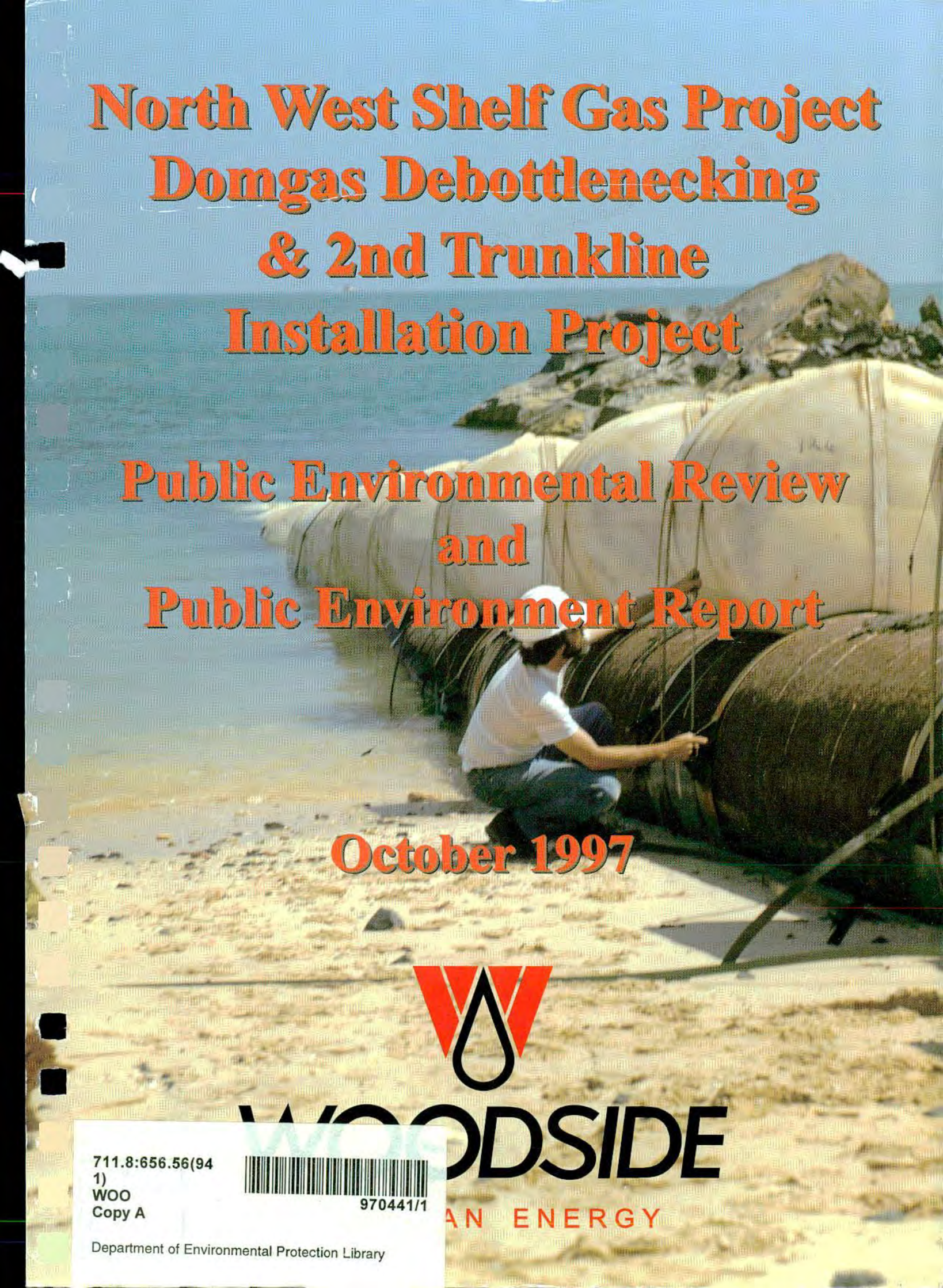
North West Shelf Gas Project
Domgas Debottlenecking & 2nd Trunkline Installation Project

Public Environmental Review and Public Environment Report

October 1997



WOODSIDE

AN ENERGY

Woodside Offshore Petroleum Pty Ltd

PUBLIC ENVIRONMENTAL REVIEW
PUBLIC ENVIRONMENT REPORT

DOMGAS DEBOTTLENECKING and SECOND TRUNKLINE INSTALLATION PROJECT

October, 1997

Invitation to make a Submission

Invitation

The Environmental Protection Authority invites people to make a submission on this proposal.

Woodside Offshore Petroleum Pty Ltd proposes to construct and operate a Second Gas Trunkline from Offshore Production Facilities on the North West Shelf to the existing Onshore Treatment Plant on the Burrup Peninsula. Also proposed is a debottlenecking of the Domestic Gas process to supply potential future gas demand in Western Australia.

In accordance with the WA Environment Protection Act 1986 and the Commonwealth Environmental Protection (Impact of Proposals) Act 1976 a Public Environmental Review/Report has been prepared which describes this proposal and its likely effects on the environment. The PER is available for four (4) weeks from 21 October 1997, closing on 18 November 1997.

Comments from government agencies and from the public will help the EPA and Environment Australia (EA) to prepare an assessment report in which recommendations to government will be made.

Why write a submission?

A submission is a way to provide information, express your opinion and put forward your suggested course of action – including any alternative approach. It is useful if you indicate any suggestions you have to improve the proposal.

All submissions received by the EPA or EA will be acknowledged. Submissions will be treated as public documents unless provided and received in confidence subject to the requirements of the *Freedom of Information Act*, and may be quoted in part or in full in the EPA's or EA's report.

Why not join a group?

If you prefer not to write your own comments, it may be worthwhile joining with a group interested in making a submission on similar issues. Joint submissions may help to reduce the workload for an individual or group, as well as increase the pool of ideas and information. If you form a small group (up to 10 people) please indicate the names of all participants. If your group is larger, please indicate how many people your submission represents.

Developing a submission

You may agree or disagree with, or comment on, the general issues discussed in the PER or the specific proposals. It helps if you give reasons for your conclusions, supported by relevant data. You may make an important contribution by suggesting ways to make the proposal more environmentally acceptable.

When making comments on specific elements of the PER:

- Clearly state your point of view
- Indicate the source of your information or argument if this is applicable
- Suggest recommendations, safeguards or alternatives,

Points to keep in mind
By keeping the following points in mind, you will make it easier for your submission to be analysed:

- Attempt to list points so that the issues raised are clear
- Refer each point to the appropriate section, chapter or recommendation in the PER
- If you discuss different sections of the PER, keep them distinct and separate, so there is no confusion as to which section you are considering
- Attach any factual information you may wish to provide and give details of the source. Make sure your information is accurate

Remember to include:

- Your name
- Address
- Date
- Whether you want your submission to be confidential

The closing date for submissions is the **18 November 1997**

Submissions should be addressed to:

The Environmental Protection Authority
Westralia Square
141 St Georges Terrace
PERTH WA 6000

Attention: **Mr T Gentle**

Environmental Protection Authority

Federal Department of the Environment, Sport and Territories

SECOND OFFSHORE TRUNKLINE AND DOMGAS DEBOTTLENECKING

(Assessment No. 1105)

PUBLIC ENVIRONMENTAL REVIEW / PUBLIC ENVIRONMENT REPORT GUIDELINES

Introduction

Woodside Offshore Petroleum Pty Ltd proposes to install a second trunkline from its offshore production facilities to its existing Onshore Treatment Plant on the Burrup Peninsula, Western Australia. Woodside also plans to debottleneck the existing domestic gas trains to facilitate additional gas supplies to an expanding domestic market.

As the project involves environmental issues which fall under both State and Commonwealth jurisdiction, the environmental impact assessment is being carried out jointly by the WA Environmental Protection Authority (WA EPA) and the Commonwealth Environmental Protection Group (EPG). The proponent is producing a Public Environmental Review / Public Environment Report (PER) document which will meet the requirements of both the State and Commonwealth environmental assessment processes.

The project will be assessed through the public process of environmental impact assessment so that decision-making bodies can obtain broad-ranging advice. The proponent is required to describe the proposal, receiving environment, potential environmental impacts, and proposed environmental management.

The WA Department of Environmental Protection (on behalf of the WA EPA) has been nominated as the lead agency for the joint assessment.

These guidelines have been prepared to help the proponent identify issues which should be addressed in the PER. The guidelines are not intended to be exhaustive, and the proponent may consider that additional issues should also be considered. The aim of the PER is to emphasise those relevant environmental factors which have potential to have impacts on the physical, biological, or social environment.

Objectives of the PER

The contents of the PER should reflect the objectives of the document which are to:

- communicate clearly with the public (including Government agencies) so that the WA EPA and the Commonwealth EPG can obtain informed public comment to assist in providing advice to the State and Commonwealth Governments respectively.

- describe the proposal and alternatives clearly, so that the state and Commonwealth Ministers for the Environment can consider clearance of a well-defined project; and

- detail the proponent's environmental management commitments, showing that the environmental impacts of the proposal can be adequately managed.

The PER will form the legal basis of the State and Commonwealth Ministers' clearance of the proposal. Hence the PER should include a description of all the main and ancillary components of the proposal. The PER should be simple and concise as the audience will include non-technical people. Any extensive technical detail should be referenced or appended to the PER.

The PER should clearly explain the advantages and disadvantages of the various alternate trunkline routes proposed, and should also explain the advantages and disadvantages of the alternate onshore land requirements.

Contents of the PER

- introduction of the proponent, the project and location. This should include a brief history of the project and location, and possible future stages.

- a clear overlay of a suitably scaled aerial photograph, which clearly indicates the nature and extent of works proposed[1].

- a map showing the proposal in the local context - an overlay of the proposal on a base map of the main environmental constraints;

- a map showing the proposal in the regional context;

- a process chart / mass balance diagram showing inputs, outputs and waste streams;

- a summary table which describes the key characteristics of the proposal. This should a description of the components of the proposal, including the nature and extent of works proposed;

- justification and objectives for the proposed development;

- the legal framework, decision-making authorities and involved agencies;

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[1] All figures should include a north arrow, a scale bar, a legend, grid co-ordinates, the source of the data, a title and (where applicable) the date of aerial photo.

- project benefits and justification for the project;
- an indication of the consequences of not proceeding with the proposal;
- description of the components of the proposal and particularly those aspects likely to involve environmental effects;
- identification of the potential impacts, including short-term, long-term, and cumulative impacts on the environment;
- route/site selection criteria for the Second Trunkline and onshore land requirements and discussion of the advantages/disadvantages of feasible and prudent alternatives and reasons for the final choice;
- description of the receiving environment which may be impacted, including relevant quantitative data and biological information;
- discussion of the relevant environmental factors, including an assessment of the significance as related to objectives and standards which may apply; and consideration of relevant Government reports which may apply (eg the Burrup Land Use Plan);
- a summary of the environmental management program, including the key commitments, monitoring work and the auditing of the program; and
- consideration of alternatives.

Relevant Environmental Factors

The PER should focus on the relevant environmental factors for the proposal. A description of the project component and the receiving environment should be directly included with, or referenced to, the discussion of the factor. The technical basis for measuring the impact and any specifications or standards for assessing and managing the factor should be provided.

The environmental factors (and their corresponding environmental management objectives) should be set out under the following categories:

- biophysical;
- pollution; and
- social surroundings.

Further factors may be raised during the preparation of the PER, and on-going consultation with the WA EPA (through the DEP), Commonwealth EPG and other relevant agencies is recommended. Minor issues which can be readily managed as part of normal operations for the existing operations or similar projects may be briefly described.

Information used to reach conclusions should be properly referenced, including personal communications. Assessments of the significance of an impact should be soundly based rather than unsubstantiated opinions, and the assessment should lead to a discussion of the management of the factor.

Preliminary Relevant Environmental Factors	Preliminary Environmental Objectives
Global Level Factors	
Greenhouse gases	Reduce net output of Greenhouse gases in accordance with the International Framework on Climate Change. Ensure that Greenhouse gas emissions meet acceptable standards and requirements of the Environmental Protection Act 1986 (all reasonable and practicable measures are taken to minimise greenhouse gas discharge)
Ozone layer	Protect the ozone layer in accordance with policies and requirements of Commonwealth Ozone Protection Act 1989 and the WA Environmental protection (Ozone Depletion) Policy 1993.
National Level Factors	
Endangered species	Protect endangered or threatened species (including marine wildlife) as required by the State Wildlife Conservation Act 1950, the Commonwealth Endangered Species Protection Act and international legal obligations.
National Estate	Protect areas listed on the Register of the National Estate or currently under assessment.
Increased demand for natural resources	Specify the impact this proposal will have on current reserves.
Offshore Factors	
Condensate or oil (from accidents)	Ensure minimal risk of leakage by identifying and managing risks and by adopting international best practice equipment and operating procedures. Protect sensitive environments and species from hydrocarbon spills. Note: risk from both pipeline leaks and increased shipping will need to be assessed.
Sea floor	Maintain the biodiversity of the sea floor and ensure that any impacts on locally significant marine communities are avoided. Note: pipeline construction and trenching in inshore areas should be managed so as to avoid impacts on coral spawning.
Dredging and disposal of dredge spoil	Protect environment from significant impacts consistent with the Environment Protection (Sea Dumping) Act and the London Dumping Convention. Note: pipeline construction and trenching in inshore areas should be managed so as to avoid impacts on coral spawning.
Shore crossing	Protect natural landforms and sensitive habitats from significant impacts

Historic ship wrecks	Protect historic ship wrecks from damage during trunkline installation in accordance with the Historic shipwrecks Act and Maritime Archaeology Act.
Hydrotest fluids / pickle liquors	Demonstrate that there will be no significant impacts from disposal of hydrotest fluids / pickle liquors. Note: The preferred method of disposal is to return the fluids to a bunded area on shore where fluids will be allowed to evaporate.
Preliminary Relevant Environmental Factors	**Preliminary Environmental Objectives**
Produced formation water (PFW)	Demonstrate that there will be no significant environmental impacts from disposal of PFW. Use best practice technology to reduce the size of the mixing zone to the maximum extent practicable. Beyond the mixing zone, ambient levels of total dissolved hydrocarbons in seawater should not exceed the interim guideline as specified in the draft WA Water Quality Guidelines for Marine and Freshwaters (EPA Bulletin 711, 1993). Levels of heavy metals and naturally occurring radioactive material (NORM) should meet the requirements of the Department of Minerals and Energy (DME).
Decommissioning	Protect environment from adverse impacts and ensure that the State and Commonwealth Governments do not incur a long-term liability, in accordance with the Environment Protection (Sea Dumping) Act, the Petroleum (Submerged Lands) Act and the London Dumping Convention.
Onshore Factors - Burrup Peninsula	
Site selection	Protect the environment to the maximum extent possible. Protect vegetation and natural landforms from significant disturbance. Document site selection criteria and process in detail
Noise	Protect the amenity of nearby residents from noise and vibration impacts resulting from activities associated with the proposal by ensuring that noise and vibration levels meet statutory requirements and acceptable standards.
Dust	Protect the surrounding land users such that dust emissions will not adversely impact upon their welfare and amenity or cause health problems.
Air emissions - NOx and SOx	Ensure that emissions of NOx and SOx meet acceptable standards and requirements of Section 51 of the Environmental Protection Act 1986. Ensure that all reasonable measures are taken to minimise discharges of NOx and SOx.
Mercury regeneration	Prevent losses to the environment.
Solid wastes	Adopt measures to reduce and recycle solid wastes where practicable. Dispose of remaining wastes so as to reduce any environmental impacts.

Surface water	Maintain the beneficial uses of surface water, including ecosystem maintenance, consistent with the draft WA guidelines for marine and fresh waters (EPA 1993).
Groundwater	Maintain the beneficial uses of groundwater, including ecosystem maintenance, consistent with the draft WA guidelines for marine and fresh waters (EPA 1993).
Terrestrial fauna	Maintain the abundance, species diversity and geographical distribution of terrestrial fauna. Protect threatened fauna and their habitats, consistent with the provisions of the Wildlife Conservation Act and the Endangered Species Act.
Terrestrial vegetation	Maintain the abundance, diversity, geographical distribution and productivity of vegetation communities. Protect Declared Rare Flora consistent with the provisions of the Wildlife Conservation Act and the Endangered Species Act.
Preliminary Relevant Environmental Factors	**Preliminary Environmental Objectives**
Social/Heritage Factors	
Risk (Human health and safety)	Ensure that risk is managed to meet the EPA's criteria for individual fatality risk off-site and the DME's requirements in respect of public safety. Ensure that public risk associated with implementation of the project is as low as is reasonably achievable and in compliance with the criteria detailed in EPA Bulletins 611 and 627. Note: the major generator of public risk would be the trunkline onshore terminal (TOT). The existing onshore QRA should be updated to include the new TOT and to look at knock-on effects to and from other parts of the plant.
Social impacts	Ensure social impacts are acceptable. Information should be provided on the following: - numbers of workers required at the various stages of the project - requirements for accommodation - provision of other services and facilities to support the project workforce and families.
Heritage	Comply with statutory requirements in relation to areas of cultural or historical significance. Demonstrate that changes to the environment resulting from the project do not adversely affect cultural associations with the area

Public consultation

The PER should include a description of the public participation and consultation activities undertaken by the proponent in preparing the document. It should describe the activities undertaken, the dates, the groups/individuals involved and the objectives of the activities. Cross reference should be made with the description of environmental management of the factors which should clearly indicate how community concerns have been addressed. Those concerns which are dealt with outside the WA EPA and Commonwealth EPG process can be noted and referenced.

