern Territory Government and the Commonwealth Government. The Environment and Heritage Division of the NT Department of Lands, Planning and Environment will take the lead role in the assessment process in consultation with the Environment Protection Group, Environment Australia.

The object of these guidelines is to identify those matters that should be addressed in the draft EIS. The guidelines are based on the initial outline of the proposal in the Notice of

Intent. Not all matters indicated in the guidelines may be relevant to all aspects of the proposal. Only those matters that are relevant to the proposal should be addressed. The guidelines should, however, not be interpreted as excluding from consideration any matters which are currently unforeseen, which may arise during ongoing scientific studies or which may arise from any changes in the nature of the proposal during the preparation of the draft EIS, including the public consultation process.

The draft EIS should be a self-contained and comprehensive document written in a clear, concise style that is easily understood by the general reader. Cross referencing should be used to avoid unnecessary duplication of text. Text should be supported where appropriate by maps, plans, diagrams or other descriptive material. Detailed technical information and baseline surveys should be included as appendices or working papers.

The justification of the project in the manner proposed should be consistent with the principles of ecologically sustainable development. Assessment of the environmental impacts of the proposal and alternatives should consider the life-cycle impacts, from cradle-to-grave, including sourcing of materials, operational impacts and decommissioning. For the purpose of these Guidelines, the "principles of ecologically sustainable development" are as follows:

> the precautionary principle - namely, that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation;
> inter- and intra-generational equity - namely, that the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations;
> conservation of biological diversity and ecological integrity; and
> improved valuation and pricing of environmental resources.

CONTENTS OF THE DRAFT EIS

The draft EIS should include the following sections, but need not be limited to these sections or inferred structure.

1 EXECUTIVE SUMMARY

The Executive Summary should include a brief outline of the Sunrise Gas Project and each chapter of the draft EIS, allowing the reader to obtain a clear understanding of the proposed project, its environmental implications and management objectives. The Executive Summary should be written as a stand alone document, able to be reproduced on request by interested parties who may not wish to read or purchase the draft EIS as a whole.

The summary should include:

the title of the project;
name and contact details of the proponent, and a discussion of previous projects undertaken by the proponent and their commitment to effective environmental management;
a concise statement of the aims and objectives of the project;
the legal framework, decision-making authorities and involved agencies;
a discussion of the background to and need for the project, including the consequences of not proceeding with the project;
a discussion of the alternative options considered and reasons for the selection of the proposed development option;
a brief description of the project and the existing environment, utilising visual aids where appropriate; and
an outline of the principal environmental impacts predicted and proposed, environmental management strategies (including waste minimisation and management) and commitments to minimise the significance of these impacts.

2 INTRODUCTION

The introduction should include:

a brief explanation of the structure of the document;
an outline of the environmental assessment processes under the relevant NT and Commonwealth legislation;
reference to initial investigations and feasibility studies;
relevant Territory, Commonwealth and International policies, legislation, and treaties; and
planning issues such as land tenure, zoning, timeframes, potential for additional development and the lifetime of the project.

3 OBJECTIVES AND BENEFITS OF THE PROPOSED PROJECT

The draft EIS should discuss the social and financial benefits and impacts of the project. This should include:

socio-economic objectives and impacts, including reference to local and global markets, impacts on other economic activities in the affected area (e.g. commercial fisheries), foreign trade objectives, occupational health and safety objectives and benefit to the local workforce;
production objectives (e.g. predicted volume of product and proportion of market demand to be met by output); and

local, regional and global environmental objectives (e.g. reference to the environmental policies of the joint venture partners and the implications of the project with respect to the National Greenhouse Strategy).

4 ALTERNATIVES

Alternative proposals for the project should be discussed, detailing reasons for the selection and rejection of particular options. Where alternatives are available, which may still allow the objectives of the project to be met, the existing environment in these areas should also be addressed to a similar level of detail. The selection criteria for the onshore and offshore facilities should be discussed, and the advantages and disadvantages of preferred options and alternatives detailed.

Alternatives should include:

not proceeding with the project;
alternative development scenarios/strategies for the natural gas resource;
alternative sites and pipeline routes for the project;
alternative process technologies considered, such as storage and offloading arrangements; and
alternative environmental management technologies considered, such as treatment and disposal of discharges.