Environmental Management

The proponent should approach environmental management in terms of best practice. Best practice environmental management includes:

- development of an environmental policy;
- agreed environmental objectives;
- management of environmental objectives;
- involve the public as appropriate;
- audit performance against agreed indicators;
- regular reporting to the WA EPA or DEP (or nominated agencies) and Commonwealth EPG;
- commitment to a quality assured environmental management system and continuous improvement; and
- periodic (for example 5 yearly) review in conjunction with the EPA or DEP or nominated agencies and Commonwealth EPG .

Environmental management commitments

The method of implementation of the proposal and all commitments made by the proponent become legally enforceable under the conditions of environmental approval issued by the State Minister for the Environment the Commonwealth Minister in the statement Proponents are encouraged to consolidate the important commitments in the public review document, and these are attached to the Minister's statement.

Commitments which address relevant environmental factors will be audited by the DEP, along with the environmental conditions. The commitments should have the form of:

- the proponent (who) will prepare a plan or take action (what) to meet an environmental objective (why) by doing something (how/where), to a time frame (when), and to whose requirements or advice, if not the DEP, the action/plan will be prepared. These commitments may be addressed in tabular form.

Other commitments, addressing less contentious issues, serve to demonstrate that the proponent is dedicated to good environmental management. The DEP expects that the proponent will audit these commitments by internal processes (under an Environmental

Management System). Though not subject to routine audit by the DEP, the DEP may periodically request the proponent to demonstrate compliance with these commitments.

All commitments should define the objective and action in sufficient detail so that compliance can be measured.

An example of a typical commitment is:

Issue	Objective	Commitment	Timing (Phase)	Whose Requirements	Specification (Performance Indicators)
EMP	Implement an effective EMP	Develop and implement an effective EMP	Pre-development and on-going	EPA	developed and implemented to requirements of EPA.

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EXECUTIVE SUMMARY and SUMMARY TABLE

A. Background and Development Proposal

The North West Shelf Gas Venture (NWSGV), operated by Woodside Offshore Petroleum, on behalf of its 6 Joint Venture Partners, has been supplying natural gas to homes and industry in Western Australia since 1984 and exporting Liquefied Natural Gas (LNG) to Japan since 1989. It is Australia's biggest resource development project, currently earning more than $3 billion a year in oil and gas export revenue for the nation.

During 1998, the NWSGV facilities will commence supplying natural gas to its newest customer, BHP DRI Pty Ltd for its Hot Briquetted Iron Plant currently under construction at Port Hedland. This increased demand can be satisfied from the NWSGV existing facilities.

There is, however, significant potential for further expansion of the Domestic Gas market . To cater for this growth, Woodside proposes to (a) debottleneck facilities at the Onshore Treatment Plant (OTP) on the Burrup Peninsula (refer to Figure 1 for location) and; (b) install a second trunkline to supply additional gas from existing offshore facilities. The existing trunkline is close to its maximum capacity.

Woodside has been reliably and safely operating the existing trunkline for over 10 years. In that time a large body of knowledge on the operation and environmental impacts of such facilities has been accumulated. The evaluation of the environmental impacts of the second trunkline installation is thus based on real experience.

Debottlenecking refers to minor modifications of existing equipment and piping to increase the capacity of the existing Domgas trains from the current design capacity of 550 TJ/d to 850 TJ/d (average). The design intent is that both of the existing Domgas trains will normally be in operation, each supplying in the order of 450 TJ/day. In the event that only one Domgas train is available, the modifications will allow the supply of 910 TJ/day (peak) through the other train. A third sales compressor and a fuel gas booster compressor is required to provide security of supply for existing and new contracts.

The Domgas debottlenecking scope contains a second Trunkline Onshore Terminal (TOT), comprising a new Slugcatcher for safe separation of gas and liquid hydrocarbon from the trunkline and a pig receiver to enable running of sweeping and monitoring "pigs" through the trunkline. The construction of the second TOT may be deferred until sufficient gas/condensate volumes warrant the need for it. In this case the new trunkline may be temporarily connected to the existing TOT.

Also included in the scope of this project is additional fractionation capacity (from a current 2000 tonnes per day to a technical maximum of 5000 tonnes per day). This part of the second trunkline project is the same as that included in the *Liquids Expansion Project*, currently under assessment by the WA Government. Should the latter project not proceed, additional fractionation will still be required and is separately assessed in this document.

The proposed new trunkline would run to shore from either the Goodwyn Alpha (GWA) (Option 1a) or North Rankin Alpha (NRA) (Option 1) platform, or both. Connection to the platform(s) will be by new riser pipes installed on the existing platforms or, in the case of NRA, a subsea tie-in to the existing NRA-GWA interfield pipeline. A second Trunkline Onshore Terminal (TOT) will eventually be required to receive and separate the two

phase mixture of gas and condensate from the platform(s) and to safely accommodate any liquid slugs forming in the new trunkline.

The trunkline-to-shore route will be as direct as practicable to the entrance of Mermaid Sound and then continue through Mermaid Sound, parallel to the existing trunkline, to the OTP. A pipeline lay barge will install the trunkline. However, the shallow areas (< 8-10m) inshore will be installed via a shore pull technique.

Along part of its route, trunkline stability will be achieved by ploughing, however, in some areas, where sediment cover is thin, additional stability measures will be required. Rock berm emplacement is the most likely supplementary stabilisation method, although other potential methods are under consideration for this purpose. Where surface or subsurface igneous and strong calcareous rock occurs, blasting may be required prior to trenching. Additionally, rock armour may be applied (if required) in inshore areas for trunkline protection from ship groundings and anchor damage.

The application of anti-corrosion and concrete weight coating of the pipe lengths will be performed either *en-route* from the pipe mill or at a purpose built coating facility. The preferred location is at the rehabilitated Hearson's Village Site, but other sites in WA are under investigation.

A quarry or quarries may be established on the Burrup Peninsula to provide the approximately 3 million tonnes of rock is likely to be required for stabilising and protecting the trunkline.

B. Development Alternatives

Trunkline Route

A number of pipeline route approaches to the OTP were examined, ranging from:

- The north via Legendre and Dolphin Islands
- The east via Nickol Bay
- The west via Mermaid Sound and including
- Routes to the east and south of Conzinc Island (at the request of Government)

Screening studies considered technical, cost, socio-political and environmental issues and resulted in two approaches (Nickol Bay & Mermaid Sound) being selected for more detailed evaluation (Refer Figure 4).

The Nickol Bay option was subsequently eliminated, leaving the Mermaid Sound approach to the OTP. In addition, the option of routing the trunkline to either NRA and/or GWA platforms is to be retained (Refer Figure 2).

A detailed evaluation of alternative trunkline routes is provided in Section 2.4.4

Quarry Location

Given the large volumes of rock to be transported, potential quarry site investigations have been limited to the central portion of the Burrup Peninsula. In all, some 28 potential quarry sites were considered for their suitability against a range of technical, economic, safety, logistical, environmental and social constraints.

Screening of these alternatives identified two suitable quarry locations to the south of the existing plant, within the area identified by the State Cabinet-ratified Burrup Land Use Plan and Management Strategy for industrial development.

Investigations have shown that adequate quantities of the appropriate construction material can be obtained from two areas; quarry sites A and B (refer Figure 9).

Pipe Weight Coating Location

Seven alternate pipe weight coating locations have been investigated on the Burrup Peninsula. The selection criteria considered in assessing site suitability for a pipe weight coating area included:

- Availability of sufficient land area
- Availability of flat land, requiring minimal preparatory earthworks
- Ease of vehicle access
- Proximity to power, water and ancillary services
- Proximity to wharf area
- Environmental values (preference for an area previously disturbed)
- Ease and potential for successful rehabilitation
- Aboriginal heritage values

The preferred location at the previously disturbed Hearson's Village site is the only location investigated which meets all Project requirements. A detailed evaluation of alternative pipe weight coating locations is provided in Section 2.3.1.

Rock Loadout Locations

Rock loadout will occur over a vertical sheet pile wharf at the King Bay Supply Base (KBSB) and/or a purpose built, temporary conveyor loadout jetty extending from either the KBSB, Holden Point (to the south of No-Name Bay) or the Dampier Public Wharf (Refer Figure 9).

The KBSB option will require a new land backed rock loading facility, minor maintenance dredging, and the possible reclamation of 100-200m of land on the south east side of the existing turning basin. In addition, a possible deepening of the existing channel into a layover pocket to service an extended temporary conveyor jetty may be required.

The Holden Point conveyor loadout option is a trestle jetty extending from just above the proposed southern lease boundary on Holden Point. A rock storage area and a haul road from the quarry site will be constructed. The channel to the jetty may require some minor dredging to enable access to rock dumping vessels. Upon completion of the dumping operation the jetty will be removed at seabed level and the associated laydown areas and haul roads rehabilitated to a standard consistent with the future land use.

C. Existing Environment

Marine Environment

The offshore portion of the proposed trunkline (30-130m bathymetric contour) will pass through two broad marine habitat types. The predominant habitat is fine soft calcareous substrates that support a burrowing benthic infauna dominated by polychaete worms and

crustaceans. Areas of hard calcarenite substrate supporting a relatively sparse epibenthic fauna of sponges, soft corals and gorgonians will also need to be crossed.

Inshore, from the 30m bathymetric contour to shore, the trunkline will cross a broader range of habitat types. The predominant habitat will be soft sediments - though generally coarser than offshore, supporting fish and a range of invertebrates including crustaceans, echinoderms and molluscs. Sections of relatively shallow (7-10m) limestone pavement will need to be crossed in the vicinity of Hammersley Shoal and Conzinc Island. These pavements support algae, scattered corals, sponges and sea whips. At the shore crossing adjacent to the OTP, the trunkline will cross sparse subtidal coral assemblages and intertidal coral/mollusc and oyster/barnacle assemblages on igneous rock.

Terrestrial Environment

Disturbance to natural landforms and undisturbed biological communities on the Burrup Peninsula will be restricted to a short haul road extension, two potential quarry locations and an additional rocky outcrop area near the King Bay Supply Base. These areas are similar in that they are primarily comprised of rocky outcrops and scree slopes supporting sparse grasses, shrubs and woodlands. The landforms and vegetation units recorded are widespread on the Burrup Peninsula and contain no rare flora. The only rare fauna species known for the Burrup Peninsula is the Pilbara Olive Python.

D. Major Project Effects and Management Commitments

The main environmental issues associated with the project include the potential effects on sensitive marine communities from pipelaying operations and the source of rock for trunkline stabilisation.

The trunkline route selected provides suitable buffers between significant areas of coral reef and crosses directly into the OTP lease area, avoiding areas of undisturbed habitat and Aboriginal sites.

Rock sources for the trunkline stabilisation and possible armouring have been located in areas identified for industrial development by the State Cabinet-ratified Burrup Land Use Plan and Management Strategy.

An additional long term lease over land to the south of the existing lease will be required and has been requested from the WA State Government in July 1995. Other land requirements are limited to a temporary requirement of two areas, both of which have been previously disturbed; and a short extension of an existing haul road through undisturbed habitat to minimise disruption to public road traffic.

All proposed new facilities associated with the Domgas debottlenecking and the new TOT will be accommodated within the existing OTP boundary. No new liquid effluents are envisaged from the proposed expansion. Atmospheric emissions of CO_2 equivalents and NO_x are anticipated to increase by approximately 2-5% and 4-6% respectively, primarily as a result of increased fuel-gas consumption in proposed and existing gas turbines.

A summary of the Project's environmental commitments and management systems is provided in Section 9.0. Detailed discussion of environmental issues is provided in Section 4.0.

E. Conclusion

The trunkline route, quarry and weight coating options proposed offer the least environmental impact of all the options that have been considered.

The cumulative increases in atmospheric emissions from the debottlenecked Domgas plant are minimal and a comprehensive series of management safeguards will ensure that risks to the environment and people during the construction and operating phases of the Project are acceptably low.

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 is crucial to continued economic development in Australia whilst minimising additional greenhouse gas emissions in line with the Framework Convention on Climate Change to which Australia is a signatory.

The Project will bring benefits to the local and wider Western Australian communities during both the construction and operating phases. New and expanded industry will lead to a direct increase in direct and flow-on employment opportunities. The new trunkline, by duplication, will itself lead to greater availability and reliability of gas supplies to industry and residential consumers.

F. Summary Table of Proposal

Environmental Factors	EPA/Environment Australia Objective	Existing Environment	Potential Project Impact	Proposed Management
BIOPHYSICAL				
Endangered species	Protect endangered or threatened species (including marine wildlife) as required by the State Wildlife Conservation Act 1950, the Commonwealth Endangered Species Protection Act (1992) and international legal obligations.	<u>WA Wildlife Conservation Act 1950</u> • Blue and Humpback Whales (S1). • Olive Python is a S2 species (special protection). • Dugong is a S2 species. • No "rare" flora recorded, 4 Priority species. <u>Commonwealth Endangered Species Protection Act 1992</u> • Loggerhead Turtle (Endangered). Blue Whale (Endangered) • Humpback Whale (Endangered).	• Trunkline installation disturbance. • Quarrying & construction disturbance. • Trunkline installation disturbance • Destruction of some individuals in quarrying/pipe-coating area. • Trunkline installation disturbance	• Offshore trunkline installation activities limited to small area. No impact expected. • Preferred habitat (rockpool areas) not impacted. • Dugong feeding areas not impacted. • Widespread distribution on Burrup. Effect on populations minimal • No impact on turtle nesting beaches or feeding areas. • Offshore trunkline installation activities limited to small area. No impact expected. **(Refer S3.5 for detail)**
Sea Floor	Maintain the biodiversity of the sea floor and ensure that any impacts on locally significant marine communities are avoided. Note: pipeline construction and trenching in inshore areas should be managed so as to avoid impacts on coral spawning.	Refer S3 of PER.	• Disturbance from dredging, Trunkline installation.	• Trunkline route selected to minimise disturbance to locally significant marine communities or features. • Buffer zone instituted where practicable to protect significant communities. • Spoil to previously used spoil ground. • Dredging operations suspended during coral spawning period. • Blasting kept to a minimum. • Watches kept for marine mammals and turtles during blasting period. **(Refer S9 for more detail)**

Environmental Factors	EPA/Environment Australia Objective	Existing Environment	Potential Project Impact	Proposed Management
Shore Crossing.	Protect natural landforms and sensitive habitats from significant impacts.	Refer S3 of PER.	• Shore crossing point on existing OTP lease.	• Trunkline crosses directly into OTP lease; no impact to landforms or sensitive habitats. **(Refer S 4.3.1 for more detail)**
Site Selection.	Protect the environment to the maximum extent possible. Protect vegetation and natural landforms from significant disturbance. Document site selection criteria and process in detail.	Refer S3 of PER.	• Quarry and rock loadout options. • Trunkline routes selected. • Pipe weight-coating areas selected.	• 23 quarry sites evaluated, 2 selected in largely disturbed areas. • Temporary trestle jetty loadout facilities constructed. Will be removed after use. • Rock laydown area rehabilitated to fit in with future use of land. **(Refer S2.5.2 & 3.4.5 for detail)** • Coarse screening identified 4 favoured routes. • Legendre and Conzinc Routes studied in detail and eliminated. • Trunkline route selected is through Mermaid Sound, parallel to existing trunkline. **(Refer S 2.4.4 for more detail)** • Pipe weight Coating sites selected from 8 possible areas. • Selection based on logistical and environmental grounds. • Sites selected are previously disturbed. **(Refer S2.3.1 for more detail)**
Terrestrial Fauna	Maintain the abundance, species diversity and geographical distribution of terrestrial fauna. Protect threatened fauna and their habitats, consistent with the provisions of the Wildlife Conservation Act and the Endangered Species Act.	Refer S3 of PER	• Fauna/flora with conservation status (refer to Endangered species above). • Disturbance by Laydown areas, pipecoating areas, haul road activities, etc.	• Woodside previously undertaken fauna monitoring (1979 to 1995). • Small area disturbed is not expected to impact terrestrial fauna. **(Refer S3.4.4 & 3.5 for more detail)**
Terrestrial Vegetation	Maintain the abundance, diversity, geographical distribution and productivity of vegetation communities.	Refer S3 of PER	Destruction of some individuals of Priority Flora.	Species widespread on Burrup. No impact on overall populations expected. **(Refer S 3.4.2 for more detail)**