5 PROJECT DESCRIPTION

The draft EIS should describe the project in sufficient detail to allow an appreciation of the construction and operation timeframes and processes, and assist in determining the potential environmental impacts of the project. Key decision-making processes (such as risk assessment) should be detailed. Where appropriate, relevant Northern Territory and Commonwealth Government legislation, strategies and policies as well as international and national standards should be considered. Relevant NT Government environmental and construction guidelines should also be considered during the design phase of the project.

The use of a table describing the key characteristics of the project and a description of the phases of the proposal, including the nature and extent of proposed works likely to involve environmental impacts, may be an appropriate means of summarising this information.

The project description should consider the following, as a minimum, for all aspects and components of the project:

5.1 Location and Design Details

5.1.1 Offshore Facilities (platform/s, subsea wells)

location/s and site selection criteria;

seabed envelope/s (footprint/s and buffer zone/s);

infrastructure and service requirements (berthing facilities for support vessels, heliport, accommodation, power and water supply, sewage and other waste treatment and disposal, fuel handling and storage, workshops, communications, pollution control etc.);

power requirements/sources of supply;

water requirements in terms of quantity and sources for cooling, fire fighting and domestic uses;

existing or proposed sea area usage (such as recreation, commercial and recreational fishing, shipping and Department of Defence training);

design standards and limitations imposed by site characteristics, storm surge, climate, weather (e.g. cyclones), possible sea level rise and other climatic conditions associated with global climate change;

alternative technologies to minimise greenhouse gas emission levels, and flexibility of design for future mitigation. Identify which technologies will be used and the rationale for their selection;

disposal options for greenhouse gas emissions. Identify the options proposed for implementation and discuss the rationale for their selection;

options for offsetting greenhouse gas emission through either sink enhancement (e.g. land rehabilitation, forestry, industrial feedstock) or mitigation of emissions from other parties. Identify the options proposed for implementation and discuss the rationale for their selection;

construction locations (if different from location of offshore facility); and

construction material, types, sources and quantities.

5.1.2 Natural Gas Pipeline

selection criteria for the pipeline route;

description of the preferred alignment of the pipeline, illustrated with maps, nautical charts and diagrams to clearly show the pipeline corridor both offshore and onshore;

the preferred route with respect to other development (e.g. subsea cables), industry, national and marine parks and reserves, sites on the Register of the National Estate, declared Beneficial Uses, World Heritage Areas, historic sites, archaeological/ anthropological (including marine archaeological) sites, landforms and seabed features, other environmental features or constraints;

land requirements, land tenure, acquisition requirements (including permits and rezoning), description and justification of easement widths and access requirements along the route;

existing or proposed sea area usage (such as recreation, commercial and recreational fishing, shipping and Department of Defence training);

description of the location, nature and appearance of all infrastructure requirements associated with the pipeline, including access points and roads, markers and warnings;

design parameters, criteria and standards, including brief description of the product expected to be transported, pipeline capacity and expected lifetime, options for future extensions, environmental and safety arrangements (including a contingency and response plan to deal with rupture of the pipeline, or other relevant incident), and joint use with future developments of other gas fields;

construction material, types, sources, quantities;

details of the pipe coating and laydown areas; and

design limitations imposed by site characteristics such as storm surge and cyclones.

5.1.3 Domestic Gas Plant (Onshore)

location and design criteria for the plant, the loading jetty and the materials jetty and access points and routes;

requirements and specifications for connection to the national domestic gas supply grid;

land requirements, land tenure, acquisition requirements (including permits and rezoning), dredging and reclamation requirements;

infrastructure requirements and specifications (berthing facilities, handling facilities, breakwaters, roads and access tracks, drainage, easements, fire breaks, fencing, areas of hard stand, water and power supply, sewage and waste treatment and disposal, equipment buildings, fuel handling and storage, pollution control etc.);

power sources;

water sources for cooling, fire fighting and domestic uses as well as opportunities for recycling;

buffer zone requirements;

design standards and design limitations imposed by site characteristics, storm surge, climate, weather (e.g. cyclones), possible sea level rises and other climatic conditions associated with global climate changes etc.;