Environmental Factors	EPA/Environment Australia Objective	Existing Environment	Potential Project Impact	Proposed Management
	Protect Declared Rare Flora consistent with the provisions of the Wildlife Conservation Act and the Endangered Species Act.			
POLLUTION MANAGEMENT				
Greenhouse Gases	Reduce net output of Greenhouse gases in accordance with the International Framework on Climate Change. Ensure that Greenhouse gas emissions meet acceptable standards and requirements of the Environmental Protection Act 1986 (all reasonable and practicable measures are taken to minimise greenhouse gas discharge).	Current OTP produces approx 5 million tonnes of CO2 equivalents per annum.	• Extra power generation units will increase OTP greenhouse emission by approx 5%. • Project may facilitate future industrial development not assessed in this PER.	• Waste heat recovery installed on extra power generation units to improve energy efficiency. • Other energy efficiency measures studied during design (ie to reduce greenhouse emissions per unit energy produced). • Impact on overall OTP emission is small. **(Refer S 4.4.1 of PER)**
Ozone layer	Protect the ozone layer in accordance with policies and requirements of Commonwealth Ozone Protection Act 1989 and the WA Environment Protection (Ozone Depletion) Policy 1993.	Most "hard" ozone depleting substances phased out on OTP.	No increase.	No impact.
Condensate spills	Ensure minimal risk of leakage by identifying and managing risks and by adopting international best practice equipment and operating procedures. Protect sensitive environments and species from hydrocarbon spills. Note: risk from both pipeline	• Dampier Archipelago is recognised as an"Environmentally Sensitive Location". • The Archipelago is heavily used by heavy and commercial shipping as well as for recreational activities.	• Minimal increased shipping as a result of this proposal. • Risk from trunkline leaks greatest adjacent to the shipping anchorages outside Mermaid Sound. • Carriage of dry gas and previous experience indicates corrosion induced holes very unlikely.	• Oil spill models run at KP30 (outside Archipelago) and KP10 (inside) for different hole sizes • Risk of damage to trunkline causing a spill is highest after KP30. • Evaporation rate of condensate (55% loss in 10mins) means spill volumes will be very quickly reduced. • Project will employ design standards and operational practise to reduce risk of condensate spills to ALARP principles. **(Refer S5.3 for more detail)**

Environmental Factors	EPA/Environment Australia Objective	Existing Environment	Potential Project Impact	Proposed Management
	leaks and increased shipping will need to be assessed.			
Dredging and disposal of dredge spoil	Protect environment from significant impacts consistent with the Environment Protection (Sea Dumping) Act and the London Dumping Convention. Note: pipeline construction and trenching in inshore areas should be managed so as to avoid impacts on coral spawning.	• Mermaid Sound is typically a naturally turbid environment • Previously used spoil grounds exist west of Conzinc Island • Substantial dredging has been carried out in Mermaid Sound to service heavy industry in the region.	Dredging of the layover pockets for rockloading, shipping channels and for trunkline installation will generate turbidity.	• Refer to "Sea Floor" above for specific management
Hydrotest fluids	Demonstrate that there will be no significant impacts from disposal of hydrotest fluids / pickle liquors. Note: The preferred method of disposal is to return the fluids to a bunded area on shore where fluids will be allowed to evaporate.	• Hydrotest fluids to be discharged at offshore platforms. Water depth is 130m in open ocean environment • Previously hydrotest fluid discharges have occurred with no environmental impact	Hydrotest fluids used to pressure test the trunkline will have to be discharged at offshore platforms.	• Discharge will be configured to maximise dispersion • Chemical additives will be minimised and subject to toxicity criteria **(Refer S 2.5.7 for more detail)**
Produced Formation Water	Demonstrate that there will be no significant environmental impacts from disposal of PFW. Use best practice technology to reduce the size of the mixing zone to the maximum extent practicable. Beyond the mixing zone, ambient levels of total dissolved hydrocarbons in seawater should not exceed the interim guideline as specified in the draft WA Water Quality	Current Platforms produce little PFW. Water is condensed from gas and discharged offshore subject to PSLA oil in water requirements.	No significant increase in PFW is anticipated with this project.	No impact

Environmental Factors	EPA/Environment Australia Objective	Existing Environment	Potential Project Impact	Proposed Management
	Guidelines for Marine and Freshwaters (EPA Bulletin 711, 1993). Levels of heavy metals and naturally occurring radioactive material (NORM) should meet the requirements of the Department of Minerals and Energy (DME).			
De-commissioning	Protect environment from adverse impacts and ensure that the State and Commonwealth Governments do not incur a long-term liability, in accordance with the Environment Protection (Sea Dumping) Act, the Petroleum (Submerged Lands) Act and the London Dumping Convention.	Project life is currently extended to 2050.	Facilities will have to be decommissioned at the end of operational life.	• Quarries will be decommissioned to DME criteria. • Decommissioning plan to be prepared close to end of operational life. **(Refer S9 and S2.7.5 for more detail)**
Dust	Protect the surrounding land users such that dust emissions will not adversely impact upon their welfare and amenity or cause health problems.	• Burrup Peninsula frequently has elevated dust loadings from natural and industry (ore loading) sources. • Construction areas are remote from urban or operational areas.	Dust will be generated by rock loading, haulage and quarrying activities.	• Road dampening and stockpile sprays will be implemented if necessary. • Monitoring of roadside vegetation will be implemented. Due to short term activities, no effect is anticipated.
Air Emissions (NOx & SOx)	Ensure that emissions of NOx and SOx meet acceptable standards and requirements of Section 51 of the Environmental Protection Act 1986. Ensure that all reasonable measures are taken to minimise discharges of NOx and SOx.	• Existing OTP emits approximately 6000 tonnes per annum of Nox. • No SOx is produced. • OTP is 15km from nearest urban area.	The project will add approximately 5% to current NOx emissions.	• Increase in NOx is not expected to increase levels of smog in the region. • Airshed is largely unoccupied. **(Refer S9 & S4.4.2 for more detail)**
Mercury regeneration	Prevent losses to the environment.	Current Domgas unit has Mercury removal beds.	Disposal of Mercury removal beds at end of life.	Mercury removal beds will be extracted to remove mercury and disposed of by specialised third party

Environmental Factors	EPA/Environment Australia Objective	Existing Environment	Potential Project Impact	Proposed Management
				contractor or manufacturer.
Solid wastes	Adopt measures to reduce and recycle solid wastes where practicable. Dispose of remaining wastes so as to reduce any environmental impacts.	• Wastes from existing OTP disposed according to Shire of Roebourne directions or by specialised contractors if required • Woodside has internal waste management systems operating successfully.	Waste management on construction and operational wastes will be required..	Waste management on all phases of the project is overseen by on-site environmental staff according to existing Woodside procedures.
Surface water	Maintain the beneficial uses of surface water, including ecosystem maintenance, consistent with the Draft WA Guidelines for Marine and Fresh Waters (EPA 1993).	There is no surface water in the vicinity of Project operations.	Run off from some operations (eg pipe weight-coating) may contain chemicals.	Waste liquids from operations using chemicals will be collected ,treated and disposed in an environmentally acceptable manner.
Groundwater	Maintain the beneficial uses of groundwater, including ecosystem maintenance, consistent with the Draft WA Guidelines for Marine and Fresh Waters (EPA 1993).	Groundwater exists beneath the OTP plate.	Leakages from Project units on the OTP site may contaminate groundwater.	• Oil contaminated water will be conducted from collection bunds via an existing sewer system to separation facilities. • Equipment where oil contamination is possible will be bunded. Design standards and operational practise to prevent oil leakage will apply. • Groundwater beneath the OTP is monitored by a series of bores.
SOCIAL SURROUNDINGS				
National Estate	Protect areas listed on the Register of the National Estate or currently under assessment.	Dampier Archipelago is "Indicative Place" on the Register of the National Estate.	Project is situated in area listed as indicative place.	The Project will minimise impact of the Project to maintain the significant environmental values of the Dampier Archipelago.
Increased demand for Natural Resources	Specify the impact this proposal will have on current reserves.		The NWSV has existing Production Licences over a number of gas fields on the NWS.	This Project does not require additional Production Licences.
Historic ship wrecks	Protect historic ship wrecks from damage during trunkline installation in accordance with the Historic shipwrecks Act	The proposed route does not cross any listed historic shipwrecks.	Disturbance to any unlocated wrecks by trunkline installation.	The Project will liase with the WA Museum to ensure historic shipwrecks are identified.

Environmental Factors	EPA/Environment Australia Objective	Existing Environment	Potential Project Impact	Proposed Management
	and Maritime Archaeology Act.			
Noise	Protect the amenity of nearby residents from noise and vibration impacts resulting from activities associated with the proposal by ensuring that noise and vibration levels meet statutory requirements and acceptable standards.	Area is 15 km from nearest residential area.	Noise impact may be evident at the King Bay Supply Base.	Noise will be monitored as per normal workplace health measures.
Risk (Human health & safety)	Ensure that risk is managed to meet the EPA's criteria for individual fatality risk off-site and the DME's requirements in respect of public safety. Ensure that public risk associated with implementation of the project is as low as is reasonably achievable and in compliance with the criteria detailed in EPA Bulletins 611 and 627. Note: the major generator of public risk would be the trunkline onshore terminal (TOT). The existing onshore QRA should be updated to include the new TOT and to look at knock-on effects to and from other parts of the plant.	Existing OTP imposes risks on the workforce which are currently managed through the OTP Safety Case.	The risk at the OTP lease boundary may increase.	• Preliminary Quantitative Risk Assessments done on the 2nd Trunkline Onshore terminal, Trunkline and process facilities indicate risk levels remain within DEP criteria. • There are no external risk receptors.
Social Impacts	Ensure social impacts are acceptable. Information should be provided on the following: - numbers of workers required at the various stages of the project	The towns of Karratha, Dampier Wickham and Roebourne are nearby and utilise the Dampier Archipelago for commercial and recreational activities.	Construction and operation of the trunkline may interfere with competing uses	• Extensive community consultation has been undertaken. **(refer S6.7 for details)** • Close liason will be maintained with user groups, such as fishermen, during the term of the Project. • Offshore installation workforce will be accomodated offshore and fly-in/fly-out, with no impact on regional services.

Environmental Factors	EPA/Environment Australia Objective	Existing Environment	Potential Project Impact	Proposed Management
	- requirements for accommodation - provision of other services and facilities to support the project workforce and families.			• Onshore workforce will peak at 260. • Small population increase is not expected to significantly affect local services or infrastructure.
Heritage	Comply with statutory requirements in relation to areas of cultural or historical significance. Demonstrate that changes to the environment resulting from the project do not adversely affect cultural associations with the area.	The Burrup Peninsula is recognised as having significant Aboriginal heritage values.	Quarrying, pipe-weight coating, haulage and stockpiling have the potential to impact on heritage sites.	• Any impact on heritage sites will be managed in consultation with the local Aboriginal community and the WA Museum. • Disturbance will be subject to the provisions of the WA Aboriginal Heritage Act.

1 INTRODUCTION

1.1 Background

The North West Shelf Gas Venture, operated by Woodside Offshore Petroleum, has been supplying natural gas to homes and industry in Western Australia since 1984 and exporting Liquefied Natural Gas (LNG) to Japan since 1989. It is Australia's biggest resource development project, currently earning more than $3 billion a year in oil and gas export revenue for the nation.

During 1998 the North West Shelf Gas Project plans to commence supply of Natural Gas to its newest customer, the BHP DRI Pty Ltd Hot Briquetted Iron Plant currently under construction at Port Hedland. This increased demand can be satisfied from the Project's existing facilities.

There is, however, significant potential for further expansion of the Domestic Gas market. To cater for this growth, Woodside proposes to; (a) debottleneck facilities at the Onshore Treatment Plant (OTP) on the Burrup Peninsula (refer to Figure 1 for location) and; (b) install a second trunkline to supply additional gas from existing offshore facilities. The existing trunkline is close to its maximum capacity.

Woodside has been reliably and safely operating the existing trunkline for over 10 years. In that time a large body of knowledge on the operation and environmental impacts of such facilities has been accumulated. The evaluation of the environmental impacts of the second trunkline installation is thus based on real experience.

1.2 Proponent

The proposed expansion forms part of the North West Shelf Gas Project. The North West Shelf Gas Project is a joint venture between:

Woodside Petroleum Ltd.
BHP Petroleum (North West Shelf) Pty Ltd.
BP Developments Australia Ltd.
Chevron Asiatic Limited.
Japan Australia LNG (MIMI) Pty Ltd.
Shell Development (Australia) Pty Ltd.

The designated operator of the North West Shelf Gas Project is:

Woodside Offshore Petroleum Pty Ltd
GPO Box D188
Perth 6001

1.3 Legislative Requirements

The North Rankin "A" and Goodwyn "A" production platforms, where trunkline tie-ins will occur, lie in Commonwealth waters. The proposed trunkline will pass through both Commonwealth and State waters en route to the OTP on the Burrup Peninsula. The onshore components of the Project occur on land under the jurisdiction of the Western Australian State Government.

Pipeline licences will be required from the Joint Authority under Commonwealth legislation and from the Minister for Mines under State legislation. Licences will be granted under two separate Acts:

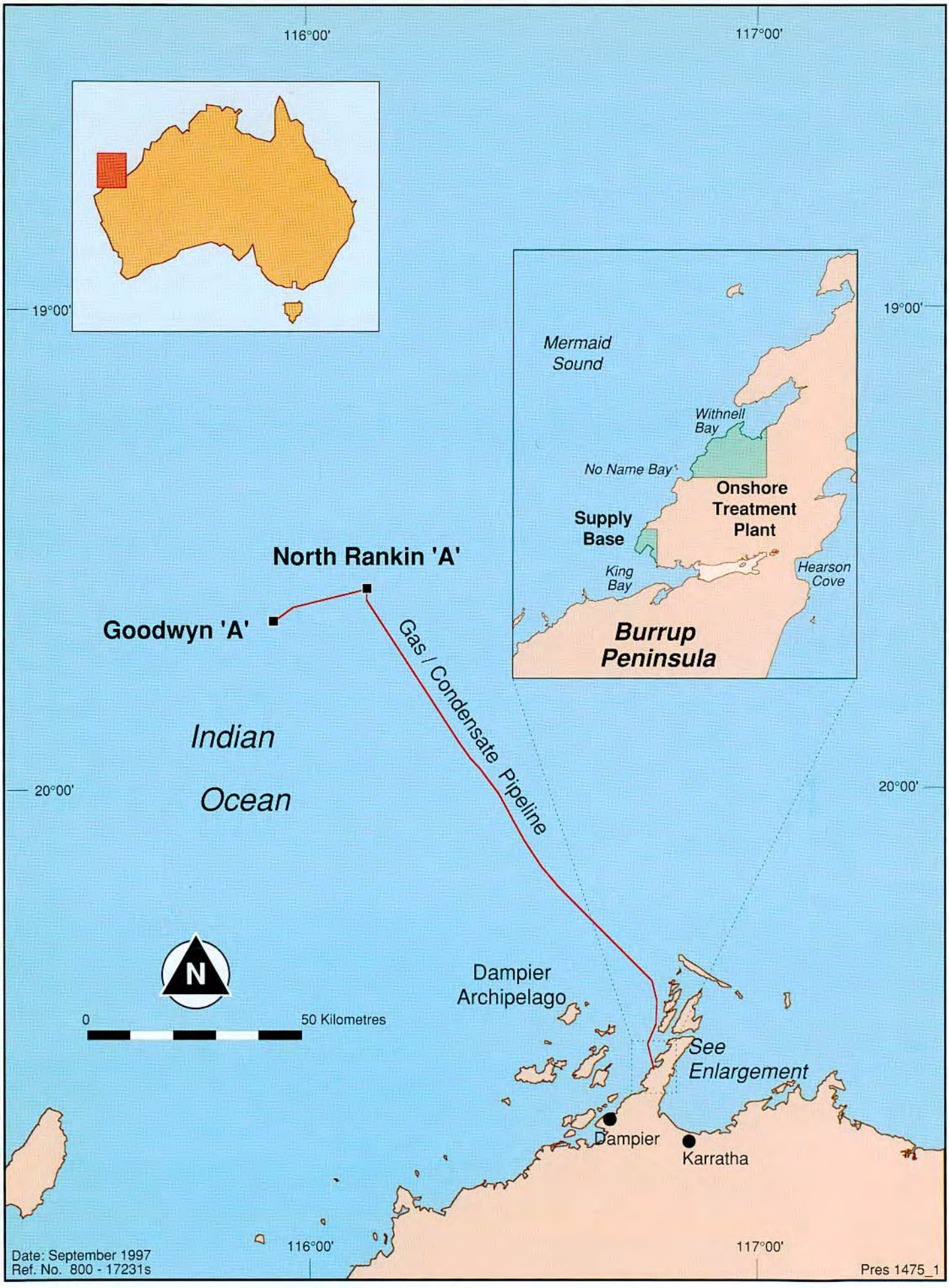

Figure 1 - Second Trunkline Project PER

PROJECT LOCATION MAP

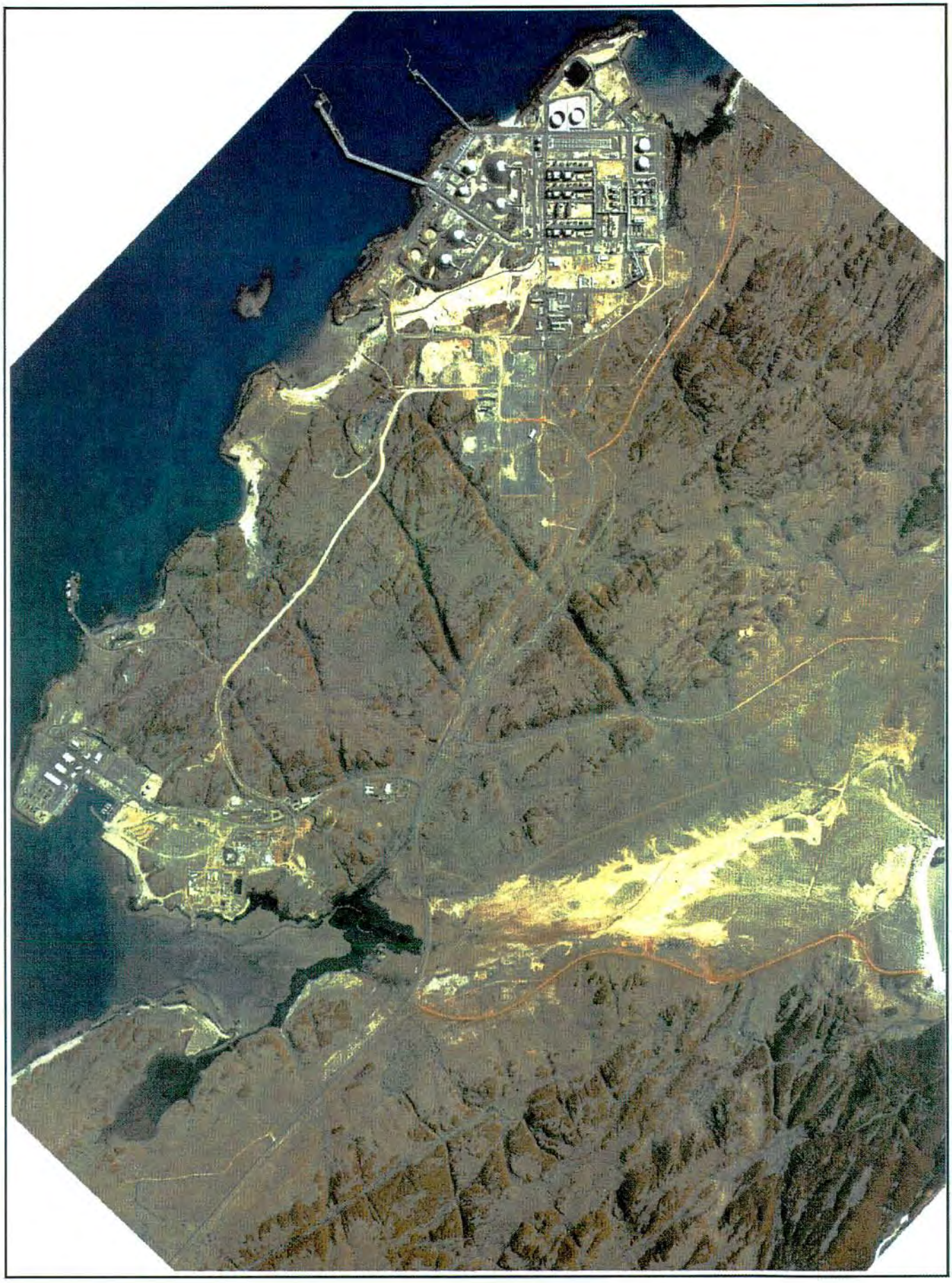

Figure 1a - Second Trunkline Project PER

AERIAL PHOTOGRAPH OF GENERAL PROJECT LOCATION

Petroleum (Submerged Lands) Act, 1967 (Commonwealth) - for offshore Commonwealth waters.
Petroleum (Submerged Lands) Act, 1982 (Western Australia) - for offshore State waters.

The Commonwealth Department of Primary Industries and Energy has referred the Project to Environment Australia and the Commonwealth Minister has designated Woodside as the proponent under the Commonwealth Environmental Protection (Impact of Proposals) Act, 1974 for Resources and Energy. The Commonwealth Environment Minister has determined that the Project is to be formally assessed and has set the level of assessment as a Public Environmental Report.

The Project has also been referred to the Western Australian Environmental Protection Authority by the WA Department of Resources and Development and will be assessed under the WA Environmental Protection Act, 1986. The Environmental Protection Authority has also determined that the Project will be formally assessed and has set the level of assessment as a Public Environmental Review.

The Project will be Jointly assessed by the Commonwealth Environment Australia and the Western Australian Environmental Protection Authority.

1.4 Current Status of Project

The Project is currently commencing detailed design, where the various options for Project implementation are being investigated with respect to safety, environmental, technical and economic considerations.

1.5 Project Scope

The Project is fully described in Section 2.0. The Project scope includes the following major components:

- New trunkline, including tie-ins offshore and onshore.
- A new Trunkline Onshore Terminal (TOT).
- Domestic gas compression facilities and ancillary equipment.
- Trunkline interface (eg: pig launcher).
- Up to 3 gas export pipelines to OTP boundary fence.
- Pipe coating yard (if required).
- Additional quarry(s), road and loadout facilities.
- Domgas plant debottlenecking.
- Fractionation (similar to Liquid Expansion proposal – see paragraph this section).

Note that debottlenecking refers to minor modification of existing equipment, such as replacement of piping or additional piping, including a bypass line to connect gas from the LNG scrub columns, replacing control valves with larger valves, replacing vessel and pump internals, additional pumps, etc.

Specifically excluded from this Project scope are:

- Export pipelines to consumers outside the OTP boundary fence.

- Possible future Domgas, Liquids and LNG plant expansion, including additional offshore production facilities and/or modifications.

Note that export gas pipeline operators will be required to seek the necessary Governmental approvals from the OTP boundary and; that any subsequent Domgas, Liquids and LNG expansion projects will be subject to their own approval processes.

In the event that the Liquid Expansion Project (currently also under assessment by the WA Government) does not proceed, additional Fractionation capability will still be required as part of this project and is therefore assessed in this document. The additional Fractionation facilities proposed, however, are identical in scope and common to both Projects.

1.6 Future Domgas/LNG Expansion

Market forecasts indicate that there may be scope to expand sales of Domgas in the future, which could require the installation of additional Domgas production facilities. Similar growth potential is forecast for LNG, which could require the installation of one or two additional trains.

The design parameters for the new trunkline will take into account the potential future capacity requirements for the NWS Gas Project. This will avoid unnecessary duplication on infrastructure in the future. The feasibility of the various scenarios is currently under review and only when this has been completed will it be possible to determine the required diameter of the proposed new trunkline. Should these expansions be proved viable, they will be subject to separate assessment and approval processes.

1.7 Community Consultations

Woodside has undertaken extensive consultations with regulatory agencies, industry and community group stakeholders throughout the early phases of the Project. Contact with key Government agencies has been ongoing since January 1995 and consultation with commercial fishing associations and Aboriginal Native Title claimants has been ongoing since 1996.

The groups that have been consulted are detailed in Section 6.7 of this document.

1.8 Project Benefits

The Project will bring benefits to the local and wider West Australian communities during both the construction and operating phases. New and expanded value-adding mineral processing industries will lead to direct and indirect increase in employment opportunities. The new trunkline, by duplication, will itself lead to greater reliability of gas supplies to industrial and residential consumers.

Relative to other alternative fossil fuels, Natural gas is one of the cleanest forms of energy currently available. Increased substitution of natural gas in Australia's primary energy fuel mix, will result in reductions in the production of greenhouse gases responsible for climate change. In addition, the specification of Natural Gas in new developments will ensure the least increase in emissions and better overall fuel efficiency.

Development of gas reserves and local use by industry avoids the expensive and polluting ongoing long distance transport of other fuels, such as oil or coal. In a similar way local development of resources, such as iron ore, provides a value added commodity rather than shipping raw materials overseas.

1.9 The No Development Option

Should the proposed 2nd trunkline not be developed, Woodside's ability to supply domestic gas to additional value-adding export industries both within the Pilbara and the wider Western Australian market would be severely constrained, with the potential for a major loss of economic benefit to both the State and Australian economies.

Significant economic benefits and employment opportunities derived from the construction phases would also be lost.

Also lost would be the environmental benefits of having Natural gas available to substitute for fossil fuels with high greenhouse emissions, such as coal.

2 PROJECT DESCRIPTION

2.1 Trunkline Description

The proposed trunkline will run either:

- Directly from the Goodwyn A platform (GWA) (**option 1A)** or
- Directly from the North Rankin A platform (NRA) (Option 1) or
- From GWA via the NRA platform

to a new Trunkline Onshore Terminal (TOT) located in the existing OTP at Withnell Bay on the Burrup Peninsula (Refer to Figure 2).

The offshore platforms will require new risers to connect the platform export pipework to the trunkline. The new risers will be installed directly on the existing platforms. In addition subsea connections to the new trunkline or pipelines may be required.

The trunkline will terminate onshore at a Trunkline Onshore Terminal (TOT) required to collect and separate liquid condensate from the gas. The trunkline will cross the shore adjacent and east of the existing trunkline and piping connections will be required onshore to connect the new TOT to the onshore gas/condensate treatment facilities (refer to Section 2.6 for more specific details of the Trunkline Onshore Terminal).

2.2 Design

The trunkline is being designed to relevant Australian and International Standards, incorporating the most recent available data and recommended practices.

The final trunkline diameter and operational parameters have not been finally determined, since production alternatives are still being evaluated and are dependent on future Domgas/LNG growth prospects.

The preliminary trunkline design combinations are shown below:

2.2.1 GWA - NRA - Plant (Option 1)

Length	:	159 km
Diameter	:	1016-1066 mm (40-42")
Wall thickness	:	25.8 mm
Design Pressure	:	14.5 MPa
Design Temperature	:	45 ° C
Product	:	Dehydrated natural gas and condensate

2.2.2 GWA to Plant (Option 1A)

Length	:	148 km
Diameter	:	1066 mm (42")
Wall thickness	:	20.1 mm
Design Pressure	:	14.5 MPa
Design Temperature	:	45 ° C
Product	:	Dehydrated natural gas and condensate

High strength line pipe will be used, manufactured to API 5L specifications, most likely X65 grade that has a yield strength of 448 MegaPascals (MPa). The pipeline system and

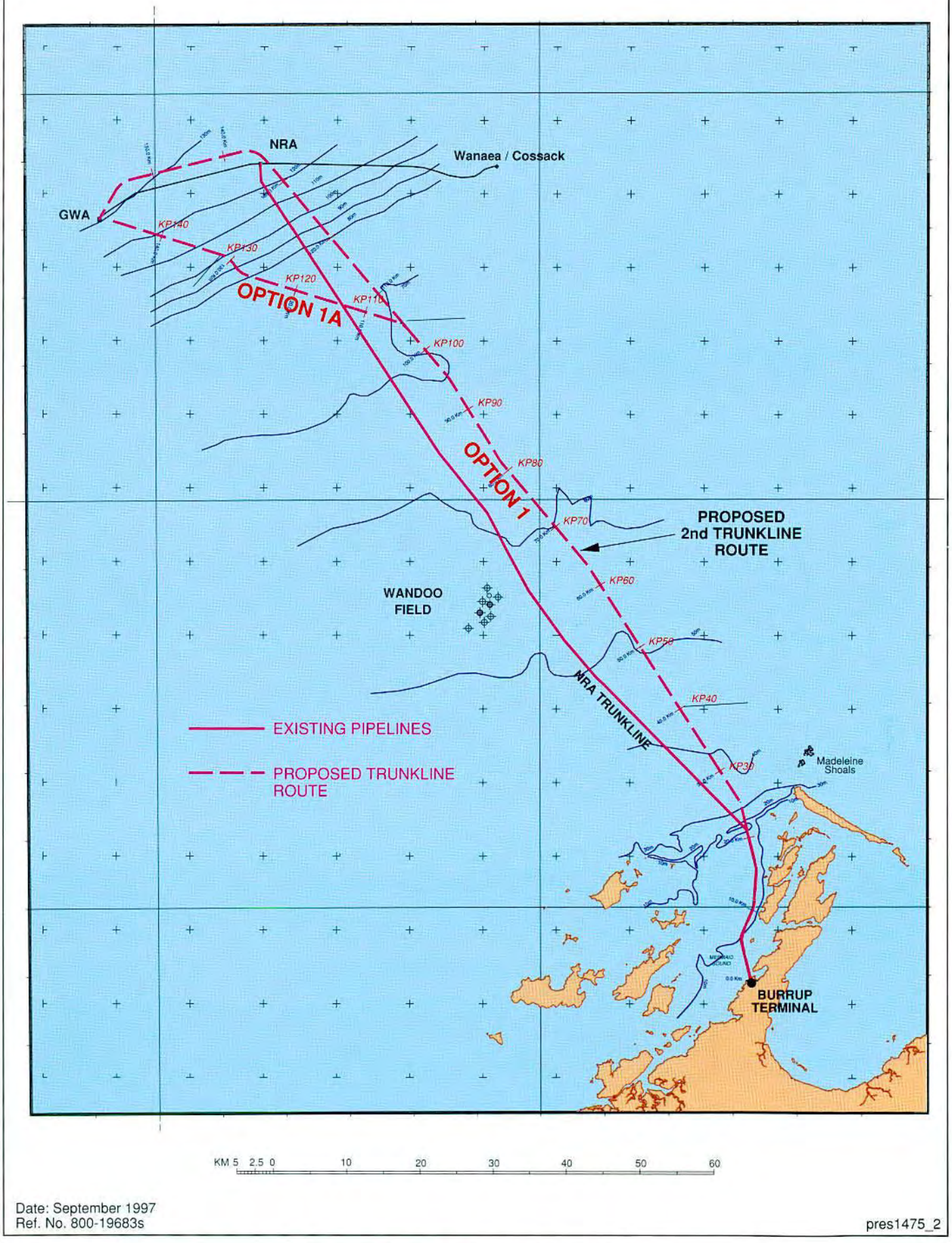

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Figure 2 - Second Trunkline Project PER

2nd TRUNKLINE ROUTE LOCATIONS

the stabilisation measures proposed will be based upon 1 in 100 year cyclonic storm conditions.

Other elements currently under consideration in the design process are:

- Route alignment optimisation.
- Internal corrosion.
- Operational loads - temperature and pressure.
- Environmental loads - wind, waves, tidal and storm current.
- Installation loads - mechanical and environmental.
- Accidental loads - dropped objects, anchor and fishing contact.
- Inspection and maintenance.
- Repair methods - minimising repair cost.
- Operating practices - pigging.
- Commissioning and decommissioning procedures.

The trunkline will be constructed from SAW welded steel pipe and protected against external corrosion by the application of a high integrity, anti-corrosion coating such as fusion bonded epoxy or asphalt enamel. Zinc or aluminium alloy anodes spaced at 50m to 100m will be added to supplement the external anti-corrosion coating protection.

To enhance the flow characteristics in the trunkline, an internal epoxy type coating may be applied.

An external concrete weight coating will be applied for on-bottom stability. The thickness of concrete will vary between 50mm and 125mm along the route.

2.3 Linepipe Coating

Anti-corrosion and concrete weight coating of the pipe lengths will occur either on route from the pipe mill (e.g. in South East Asia), at a purpose built coating facility in the vicinity of the OTP or other sites under investigation in WA. The coating application process is summarised below:

- Grit cleaning of the pipe.
- Corrosion coating application.
- Concrete weighting applied exterior to the corrosion coating (compression wrap or impingement process).
- Stockpiling prior to pipelaying.