provide information on alternative technologies to minimise greenhouse gas emission levels, and flexibility of design for future mitigation. Identify which technologies will be used and the rationale for their selection;

discuss disposal options for greenhouse gas emissions. Identify the options proposed for implementation and discuss the rationale for their selection;

discuss options for offsetting greenhouse gas emission through either sink enhancement (e.g. land rehabilitation, forestry, industrial feedstock) or mitigation of emissions from other parties. Identify the options proposed for implementation and discuss the rationale for their selection;

construction material, types, sources and quantities;

access requirements (both land and marine); and

proposed environmental and safety management arrangements including contingency and response plans in case of rupture of tanks or pipelines, and risk assessment of the above).

5.2 *Details of Construction Phase*

describe temporary and permanent facilities;

describe methods of construction and installation of offshore facilities;

describe design and location of pipeline installation including pipeline coating and laydown areas;

describe methods of construction and installation of onshore facilities;

describe timing of construction operations and shift patterns;

provide details of accommodation and infrastructure requirements of workforce for all construction options;

describe design, location and a discussion of alternative methods for earthworks (including land reclamation, land capabilities, surface drainage and borrow pits), subsea works, and methods to be used;

describe measures to minimise the potential to create biting insect breeding sites especially in tidal areas;

describe design, location and a discussion of alternative methods for dredging, including containment and disposal of dredged spoil;

identify location and methods of haulage and, including prime movers, barges and supply ships;

indicate size and location of construction camps;

identify sources of construction and marine workforce;

describe waste minimisation and management arrangements including a discussion of alternative methods; and

provide details for the decommissioning of temporary facilities.

5.3 *Details of Operational Phase*

description of processes both offshore and onshore (including shipping);

description of management structure and interaction with Government (NT and Commonwealth) of the port facility (including navigational aids, survey work, pilotage, exclusion zones, and shipping routes);

arrangements for transfer and storage of product and dangerous chemicals;

shipping routes, standby anchorage locations and navigation obstructions;

annual throughput of products and dangerous chemicals at offshore and onshore facilities, including National Pollutant Inventory listed substances;

details of all dangerous goods;

project and reservoir lifetimes;

limitations on operation (such as cyclonic and storm surge periods);

maintenance operations such as floating hose inspection, dredging, shutdown programme and inspections;

energy usage;

atmospheric emissions management, such as flaring, venting and greenhouse gas issues including an estimation of gas emissions (e.g. emissions from power generation and use and leakage);

discharge management, including produced water, deck waters, ballast water, cooling waters, sewage and surface water drainage;

likelihood and requirements for facility and process upgrade;

product loading methods;

size and origins of workforce;

workforce shift patterns;

accommodation and transport of workforce, including fixed wing, rotary wing, boat and vehicle; and

infrastructure and support arrangements.

5.4 Details of Decommissioning Phase

outline appropriate decommissioning and rehabilitation commitments (for both temporary and permanent facilities), including waste management and pollution control.

6 EXISTING ENVIRONMENT

The draft EIS should include an in-depth description of the areas potentially impacted by the project. These areas should include:

- areas affected by extraction of construction material (including off site);
- terrestrial construction sites, lay-down areas, corridors and buffer zones;
- offshore construction locations including processing and loading facilities;
- pipeline corridors; and
- operation and maintenance areas, such as dredging and discharge assimilation zones, and tanker routes.

Seasonal and diurnal meteorological changes, and any significant trends (e.g. flood, cyclone frequency), should be indicated where appropriate. Areas of environmental sensitivity should be identified and the scope of investigations fully discussed. Where areas of environmental sensitivity have been identified the inter-relationship between sensitive areas and other areas should be discussed. Sites and species of special conservation status should be identified and described (e.g. RAMSAR wetlands, endangered, protected or migratory species).

Studies to describe the existing environment should be of a scope and standard sufficient to serve as a benchmark against which the impacts of the project may be assessed over an extended period. Control areas not impacted by the project should be included in studies and long term monitoring locations established.

Description of those areas potentially impacted by the project should, as a minimum, include:

6.1 Physical Environment

6.1.1 Terrestrial and Marine (including intertidal zone)

- relevant climatic and atmospheric conditions (precipitation, evaporation, wind, temperature, seasonal variability, flooding, cyclonic storms, storm surge) and anticipated changes (e.g. due to climate change);
- geology, geomorphology (e.g. soil horizons, cheniers), seismic stability;
- geotechnical information (soils and marine sediments) such as potential and actual acid sulfate soils, background contaminant concentrations and physical characteristics;
- air quality and dispersion studies; and
- ambient light and noise levels.

6.1.2 Terrestrial

topography and land systems;

relevant soil characteristics (erodibility, compaction, etc.);

hydrology and hydrogeology (surface and groundwater systems, catchment and drainage regime, flow and discharge rates, flooding, water quality, beneficial uses);

existing fire regime; and

existing levels of soil erosion (water, wind).

6.1.3 Marine (including intertidal zone)

marine hydrography, seabed morphology and depth contours/bathymetry;

dredging areas and potential spoil disposal areas;

oceanography including tides, currents, wave action; and

hydrodynamics, including modeling of the area between Melville Island and Gunn Point/Glyde Point and possibly between Cape Don and Soldier Point depending on the determined risk of an oil spill, scouring effects, accretion rates, erosion rates and dispersion.

6.2 Biological Environment (terrestrial and marine including intertidal zone)

major habitats, communities, and flora/fauna species (both vertebrates and invertebrates) including endangered or threatened taxa, migratory species and species of commercial importance. The draft EIS should include interpreted results from detailed surveys of the marine and terrestrial fauna and flora in and around the region to be impacted. This should include more remote areas that may be impacted by prevailing currents and tidal influence transporting impacts downstream;

ecological relationships, including habitat requirements, dispersal abilities, growth patterns, an assessment of species decline or recovery from natural disturbance (e.g. cyclone), life histories, key components of ecosystems, wet and dry seasonal variability, etc. (Note: the Glyde Point area is known to contain a number of important rainforest patches. These areas along with associated habitats should be given specific consideration concerning the need for protection/retention);

conservation status of species/communities/habitats on a local, regional and national level;

other sensitive environments, areas of significance (breeding, nesting, roosting and feeding sites, etc.);

extent, representation and protection elsewhere of species/communities/habitats affected by the proposal;

resilience of species/communities/habitats affected by the proposal;

obligations/listings under Territory, national and international strategies, registers, conventions, legislation or agreements;

level of existing vegetation clearance/disturbance;
status of feral animals, vermin, weeds and plant pathogens; and
known sites where mosquitoes and other biting insects may be a problem.

6.3 Cultural Environment

areas nominated for listing or listed on the Register of the National Estate or the Interim list of the Register of the National Estate;
sacred sites - provide evidence of an Authority Certificate under the Northern Territory *Aboriginal Sacred Sites Act*[1];
archaeological and heritage places and objects under the *Northern Territory Heritage Conservation Act 1991;*
historic sites;
artificial reefs;
areas with special values (e.g. landscape, visual environment, recreational, commercial, tourism, fisheries, scientific, educational, marine archaeological sites);
areas of significance to the Aboriginal population and culture; and
national parks, conservation reserves and wilderness area.

6.4 Socio-economic Environment (terrestrial and marine)

demographic characteristics in and around the project area;
social factors (lifestyle and values, existing trends, social issues). These factors could be used as performance indicators to monitor long-term impacts on the socio-economic environment;
consistency with proposed land use objectives;
constraints the project may place on other land uses in the area;
current employment levels and characteristics;
local and regional economic structure;
existing land use, tenure and sensitivity;
native title claims under the *Native Title Act, 1993* and aboriginal land claims under the *Aboriginal Land Rights (Northern Territory) Act 1976.*;
commercial fisheries activities;
community services and facilities;
recreational resources and activities (e.g.. fishing, diving, etc.);
physical infrastructure (boat landings, roads, airstrips, communications etc.);