2.3.1 Assessment of Alternative Pipe Weight Coating Areas

At the request of Government, Woodside has assessed 8 alternate locations on the Burrup Peninsula for their suitability as a pipe weight coating area. The location of these areas are displayed in Figure 3. Woodside's preferred options for pipe weight coating are at the rehabilitated Hearson's Village site and at the original pipe weight coating site, at the Hearson's Cove turnoff.

The selection criteria considered in assessing site suitability for a pipe weight coating area included:

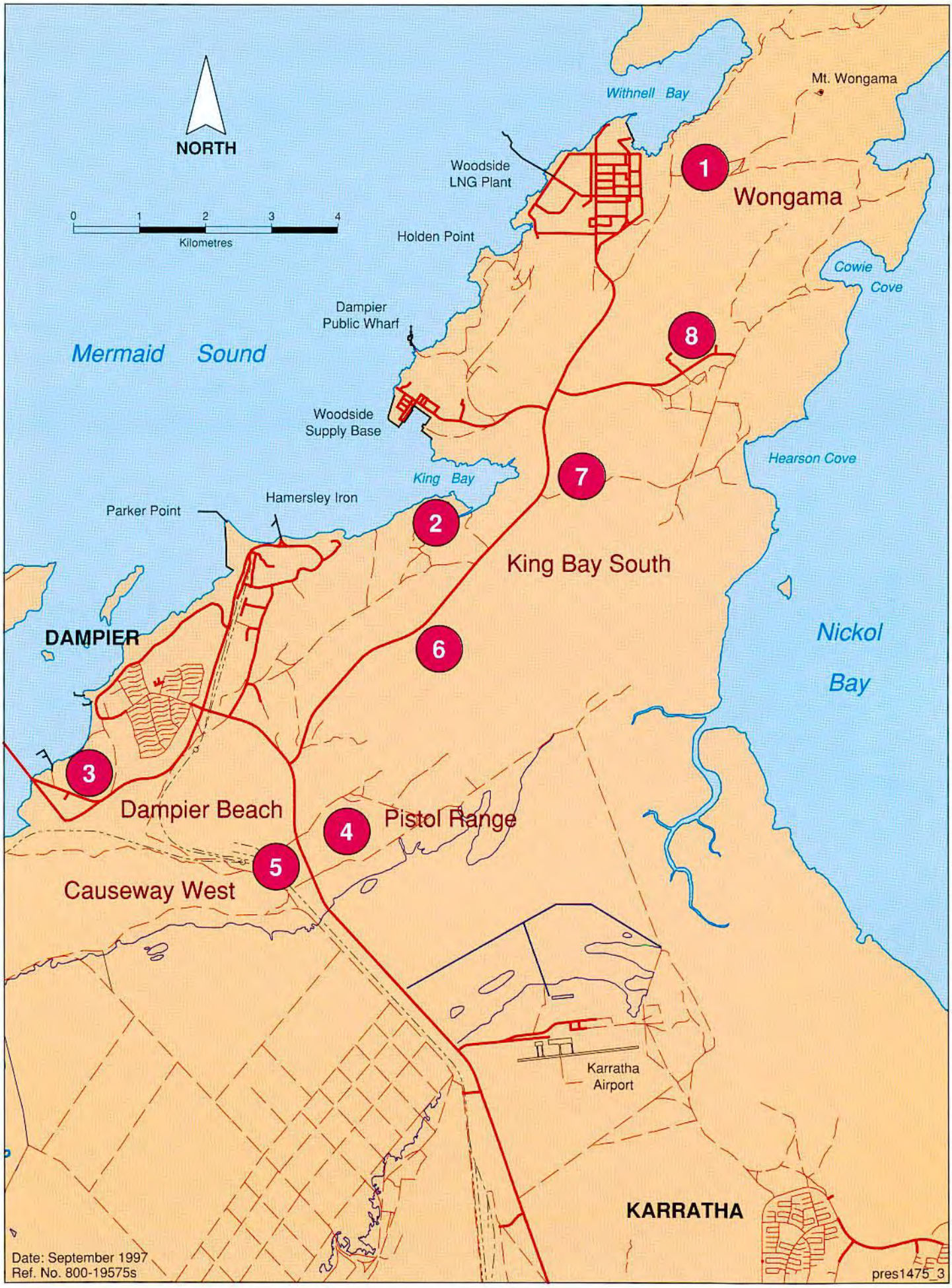


Figure 3 - Second Trunkline Project PER

ALTERNATIVE PIPE WEIGHT COATING AREAS

- Availability of sufficient land area.
- Availability of flat land, requiring minimal preparatory earthworks.
- Ease of vehicle access.
- Proximity to power, water and ancillary services.
- Proximity to wharf area.
- Environmental values (preference for an area previously disturbed).
- Ease and potential for successful rehabilitation.
- Aboriginal heritage values.

Location 1

The land available at this location is insufficient to meet requirements. Much of the land is heavily outcropped and undulating and would be unsuitable for use. Suitable vehicle access is available by gravel road. Water and telephone lines are available, however power would need to be upgraded. Haulage distances to the wharf are not excessive.

With the exception of the Mt. Wongama access road, the nominated area is undisturbed. Vegetation is dominated by *Triodia* hummock grassland with occasional shrubs such as *Acacia inequilatera* and *Grevillea pyramidalis*. Priority flora *Terminalia suprantifolia* (priority 3) and *Brachychiton acuminatus* (priority 4) occur in the area, generally in association with rock piles, rocky outcrops and rock pockets.

Disused pebble mice (*Pseudomys chapmani*) mounds are unusually common in the area and the possibility of an extant population, though unlikely, cannot be conclusively ruled out.

The area has not been completely surveyed for Aboriginal sites. The adjacent areas near Withnell Bay were found to be extremely dense in sites during the Dampier Archaeological Project (Aboriginal Sites Department, 1984) and the Burrup Peninsula Aboriginal Heritage Project (Veth, 1993).

Location 2

Much of the area is steep or sloping with massive rock outcrops. Extensive earthworks would be required to provide sufficient flat land. Vehicle access is poor, by 4WD track and no ancillary services are available. Haulage distances to the wharf are acceptable.

Whilst a number of access tracks bisect the area, it remains largely undisturbed and away from these tracks, free of exotic weed species.

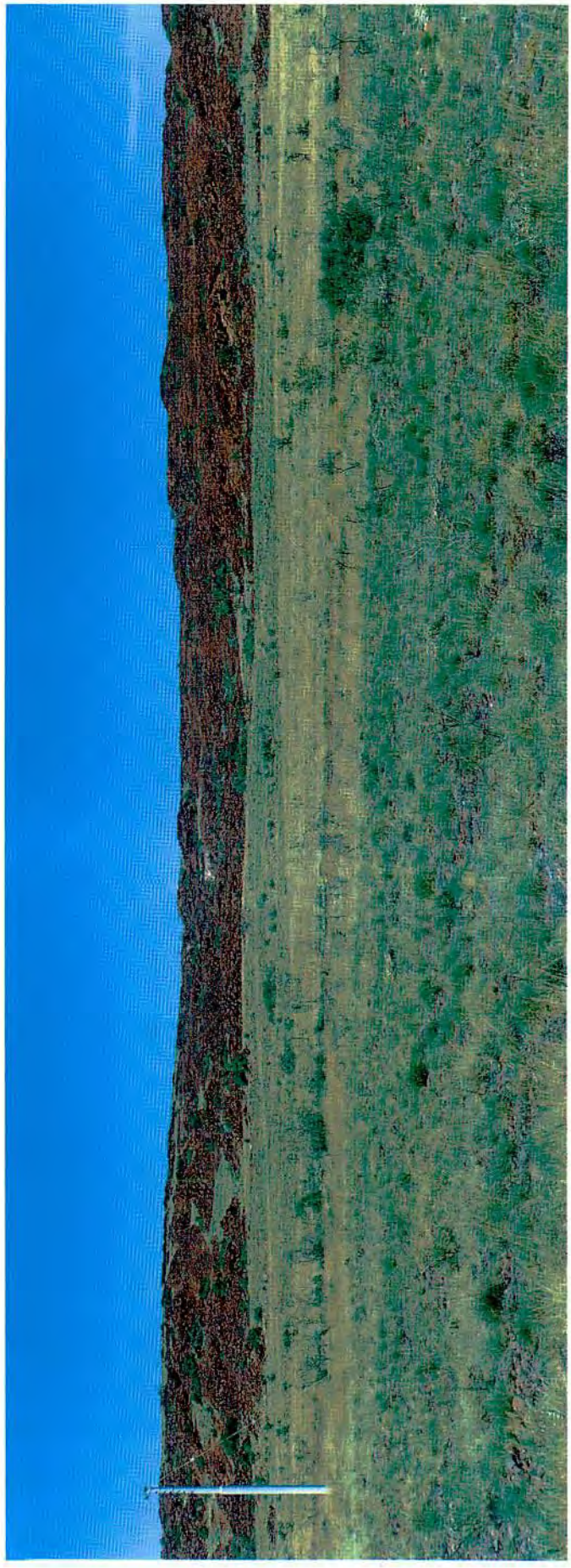
Vegetation is dominated by *Triodia spp.* steppe on rocky outcrops and scree slopes. Occasional shrubs - *Acacia spp.*, *Grevillea pyramidalis* and *Hakea subera* occur with *Eucalyptus victrix* along drain lines.

Top soil stripping would be difficult over most of the area and the potential for buffel grass invasion would be high.

The potential for weed free successful rehabilitation is presumed relatively low.

The area is well known for Aboriginal site complexes and is known to be of high significance to the local Aboriginal community.

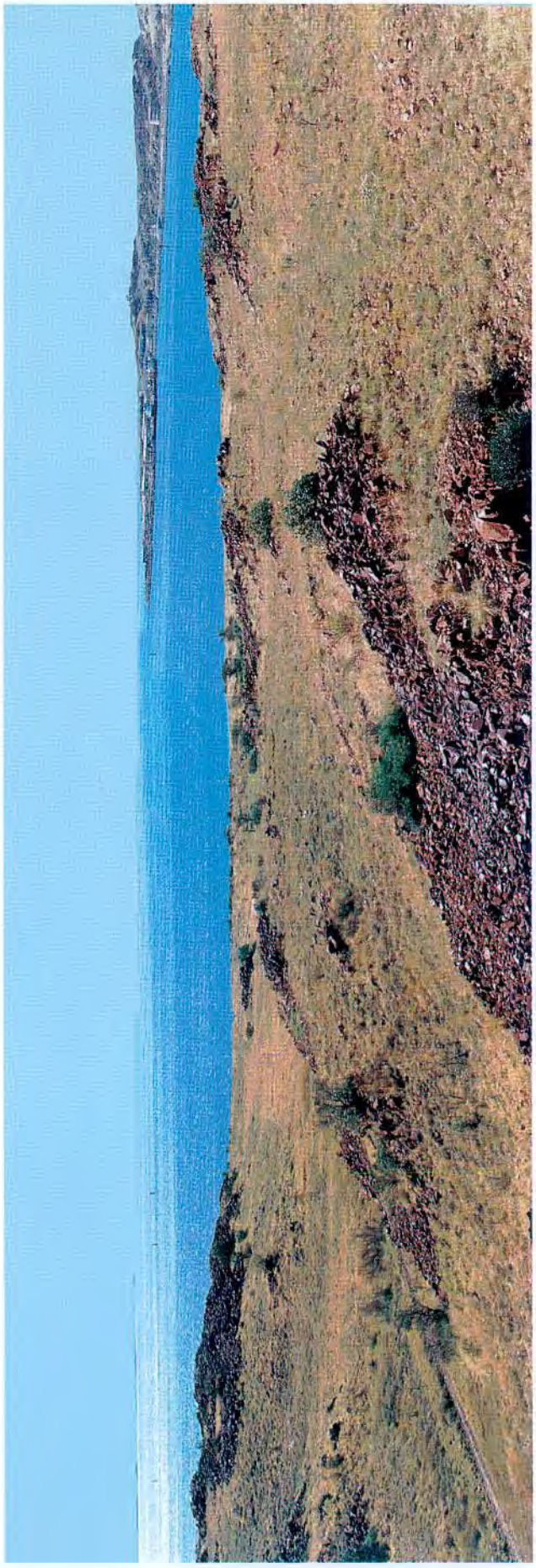
Overall the site is considered unsuitable for the establishment of a pipe weight coat site.



South west view looking from north side of access track

Figure 3a - Second Trunkline Project PER

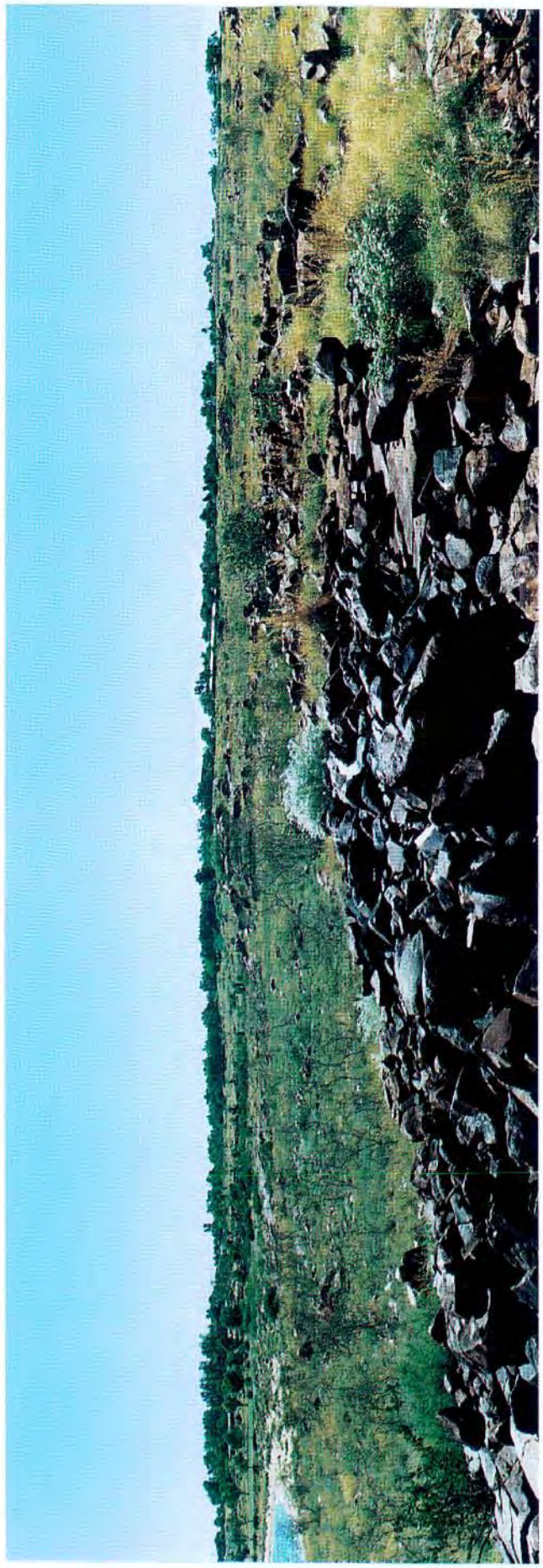
GENERAL VIEW
PIPE WEIGHT-COATING LOCATION 1



View looking north west from
southern side of identified area

Figure 3b - Second Trunkline Project PER

GENERAL VIEW
PIPE WEIGHT-COATING LOCATION 2



View looking north

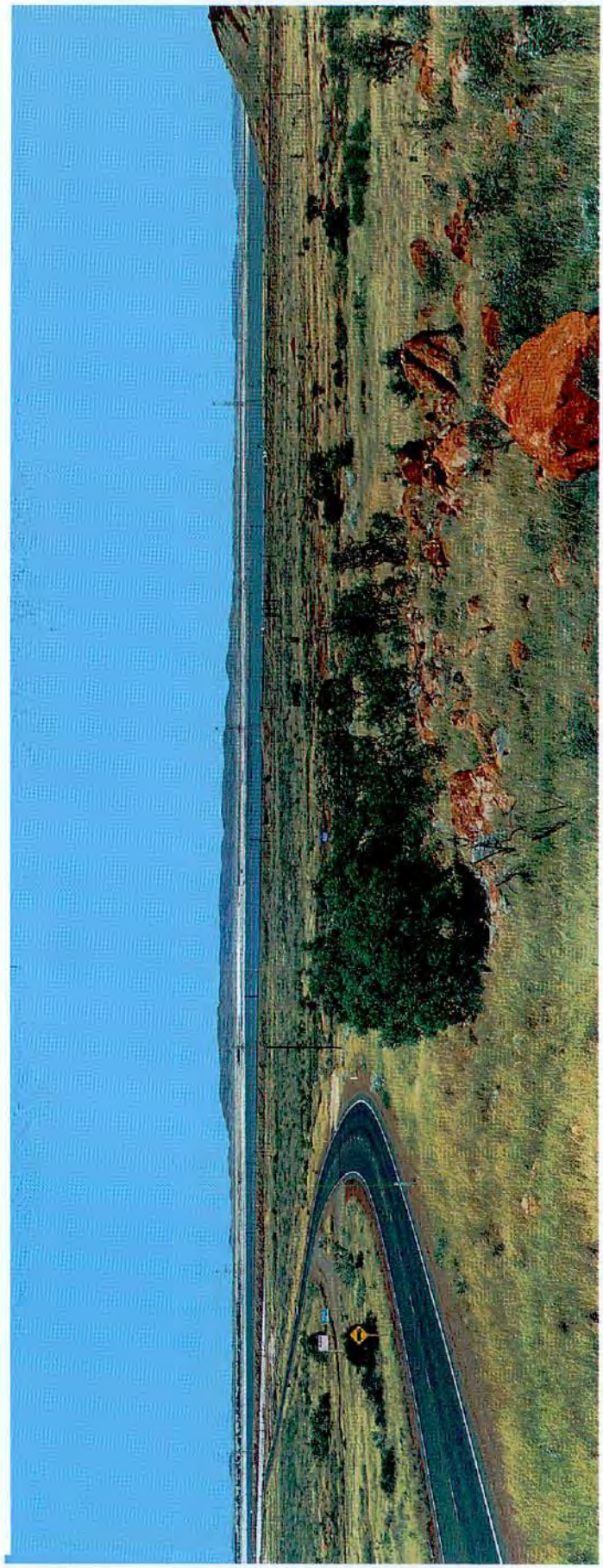
Figure 3c - Second Trunkline Project PER