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[1] *The results of an inspection of the Register of Sacred Sites maintained by the Aboriginal Areas Protection Authority, as well as details of an application lodged with the Aboriginal Areas Protection Authority for an Authority Certificate within the meaning of Part 3, Division 1 of the Northern Territory Aboriginal Sacred Sites Act. Also, if practicable, include a copy of the Certificate issued by the Authority as a result of that application containing conditions (if any) relating to the protection of sacred sites on, or in the vicinity, of the project area.*

transport network and usage (road, air, waterways, traffic volumes);
mineral and energy exploration;
impact of biting midges and mosquitoes as pests and vectors of disease; and
other potentially dangerous fauna and proposed management (e.g. crocodiles, box jellyfish)

7 ENVIRONMENTAL IMPACTS

7.1 Potential and Anticipated Environmental Impacts

This section of the draft EIS should clearly identify, qualify and quantify, where appropriate, the potential environmental impacts expected to result from the project and from any feasible alternatives.

The potential impacts of all aspects of the proposal should be discussed. All potential impacts on the existing environment (including terrestrial and marine, social and heritage) should be assessed for all relevant stages of the project (including construction, operation, decommissioning, incidents and accidents). Socio-economic impacts on existing services in the region should also be considered.

Anticipated and potential environmental effects of the project should be discussed and quantified where possible. The possibility of remediation should also be discussed. Performance indicators for all potential impacts and remediation efforts should be identified. The nature of effects should be characterised by the following qualities:

direct/indirect
short-term/ medium-term/ long-term
adverse/beneficial

The section should also include an assessment of the level of significance of the impact, be it global, regional or local (e.g. global and national implications of greenhouse gases and the localised impact of service roads or artificial water bodies). The vulnerability of key habitats and species to potential impacts should be assessed as should visual impacts of the proposed development. Cumulative impacts should also be discussed. The reliability and validity of forecasts and predictions, confidence limits and margins of error should be indicated as appropriate. Interactions between impacts on the biophysical, cultural and socio-economic environments, both individually and collectively, should be covered.

7.2 Hazard/Risk to Humans and Facilities

The draft EIS should include a preliminary hazard analysis and assessment of the risks to people, the environment and nearby facilities from potential accidents associated with the construction, operation and maintenance of the various components of the Sunrise Gas Project, storage and transport of materials to and from the Sunrise Gas Project (including pipeline transport and shipping of product). The preliminary hazard analysis and risk assessment should outline and take into account emergency plans that detail strategies, procedures and staff responsibilities in the event of an emergency or accident. Issues such as cyclones, storm surge, bush fires and lightning strikes should be considered. Contingency plans for dealing with spillage of any hazardous materials should be detailed.

8 ENVIRONMENTAL SAFEGUARDS AND MANAGEMENT

The proponent is required to achieve a level of environmental management and performance (consistent with ecological sustainable development, best practice environmental management, national and international standards and statutory obligations) during its pursuit of sound business and financial objectives. The most economically effective, environmentally sound technology and procedures should be incorporated into the design of the project. The adoption of such a strategy should ensure optimal management of all emissions, discharges and waste. A similar approach is to be adopted for all procedures involving the management of inputs, outputs and the production process itself.

This section should provide information on environmental management practices and safeguards proposed to prevent, minimise or ameliorate environmental impacts both onshore and offshore. A summary table listing undertakings and commitments made in the draft EIS, including performance indicators, with cross referencing to the text of the report should be provided.

8.1 Safeguards

8.1.1 Construction Phase

Detail environmental controls, safeguards and design features, and describe proposed management arrangements during the construction phase including:

- measures to protect important habitats including seagrass beds, coral reefs, mangroves and rainforest;
- measures to maintain connectivity of important habitats (e.g. wildlife corridors);

measures to ensure that any seismic activity does not interfere with the migration or breeding of cetaceans or dugongs;

measures to ensure the protection of threatened and endangered species (if threatened or endangered species are identified, the impacts of the potential loss of a local population on the gene pool of the species should be determined);

safeguards to minimise noise, dust, vibration, air, land and water pollution, including pollution from shipping (e.g. marine debris, discharge of effluent, antifouling paint);

safeguards to minimise vegetation disturbance and soil erosion;

safeguards to minimise the risk of introducing and/or spreading exotic organisms (e.g. from ballast water, hull fouling, other shipping activity) and diseases, including use of ‘best practice management’ and industry standards etc.;

measures to protect undisturbed mangrove areas to ensure that they remain as a buffer zone and to minimise erosion;

measures to manage potential and actual acid sulfate soils;

measures to prevent the creation of mosquito breeding sites as a result of construction operations both on and off site (in accordance with construction guidelines);

measures to protect heritage sites, terrestrial and marine archaeological sites and Aboriginal Sacred Sites;

measures to minimise visual intrusion;

measures to protect both terrestrial and marine fauna and flora;

measures to manage construction wastes both in the marine and terrestrial environment, to minimise off site impacts from debris and protect against accidental spillage;

measures to manage and minimise impacts from dredging and disposal of dredged spoil;

oil and chemical spill contingency plans should be outlined and the links to Northern Territory and National oil spill contingency plans should be clear;

measures to ensure employees and construction managers understand and act upon their environmental protection obligations including statutory obligations;

measures to ensure the safety of the community and the work force during construction and operation of the plant;

measures to minimise negative social and environmental effects of accommodating and servicing the construction workforce;

measures to rehabilitate disturbed areas (both terrestrial and marine), including quarries and sand/gravel pits (native species should be used for rehabilitation and landscaping); and

monitoring to quantify and rectify any impacts on the environment.

8.1.2 Operational Phase

Detail environmental controls, safeguards, design features and proposed management arrangements during the operational phase including:

safeguards to minimise noise, air, land and water pollution, thermal pollution, soil erosion, introduction and/or spread of exotic organisms (e.g. from ballast water, hull fouling, other shipping activity) and diseases including use of ‘best practice management’ and industry standards etc.;

measures to ensure the protection of threatened and endangered species (if threatened or endangered species are identified the impacts of the potential loss of a local population on the gene pool of the species should be determined);

measures to reduce impacts of light, noise and obstructions (e.g. the loading jetty), resulting from the development, on turtle, bat and migratory bird species;

risk management and preparation of disaster contingency plans (for: cyclones; storm surge; bush fires; oil spills and chemical spills) and occupational health and safety plan;

measures to protect identified areas of high biological value;

an operations maintenance schedule, including the nature and timing of maintenance planned, and an audit, review and revision of the operational phase at regular intervals to ensure the continued safety of the facilities (both onshore and offshore) and surrounding areas;

a waste management plan placing particular emphasis on waste avoidance, minimisation and recycling, including procedures for evaluating the most appropriate disposal methodologies (incorporating methods to prevent debris entering the marine environment);

an assessment of the potential to enhance naturally occurring radioactive materials with the transport and concentration of natural gas and the associated waste management and occupational health and safety management issues;

an energy management plan including plans for maximising energy efficiency, possibilities for co-generation of electricity using coolant water and utilisation of flare gases;

quantification of annual green house gas emissions (by gas type), including any sinks, over the expected life of the project. The methodology developed by the National Greenhouse Gas Inventory Committee or the methodology used under the Greenhouse Challenge program should be used;

undertake a comparison of the greenhouse gas efficiency of the project with the efficiency of other (similar) projects to ensure international best practice;

indicate whether a Greenhouse Challenge agreement either has been entered into, or will be entered into;

access and security arrangements and management of buffer zones;

measures to ensure employees and managers understand and act upon their environmental protection obligations;

- measures to manage natural habitats on-site and rehabilitate disturbed areas;
- measures to minimise, rectify or control biting insect populations as a result of operations both on and off site (in accordance with local construction guidelines);
- provisions for continued consultation/liaison with relevant government authorities and community groups and mechanisms for dealing with complaints from the public;
- arrangements for the decommissioning of facilities following cessation of operational activities; and
- monitoring to quantify and rectify any impacts on the environment.

8.2 Environmental Management Plan

A draft Environmental Management Plan (EMP) should be provided. The draft EMP should be strategic, describing a framework for environmental management rather than providing specific detailed initiatives. A final EMP would be prepared at the conclusion of the assessment, taking into consideration comments on the draft EIS, the Supplement and incorporating the Assessment Report recommendations. The draft EMP should:

- detail the proposed measures to minimise adverse impacts and the effectiveness of these safeguards (e.g. provide performance indicators by which all anticipated and potential impacts can be measured);
- describe monitoring to allow early detection of adverse impacts;
- describe remedial action for any impacts which are not originally predicted;
- detail how monitoring will be able to determine the differences between predicted and actual impacts; and
- provide for the periodic review of the management plan itself.