GENERAL VIEW
PIPE WEIGHT-COATING LOCATION 3

View looking south
Note - Borrow pit in foreground

Figure 3d - Second Trunkline Project PER

GENERAL VIEW
PIPE WEIGHT-COATING LOCATION 4



View looking south

Figure 3e - Second Trunkline Project PER

GENERAL VIEW
PIPE WEIGHT-COATING LOCATION 5

View looking east from approximately 1 kilometer to west of Dampier Plant Road on old H.I. Hearson Cove road

Figure 3f - Second Trunkline Project PER

GENERAL VIEW
PIPE WEIGHT-COATING LOCATION 6

Location 3

This location adjoins the town of Dampier and is comprised of steep massive rock outcrops making it totally unsuitable for the establishment of a pipe weight coat site.

Location 4

Sufficient flat land is available to meet requirements. The land is a considerable distance from the wharf and also at the base of a steep road incline. Trucking movements (some 11,250 are estimated for pipe length movements) would lead to excessive traffic delays on the busy Karratha-Dampier road.

A significant portion of the area (~40%) has been disturbed prior to October 1981 for the extraction of fill. Undisturbed areas support soft native grasses and *Triodia spp.* with occasional shrubs.

The soils are sandy loams and where fill extraction has not been too deep, rehabilitation has generally been successful. Whilst buffel grass (*Cenchrus ciliaris*) and kapok bush *(Aerva javanica*) are present, the soil type provides good opportunity for successful rehabilitation.

Extensive loamy flats such as these are relatively rare on the Burrup Peninsula and the significance of this location to native flora and fauna should be assessed prior to disturbance.

The area is not known to have been subject to any recent Aboriginal site surveys, however, its nature (flat, flood plain) is not of the type where high incidences of sites have been known to have been found.

Location 5

The land available at this location is insufficient to meet requirements. The land is, however, flat and ancillary services are available nearby. Constraints with respect to traffic movements apply as for location 4.

The area is relatively narrow and bounded by infrastructure corridors on all sides that are heavily infested with buffel grass. The undisturbed alluvial soils are dominated by *Triodia spp* hummock grassland.

Whilst top soil extraction can be readily undertaken, the close proximity of buffel grass seed load and unresolved difficulties with re-establishing *Triodia*, will most likely result in buffel grass infestation following rehabilitation.

The potential for Aboriginal sites in the area is presumed to be the same as for location 4.

Location 6

There is sufficient land at this location to meet the pipe weight-coating requirements, however, suitable land is dispersed as small cells throughout the location and access-ways between cells would have to be formed.

The eastern area is previously disturbed (1981) for borrow pits and is now dominated by buffel grass (*Cenchrus ciliaris).* The small areas west of the road are undisturbed and support *Triodia* hummock grassland with occasional shrubs of *Grevillea pyramidalis, Hakea subera* and *Acacia spp.*

Rehabilitation would be unsuccessful due to the proximity of abundant buffel grass seed sources and the difficulty of stripping topsoil from the areas. This area is not a preferred location.

Location 7

The location is the old pipe weight-coating site at the junction of the main Burrup access road and the Hearsons Cove access road. The area was last disturbed in 1981 and rehabilitated after use.

The area now supports a diverse native flora, but is still dominated by buffel grass.

Development of this area would still require additional land for pipe storage and re-alignment of the Hearsons Cove access road. For this reason, the area is not a preferred site.

Location 8

This area is the rehabilitated site of the Hearsons Village Construction Camp, last active in 1991.

The area now supports a diverse native flora, although buffel grass dominates. Topsoil would be stripped from the area and isolated "seed" pockets of the existing vegetation could be retained to assist regeneration.

The area is eminently suitable for a pipe weight-coating location and is the preferred site.

2.4 Trunkline Route

The trunkline route (Refer Figure 2) was selected after an extensive review of the alternative nearshore approaches and soil conditions offshore (Refer to Section 2.4.4 for a discussion of the alternatives considered).

Proposed trunkline routes along with considered alternatives, are displayed in Figures 2 and 4. The extent of the route refinement survey and the alignments under consideration are shown in Figure 5. A general description of the seabed features along the proposed routes is provided in Section 3.2/3.3.

2.4.1 Offshore Route

The offshore route has been selected on the following criteria:

- maintaining a safe separation distance from the existing trunkline
- maximising the length of the route that is ploughable.

The latter is essential to provide full pipeline burial. This greatly simplifies the task of ensuring the stability of the trunkline and significantly reduces the amount of stabilisation by the exceedingly slow and expensive placement of rock or concrete mattresses.

The resulting trunkline route is generally aligned with the existing trunkline, but offset up to 15 km to the north east.

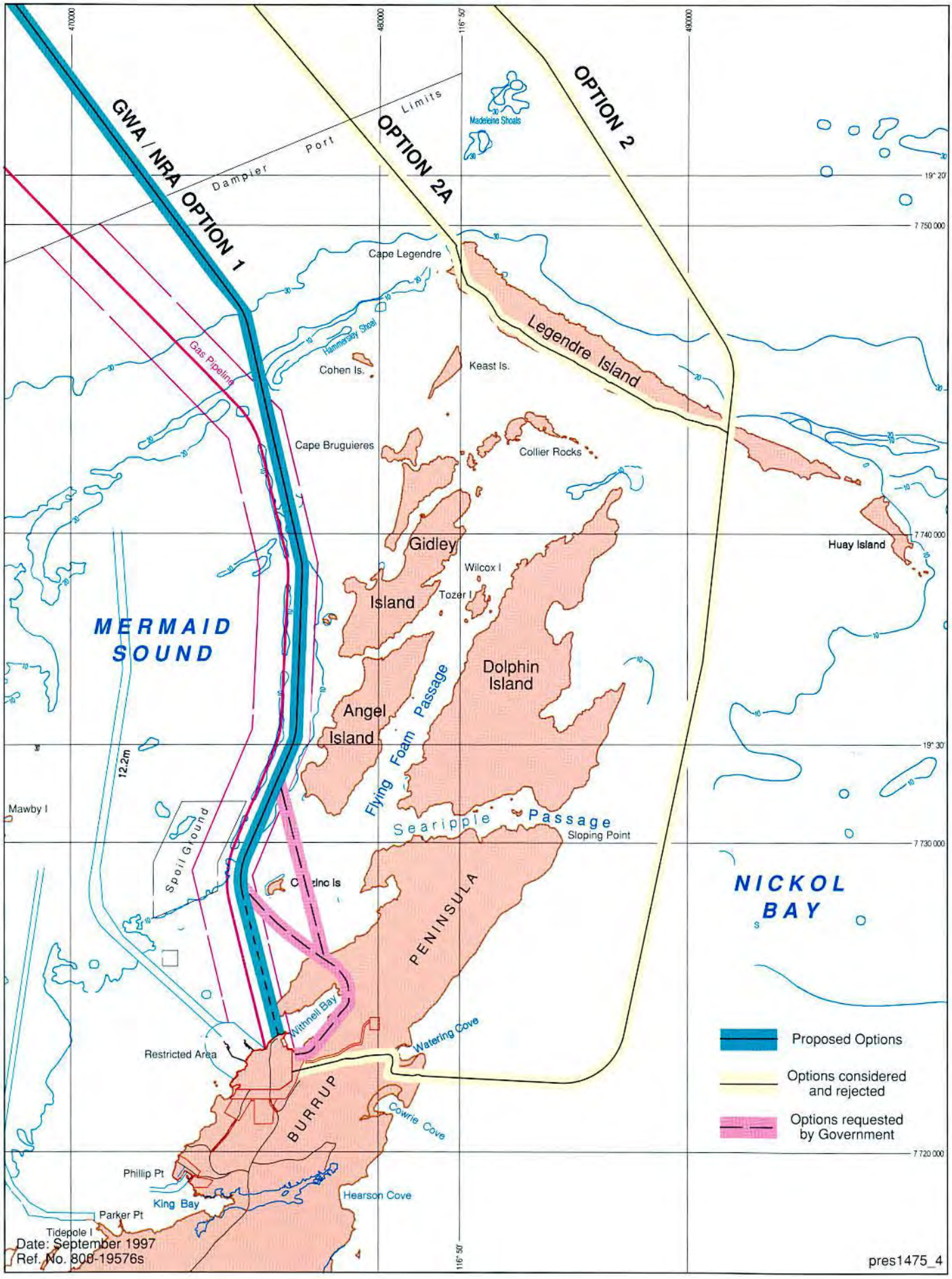


Figure 4 - Second Trunkline Project PER

TRUNKLINE ROUTE OPTIONS - INSHORE

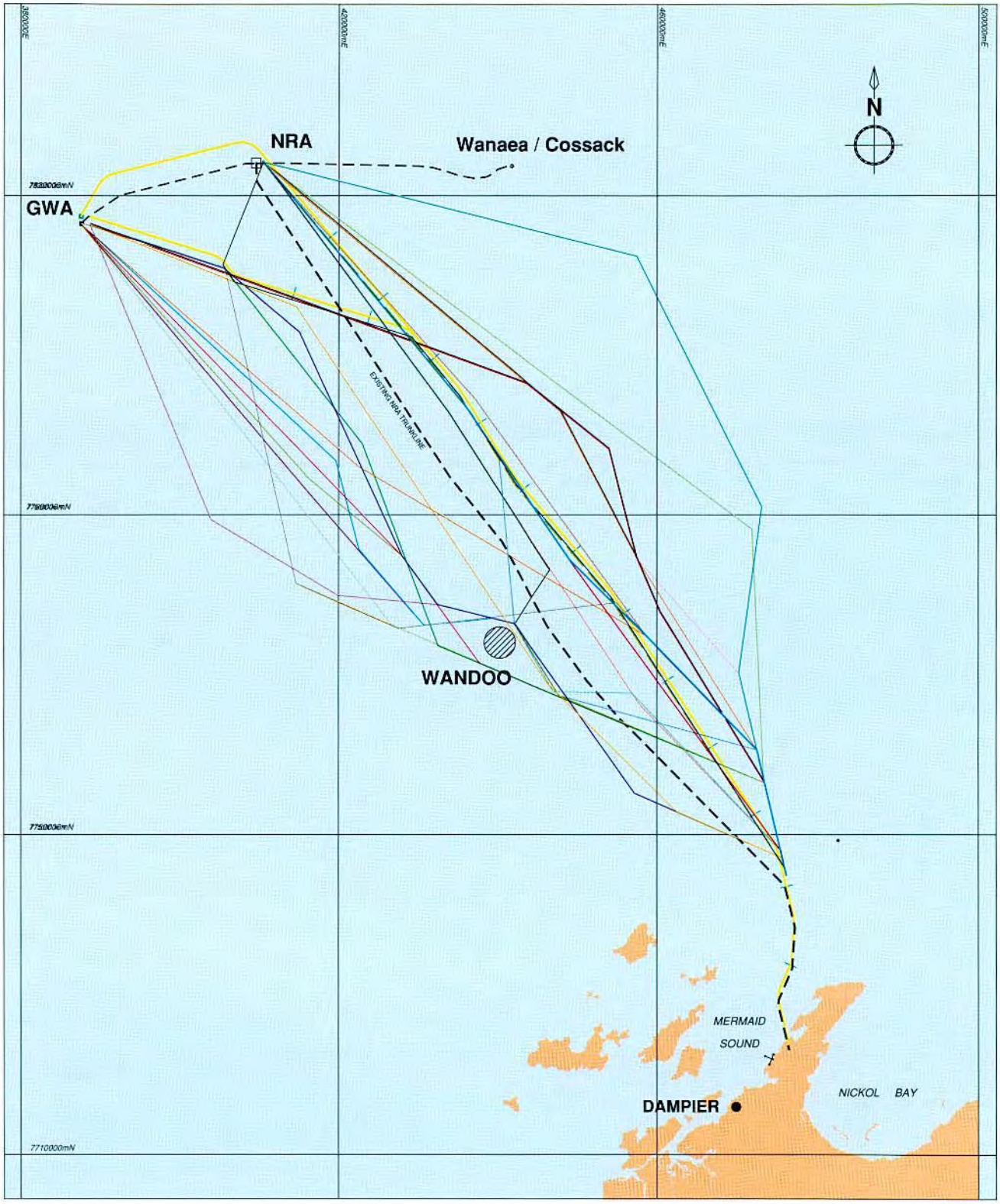


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Figure 5 - Second Trunkline Project PER

GEOTECHNICAL INVESTIGATIONS - ROUTE ALIGNMENT SURVEYS

2.4.2 Inshore Route

The route proposed for the inshore section of the 2nd trunkline involves the installation through Mermaid Sound, generally 500m east of the existing trunkline, although closer alignment sometimes occurs.

The inshore route has been selected to take advantage of the protection from shipping offered by the rock berm over the existing trunkline and to allow the ease of installation for any future pipelines.

In addition, route selection has sought to minimise the amount of "hard" dredging and avoids areas of environmental sensitivity.

2.4.3 Onshore

The trunkline will make landfall on Withnell Point, the southern entrance to Withnell Bay and at the northern end of the existing OTP.

The final location has not yet been determined, although it will be within 300m of the existing trunkline landfall. The line will be underground until it crosses the OTP boundary, at which point it will surface and be routed to the new slugcatcher (Refer Figure 10).

2.4.4 Assessment of Alternative Trunkline Routes

The trunkline route was evaluated in three distinct phases;

Initially a coarse screening study was performed identifying possible routes from GWA/NRA via:

- Nickol bay
- Northerly "island hopping" alternatives such as Angel and Gidley
- Mermaid Sound adjacent to the existing trunkline
- Western approaches such as West Intercourse island.

The routes were evaluated for technical difficulty, cost and environmental sensitivities. All routes except Mermaid Sound (East) and Nickol Bay were then discarded as a result of this consideration.

The relative merits of the remaining approaches were then studied in detail, with an approach via Conzinc Island South included at the specific request of the DRD (See Figure 4)

Significant site investigation was then performed to provide a greater degree of certainty on the cost estimates and technical difficulty of each option and a better appreciation of the risks from an operability viewpoint. In addition, environmental implications of each route were also assessed at this point.

It was concluded from this phase that a Mermaid Sound approach to the east of the existing trunkline was the preferred option.

The offshore route options were then assessed, supported by detailed hydrographic and geophysical investigations (Refer Figure 5) on options to both east and west of the existing trunkline. The major focus was on locating the most "ploughable" route as this would deliver the best cost outcome with the least disturbance to the surrounding environment.

An appreciation of the many alternative routes considered is presented in Figure 5, while the selected route, Option 1/1a, is detailed in Figure 2. The Inshore route alternatives are illustrated in Figure 4.

A detailed evaluation of alterative trunkline routes is discussed below.

Route selection criteria included:

- Identification of the shortest route feasible to minimise environmental impact and cost.
- Identification of a route which avoids hard rocky outcrops, thereby minimising technical constraints concerning on bottom stabilisation and spanning; and minimising environmental impact and potential disruption to commercial fishing operations.
- Identification of a route which minimises disturbance to sensitive marine and terrestrial habitats.

2.4.4.1 Option 2 & 2a Legendre Island-Nickol Bay Routes

Environmental considerations for the offshore portions (>30m) of these routes are similar to that for the preferred route Options 1 and 1a and are discussed in Section 4.2. In the inshore areas, however, quite different constraints are required to be addressed.

The most difficult issues are of a technical nature arising from the challenges associated with bringing the trunkline up the steep seaward face of Legendre Island and the potential spanning problems associated with the Legendre Island approach.

The proposed route through Nickol Bay also passes through the actively fished portion of the Nickol Bay Prawn Fishery. Geotechnical investigations conducted in this area have determined that thick sediment coverage exists through the western portion of Nickol Bay and deep burial of the trunkline should be possible. This would allow fishing operations to continue without the requirement for an exclusion zone and without imposing surface physical constraints from either the trunkline itself or a stabilising rock berm.

Marine and terrestrial vegetation surveys were conducted at Legendre Island, through Nickol Bay and across the portion of the Burrup Peninsula identified for the terrestrial route to connect with the OTP. A desk top review of the potential for Legendre Island to support subterranean fauna was also conducted for Woodside by the Western Australian Museum (Humphries, 1997). Consultant reports are provided in Appendices 3,4 and 5.

Legendre Island Geology and Topography

Legendre Island is a low limestone island of Pleistocene origin and is a remnant of a coastal dune system (Bowman, Bishaw and Gorham, 1994). Cliffs dominate the northern side of Legendre Island with beaches limited to the eastern end. Little to no soil has accumulated on the island's northern edge, possibly due to the action of cyclonic waves that are reported to periodically inundate the northern face. Holocene sand deposits are, however, present on the island's southern side.

Marine Environment

The proposed crossings of Legendre Island would result in the direct impact of fringing corals on both the seaward and southern sides of the island. The seaward fringing reef is comprised of a narrow pavement with the reef slope chiselled to a spur and groove structure, typical of high wave energy environments. The reef pavement and crest was found to be encrusted with coralline algae and largely devoid of epifauna. Hard coral cover on the spurs was found to increase downslope ranging from 25-50% and is

believed to be typical of the entire reef edge. Corals on the southern edge of Legendre Island were found to be generally restricted to the edge of the fringing rocky pavement with cover in the order of 25%. The pavement itself was found to be sand veneered with scattered algae and seagrass.

As the seaward fringing reef at Legendre Island is approximately 15 km long, the impact on corals at the crossing point is not considered to be particularly significant.

South of the southern Legendre reef slope the trunkline route traverses a broad expanse of soft substrate, predominantly clay with a silt veneer. The area is extensively trawled during the prawn fishing season and surveys found little to no epifauna and low bioturbation of sediments.

The rocky eastern shorelines of Dolphin Island and the Burrup Peninsula, including the proposed shore crossing point on the Burrup were investigated during the survey. Coral cover on these shorelines was found to be low (<10%) and silt deposition rates quite high. Given the high natural turbidity in Nickol Bay, trunkline installation within 500m of these habitats is unlikely to result in any significant impact on corals.

Significant Marine Fauna

The beach on Legendre Island's north eastern end supports a significant turtle rookery for Hawksbill (*Eretmochelys imbricata*), Flatback (*Nattator depressus*) and Green (*Chelonia mydas*) turtles.

Dugongs (*Dugong dugon*) have been observed on the southern side of Legendre Island, however, the major concentration of dugongs occurs at the western end of Legendre Island in an area bounded by Keast Island and Collier Rocks.

An aerial survey conducted by the Department of Conservation & Land Management in 1992 (unpublished), over the Keast and Legendre Island intertidal pavement, observed 75 dugongs. All but two of these observations were in the area bounded by Legendre Island, Keast Island and Collier Rocks, or, in the Flying Foam Passage.

Terrestrial Environment

Vegetation

Burbidge and Prince (1972) whom recorded 76 species of plants conducted a vegetation survey on Legendre Island.

Potential shore crossing points on both Legendre Island and the Burrup Peninsula and proposed terrestrial trunkline routes were surveyed. Descriptions of the predominant vegetation associations were made and mapped and locations of existing weed distributions, priority flora and significant vegetation associations recorded in the event that this route option was to be considered further.

No rare flora was identified on either Legendre Island or on the Burrup Peninsula; however, some priority flora (*Brachychiton acuminatus*, *Terminalia supranitifolia* and *Triumfetta appendiculata*) was noted in the vicinity of the Burrup Peninsula route. Isolated weed patches (buffel grass *Cenchrus ciliaris* and Kapok bush *Aerva javanica*) were found near the proposed routes on both Legendre Island and the Burrup Peninsula. Their locations were fixed by DGPS to enable effective management controls to be implemented should the trunkline proceed via these routes. Vegetation associations in the vicinity of the trunkline route were generally widespread, however, a number of

communities or specific stands were located, for which it would be preferable to protect by minor trunkline deviations.

Fauna

Fauna observations and collections have previously been made on Legendre Island and are reported in the Dampier Archipelago Nature Reserves Management Plan 1990-2000 (Morris 1990). Two species of mammals, the Rock Rat (*Zyzomys argurus*) and the Pale Field Rat (*Rattus tunneyi*), fifteen species of terrestrial reptiles and 35 species of bird have been recorded from Legendre Island. Breeding records are reported for the Wedge-tailed Shearwater (WTS), Osprey and Brahminy Kite.

Recent surveys have failed to find any evidence of WTS nesting in the vicinity of the trunkline route or on adjacent sand plain areas, suggesting that earlier observations may have confused *Rattus tunneyi* burrows for those of the WTS.

Subterranean Fauna

The desk top review on subterranean fauna conducted for Woodside by the Western Australian Museum, was of the view that subterranean fauna is likely to occur within the Legendre karst formations. Installation of a trunkline across Legendre Island would need to adopt appropriate precautions for the protection of fresh and marine ground water.

Aboriginal Heritage

Aboriginal sites have been observed on Legendre Island and include tool and midden sites. A comprehensive site survey would need to be conducted if this route was to be utilised.

General Assessment

Whilst, overall, no major or unresolvable environmental or social constraints to the use of the Legendre Island - Nickol Bay route were noted, the option provides significantly greater technical challenges and may result in some temporary disruption to commercial fishing activities in Nickol Bay. Indirect impacts to corals from dredging operations are likely to be more significant than for the preferred route option; and construction timing constraints arise due to the need to avoid disrupting turtle nesting activities on the north eastern beaches of Legendre Island.

2.4.4.2 Conzinc Island Route

At the request of Government, Woodside has examined the options of installing the 2nd trunkline to either the east or south of Conzinc Island. These routes, illustrated in Figure 4, require a landfall on either the southern end of Conzinc Bay or along the rocky headland which separates Withnell and Conzinc Bays. There are a number of potential constraints associated with these options which make them less favourable to the preferred route, Option 1. These include:

- A significant increase in trunkline installation costs.
- Additional need for marine blasting and associated environmental impacts.
- Increased risk to potentially sensitive and highly diverse coral communities near Conzinc Island and in Conzinc Bay.
- High incidence of Aboriginal sites, including known burial sites in Conzinc Bay dunes.

2.5 Construction Activities

The process of construction of the second trunkline has two basic activities, trunkline stabilisation and trunkline installation. Trunkline stabilisation incorporates pre-trenching and blasting, ploughing and final trunkline protection and stabilisation.

Trunkline installation is the mechanical process of installing the trunkline on the seabed.

2.5.1 Trunkline Stabilisation and Dredging

Dependant on water depth and associated design for expected wave and current forces, stabilisation will be achieved by one of the following methods:

- Laying the concrete coated trunkline on the seabed with no further protection.
- Sheltering the weight coated trunkline in a pre-excavated trench and either mechanically backfilling with suitable material or allowing natural infill to occur.
- Laying the weight coated trunkline onto the seabed and then trenching to a suitable depth with mechanical equipment. Some suitable (natural or mechanical) backfill process may follow this.
- Laying the weight coated trunkline onto the seabed and dumping rock over the top or covering with concrete mats. For isolated areas a retaining pin-pile system may also be used.

These measures vary widely in terms of risk to the trunkline and cost and, to this end, an extensive geotechnical survey has been carried out, the results of which are currently being processed. Figures 6a and 6b show the preliminary stabilisation techniques proposed for the trunkline.

Dredging

In the shallower waters of Mermaid Sound a mixture of deep, readily ploughable sediments and thin soft sediment overlaying harder rock exists. Where ploughing is not possible, the route will be pre-trenched by conventional dredging techniques and the trunkline laid into the trench. Ploughing is the option resulting in the least disturbance to the surrounding environment.

Trailer dredges will remove the uncemented overburden and Cutter-suction dredges will then cut the hard calcareous sediments to achieve the required trench profile.

Spoil from the cutter dredging will be either sidecast below water or dumped behind (again below water to minimise dredge plumes). The dumped spoil will be collected by the Trailer dredge and relocated to the existing spoil ground, west of Conzinc Island.

Some of the cut rock may be left adjacent to the trench for later backfilling after the trunkline is installed. Backfilling would be performed by re-processing the cut rock through the Trailer dredge or the Cutter-suction dredge.

Within the first 300m of the route, hard igneous rock will be encountered. At these points a jack-up barge mounted drill will assist to drill and blast the rock which will be subsequently removed by a clamshell dredge. Disposal will be at the existing spoil ground.

Outcrops of reef at the entrance to Mermaid Sound are too deep for Cutter-suction dredges and are too hard to plough. In this area, fragmentation blasting by charges placed on the surface of the outcrops, supported by grab dredging, may be used to