Reference should be made to relevant legislation and standards, and proposed arrangements for necessary approvals and permits should be noted. The agencies responsible for implementing and overseeing the management plan should be identified. Proposed reporting procedures in relation to the implementation of the management plan, independent and self- auditing and reporting of accidents should be outlined.

8.3 Monitoring

The proposed monitoring programmes, reporting and management arrangements should be detailed. Monitoring programs associated with activities that could significantly impact on the surrounding environment (e.g. land reclamation, dredging, pipeline laying, shipping operations etc.) should be outlined.

Consideration should be given to a baseline biting insect monitoring program over a period of 12 months preceding any initial earthworks due to the expected significant level of biting insects, the sensitivity to disturbance in tidal areas; and the scope for impounding water as a result of construction and operation of the plant, pipeline and access roads to the facility.

9 PUBLIC INVOLVEMENT AND CONSULTATION

Public involvement and the role of government organisations should be clearly identified. The outcomes of surveys, public meetings and liaison with interested groups should be discussed, and any resulting changes made to the proposal clearly identified. Details of any ongoing liaison should also be discussed.

Negotiations and discussions with local and community government, Territory Government, Commonwealth Government and the ZOCA Joint Authority should be detailed, and any outcomes referenced. Details of any ongoing negotiations and discussion should also be presented.

10 INFORMATION SOURCES AND BIBLIOGRAPHY

The draft EIS should contain a comprehensive reference list. Any source of information such as studies, research, maps and personal communications used in the preparation of the draft EIS should be clearly identified, cited in the text and referenced in the bibliography.

11 GLOSSARY

A glossary should be provided, defining the meaning of technical terms, abbreviations and colloquialisms. (Note: throughout the EIS, technical terms and jargon should be minimised).

12 APPENDICES

Information and data related to the draft EIS but unsuitable for inclusion in the main body of the statement should be included as appendices. This may include detailed analyses, monitoring studies, baseline surveys, raw data and dispersion modeling data. Where necessary, specific guidance should be provided on the most appropriate means of accessing information not appended to the draft EIS.

13 ADMINISTRATION

The Project Officer is Lisa Banks, Environment and Heritage Division, Department of Lands, Planning and Environment. The contact number is (08) 8924 4022 and fax (08) 8924 4053, e-mail lisa.banks@nt.gov.au

“Preliminary” copies of the draft EIS should be lodged with the Environment and Heritage Division of the NT Department of Lands, Planning and Environment and the Environment Assessment Branch of Environment Australia for internal review prior to release for public and advisory body comment.

The number of copies of the draft EIS required for distribution to Territory and Commonwealth advisory bodies will be determined at the review of the ‘preliminary” draft EIS. The NT will require approximately 20 copies (plus 10 CD rom copies) and the Commonwealth approximately 15 copies. ***CD rom** copies should be in ADOBE*^{â} **.pdf format for placement on the internet*. The executive summary should be supplied in HTML 3.2 format with *.jpg graphics files.

Several copies of the draft EIS should also be prepared for distribution to relevant interstate and intrastate Public Libraries for public review. Several copies of the draft EIS should be available for purchase by the public on request. Locations for public review will be determined at the review of the “preliminary ” copies of the draft EIS.

Corporate Environmental Policy
Health and Safety Policy
Waste Management Policy

APPENDIX B

WOODSIDE
AUSTRALIAN ENERGY

THE WOODSIDE GROUP OF COMPANIES
ENVIRONMENTAL POLICY

General Policy Objectives

As an Australian Company, Woodside shares the desire of the community to develop resources in a way that meets the needs of the present, without compromising the ability of future generations to meet their own needs.

All Woodside activities will be planned and performed so that adverse effects on the environment are either avoided or kept to an acceptable level while meeting all statutory requirements.

Strategies

Our strategies to implement this Policy are:

- Apply a systematic approach to environmental management to achieve and demonstrate continuous improvement.
- Delay or stop activities where effective environmental controls are not in place.
- Comply with all applicable laws and regulations, strive towards higher standards and apply responsible standards where laws and regulations do not exist.
- Seek and demonstrate continuous improvement in all aspects of environmental management including energy use, discharges, emissions and wastes.
- Monitor the effects of our activities on the environment and take action to address effects where necessary.
- Openly communicate our environmental performance with our workforce, Government and the wider community.
- Promote a positive culture by providing environmental training and awareness programs and encouraging individual involvement with environmental issues.
- Assure the effectiveness of our systems through rigorous application, review and improvement processes.

Application

The Managing Director of Woodside Energy Ltd. is accountable to the Board of Directors for ensuring this Policy is implemented and that its effectiveness is reviewed annually. This Policy will be updated every three years.

All Woodside personnel and contractors in all areas of the Company's activities are responsible for applying the Environmental Policy.

J H Akehurst
Managing Director
January 2000

WOODSIDE
AUSTRALIAN ENERGY

THE WOODSIDE GROUP OF COMPANIES

HEALTH & SAFETY POLICY

General Policy Objectives

Woodside believes that all injuries and industry related diseases are preventable and that striving continuously to improve the health and safety of all employees, contractors and third parties who are impacted by our activities is fundamental to our business success.

Strategies

Our strategies to implement this Policy are:

- Give health and safety prevailing status over other primary business objectives.
- Delay or stop activities where effective controls are not in place to manage identified hazards.
- Apply and demonstrate a systematic approach to HSE Management to achieve continuous performance improvement.
- Design our workplaces to minimise risk to personnel and to develop work practices that further reduce risk to levels which are as low as reasonably practicable.
- Develop and maintain the competence of our personnel to control the risks we generate.
- Develop appropriate systems and train personnel to deal with and recover from a wide range of potential emergency situations.
- Set targets for improvement in all areas of health and safety.
- Include health and safety performance as a factor in the appraisal and reward of staff.
- Demonstrate compliance with all applicable occupational health and safety laws.

Application

The Managing Director of Woodside Energy Ltd is accountable to the Board of Directors for ensuring that this policy is implemented and that its effectiveness is reviewed annually. This policy will be updated every three years.

All Woodside personnel and contractors in all areas of the Company's activities are responsible for applying the Health and Safety Policy.

J H Akehurst
Managing Director
January 2000

HSE 24

WASTE MINIMISATION AND DISPOSAL POLICY

GENERAL STATEMENT

Waste avoidance, minimisation, reuse and recycling are practices widely used to protect the environment and conserve resources within the Australian community.

In support of the Australian community concerns and to promote sustainable development, all Woodside activities will be planned and performed to eliminate or minimise the generation of wastes as far as is reasonably practicable.

Wastes generated will be reused or recycled wherever reasonably practicable and final waste products will be disposed of in a safe and environmentally acceptable manner.

OBJECTIVES

In fulfilling this statement, Woodside will

- as a minimum comply with all applicable laws and regulations
- apply responsible standards for all wastes generated, including development and implementation of safe handling, storage, transport, treatment and disposal procedures
- review on a three yearly basis and update its waste minimisation and disposal procedures in light of developments in technology, legislation, industry practices and changing community expectations
- identify all waste and in order of priority, aim to eliminate, reduce, reuse, recycle, treat and dispose of wastes generated
- monitor the nature and quantity of waste produced with a view to improve Woodside's performance
- give guidance to project groups to ensure that new facility designs give sufficient consideration to waste minimisation and disposal requirements
- include environmental criteria in the selection of contractors and ensure contractors understand and adhere to this Policy
- periodically audit Woodside and Contractor activities involved in the handling, storage, transport, treatment and disposal of its wastes to ensure compliance with agreed Policy and procedures

APPLICATION

Line Managers are expected to address the objectives of this Policy in setting and carrying out their annual Business and HSE plans.

Achievements in waste management will form part of Woodside's regular performance review and auditing processes.

RESPONSIBILITIES

The Managing Director of Woodside has overall responsibility for establishing and reviewing this Policy.

Responsibility for implementing the Policy lies with Line Management.

All employees and contractors shall be responsible for implementation of this Policy within their sphere of influence.

J H Akehurst
Managing Director
August 1998