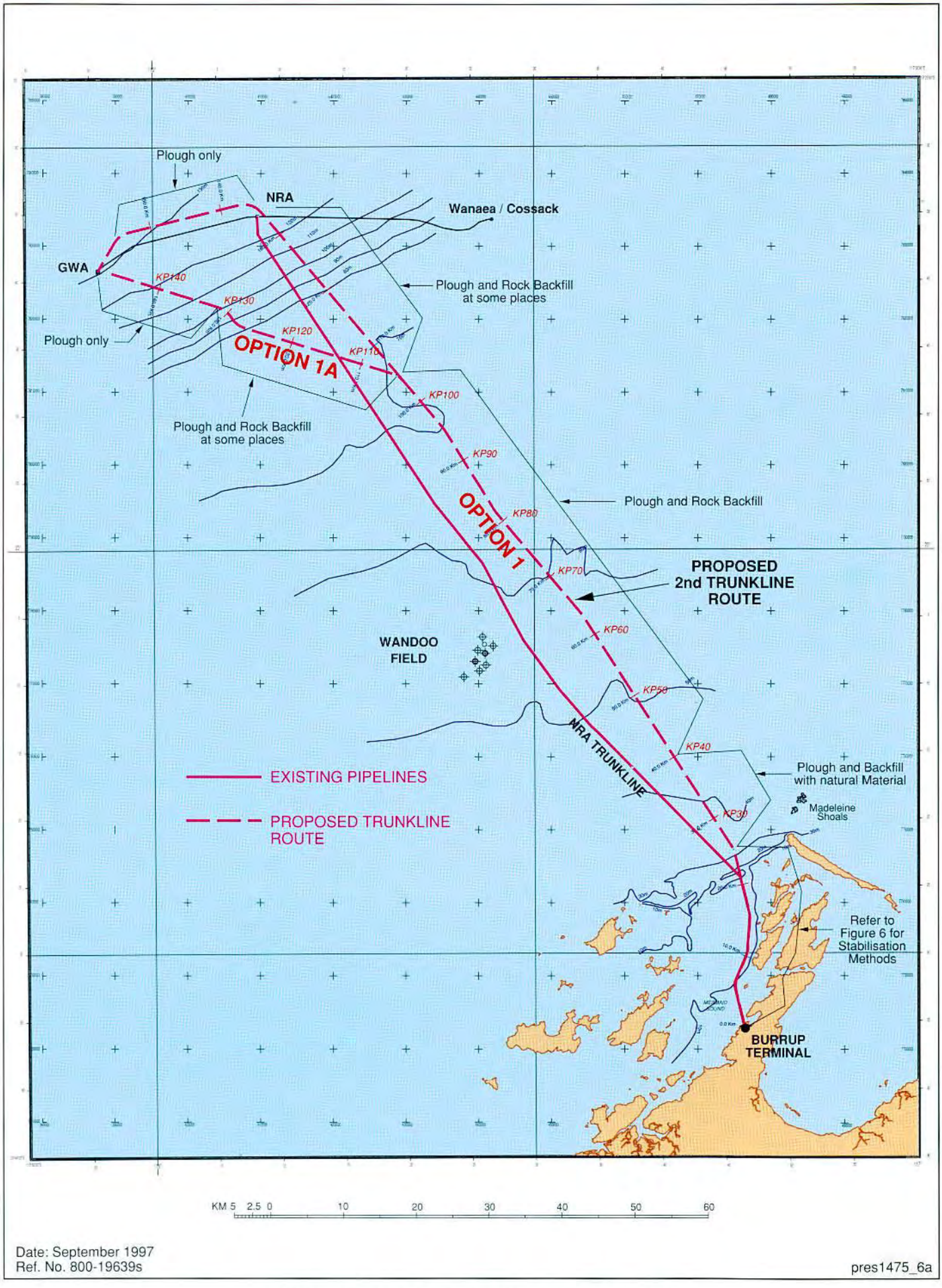

Figure 6a - Second Trunkline Project PER

POTENTIAL STABILISATION METHODS

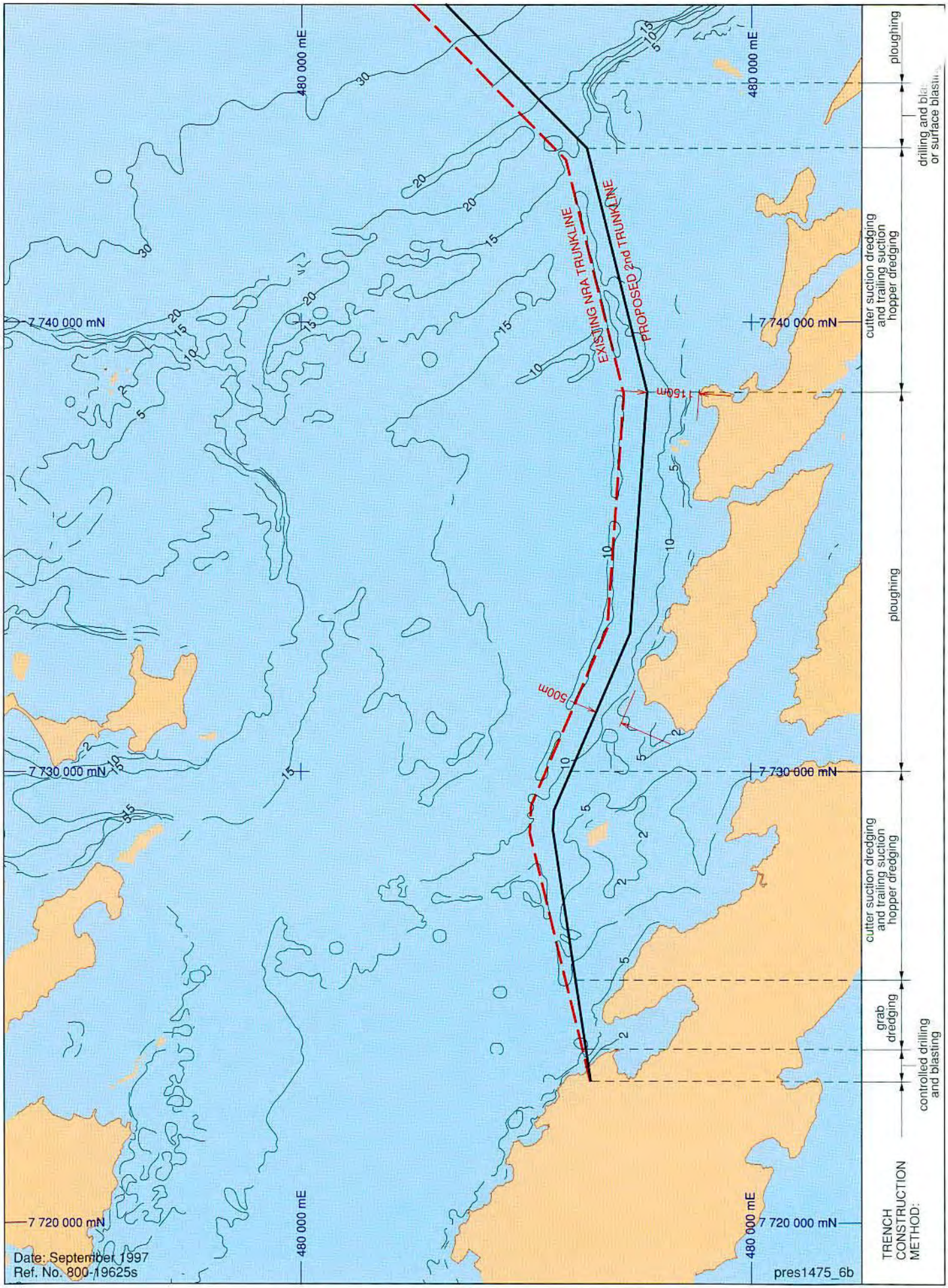

Figure 6b - Second Trunkline Project PER

POTENTIAL STABILISATION METHODS - INSHORE

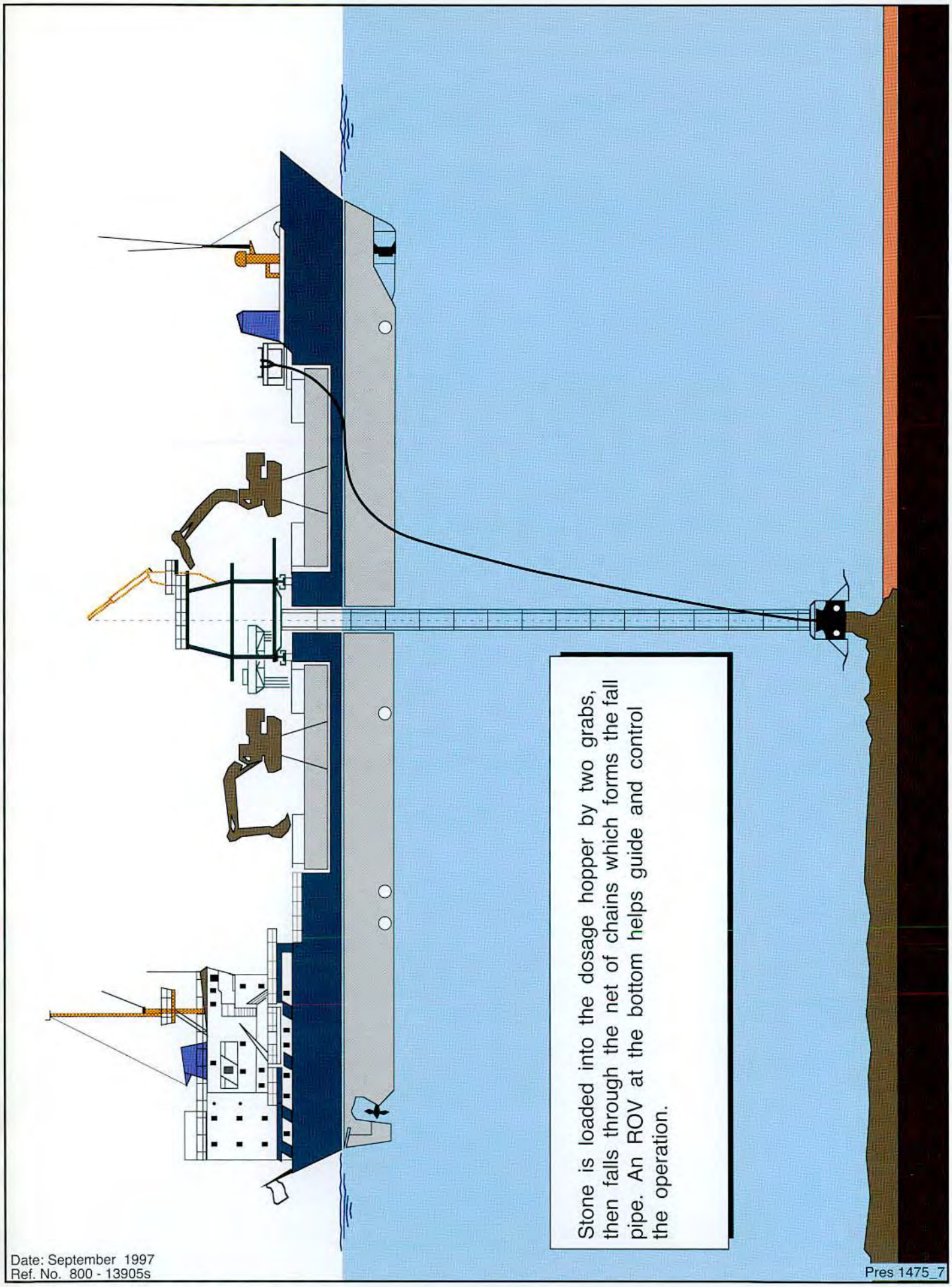

Figure 7 - Second Trunkline Project PER

SCHEMATIC OF ROCK FALL-PIPE VESSEL

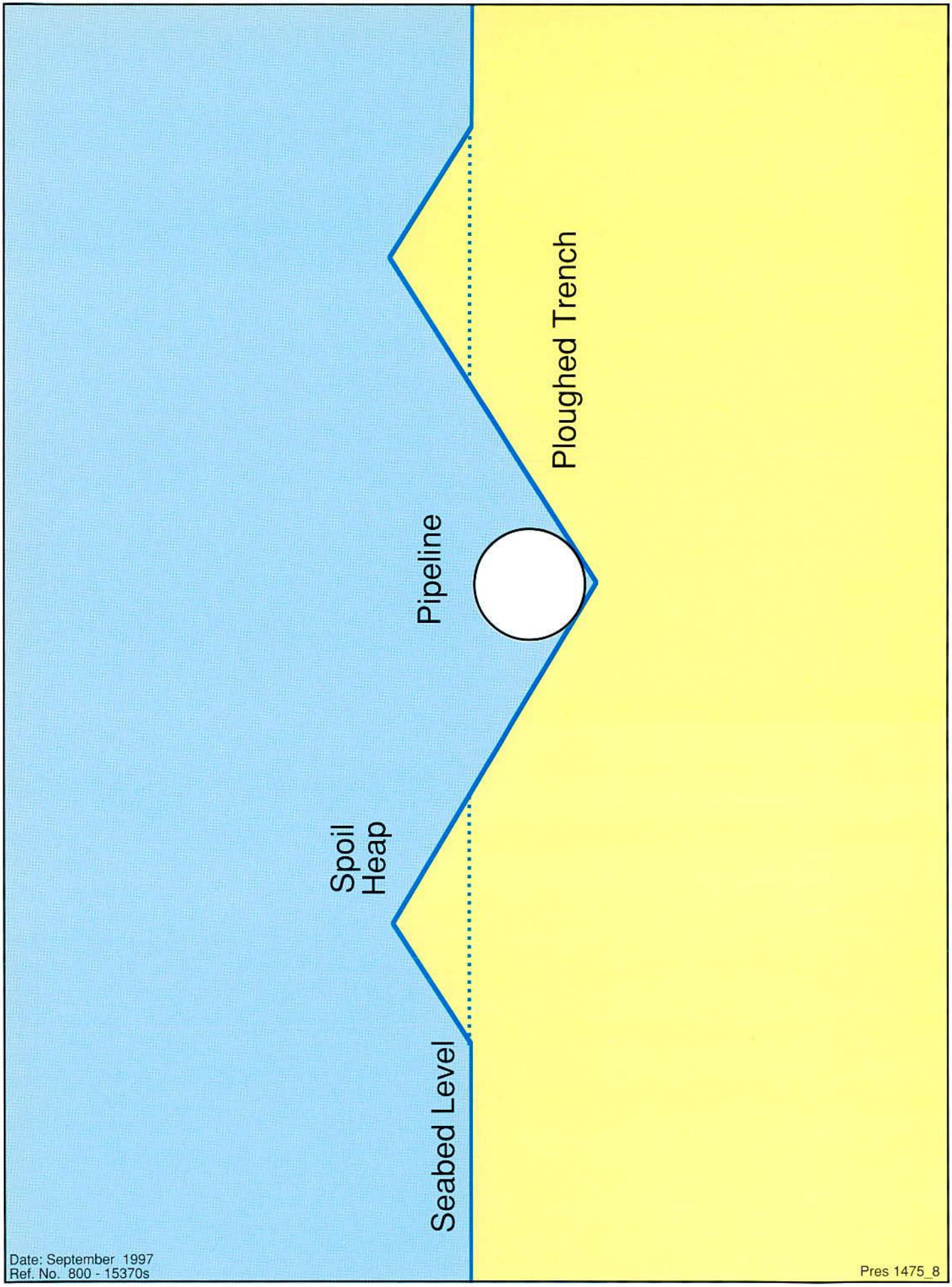

Figure 8 - Second Trunkline Project PER

SCHEMATIC OF PLOUGHED "V" TRENCH

remove rock pinnacles. Removal of these pinnacles is necessary to prevent unsupported trunkline spans between reef outcrops.

In all, approximately 500,000m^3 of material is expected to be dredged. Except for material used to backfill over the trunkline the remainder will be relocated to the spoil ground.

Trunkline Stabilisation

Where hydrodynamic forces on the trunkline are sufficiently low, stabilisation of the trunkline will be obtained by laying weighted pipe directly on the seabed. This poses the least construction risk to the trunkline and is the most cost effective, with the advantage that once installed on the seafloor the pipeline is immediately secure. However, in shallow water areas it will not be possible to provide sufficient weighting to prevent movement and stress under cyclonic conditions.

The risks associated with sections of the trunkline inshore of KP30 are currently being assessed. In some locations a rock berm may need to be placed over the pipe to prevent damage from vessel activity.

In the deeper, soft offshore areas the only viable way of creating a trench is to use a deep capacity trailer dredge or a jetting machine in a plough. Where sediments are hard and cemented, a specialist rock trenching machine is used, though frequently with limited success. Sediments are thin along much of the route and supplementary stabilisation using dumped rock or concrete mattresses will be required.

Jetting, which can only be used in the softest sediments (beyond the outer Dampier Archipelago) involves liquefaction of the sediment with water under pressure and allowing settling of the pipe into the sediment under its own weight.

The ploughing operation involves pulling the plough along the already laid trunkline using a barge fitted with anchors. Alternatively, tandem tugs may be used. The pipe is lifted into the plough's body as the plough is pulled along the pipe concurrently excavating a "V" shaped trench. The trunkline settles into the excavated trench behind the plough. The process leaves two spoil banks - one on either side of the trunkline, each approximately 1-1.5 times cut depth. A schematic of the "V" shaped trench is provided in Figure 8. In time these banks fall back into the trench until eventually the trunkline is buried

Where a specialist trencher is deployed, mechanical cutters will cut the harder sediments that are not readily ploughable. Development work on suitable machines is ongoing.

Rock dumping will be performed from specialist vessels using a combination of either side dump or fall pipe techniques. Such vessels can carry between 3,000 and 15,000 tonnes of rock per trip that will be deposited over the trunkline. The rock is dumped from the vessel using a fall pipe for smaller (<200mm) rock. Larger rock will be pushed directly over the side of the vessel. A schematic of a fall pipe vessel is provided in Figure 7. Rock sizes will range from 10-1200mm in diameter and a total of up to 3 million m^3 of rock may be required to stabilise and protect the trunkline.

2.5.2 Rock Quarrying Transport & Load Out

Rock fill will be required for the Second Trunkline Project for the following purposes:

- Stabilisation and protection of the installed pipeline.
- Construction of temporary shore approach works.

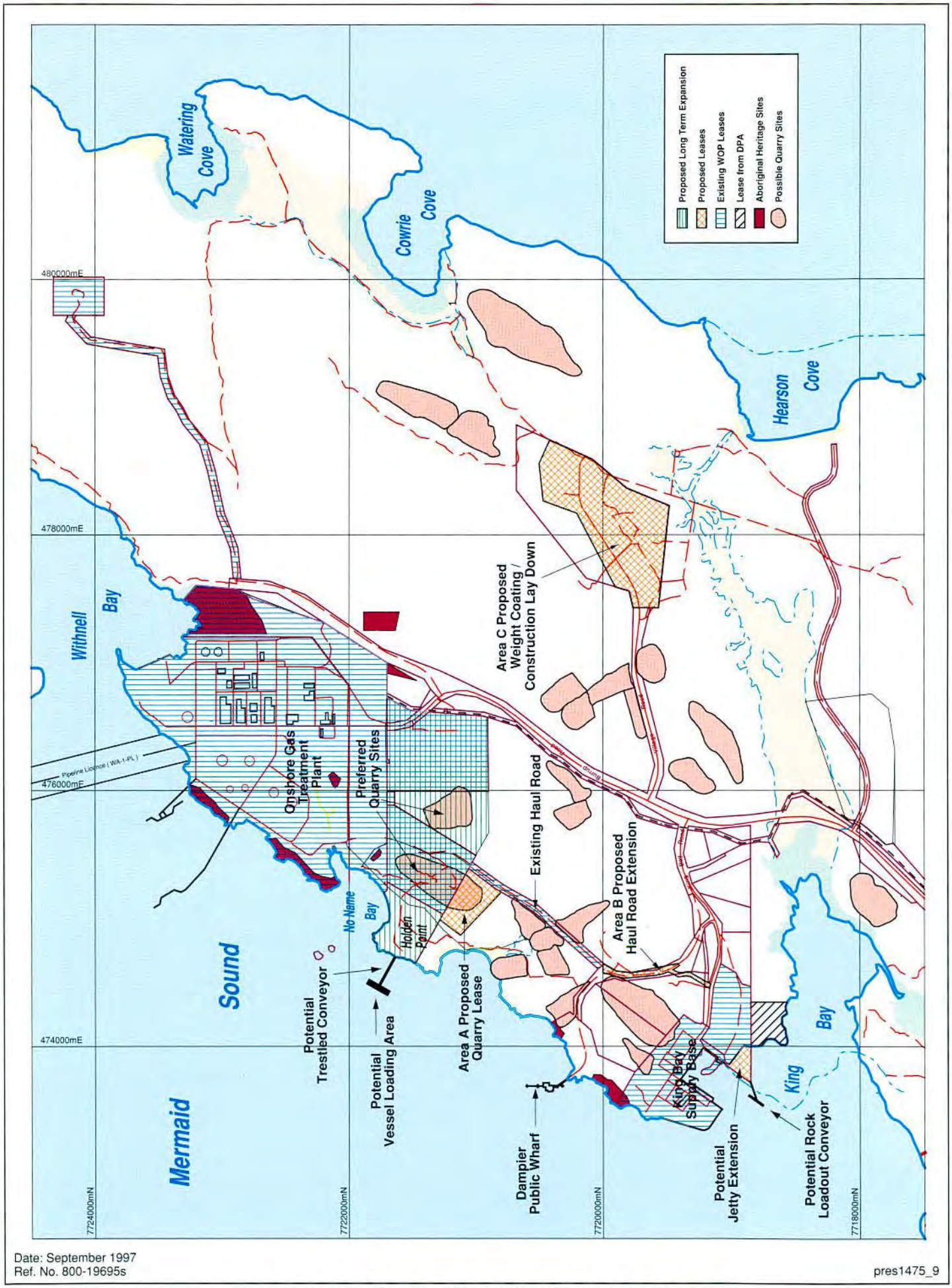

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Figure 9 - Second Trunkline Project PER

QUARRY LOCATIONS INVESTIGATED AND ADDITIONAL LAND REQUIREMENTS

- Other relatively minor uses eg. filling, road construction and slope protection.

The total quantity of rock that will be required for project purposes has not yet been accurately assessed, but studies to date have shown that the requirements are likely to be of the order of 0.8 to 2 million m^3 requiring a total up to 3 million m^3 of rock to be quarried. To provide this rock volume a new quarry (or quarries) is required.

Safety aspects of rock haulage dictate that the quarry site should be located as close as possible to the loadout point and that haul roads should avoid interactions with normal road traffic as much as is feasible.

With these constraints in mind, geological investigations were performed over the central area of the Burrup Peninsula, including Hamersley Iron lease areas between King Bay and Parker Point and the proposed industrial area between King Bay and Hearson Cove.

This work concluded the existing quarry behind Holden Point should be extended South. This quarry would be supplemented by an adjacent area proposed for inclusion in Woodside's new lease for future OTP expansion. The alternatives considered for quarry locations are presented in Figure 9.

The quarrying operations will include the following conventional techniques:

- Drilling and blasting on a prearranged pattern to produce suitably sized feedstock for the crushing process. Blasting will, most likely, be carried out at change of shift times.
- Operation of a large crushing plant to achieve the required gradings, ranging from 10-1200mm diameter. The plant will be located within the quarry confines.

The quarry will be worked on two faces simultaneously to allow a suitable rate of production. Quarry operations may be carried out on a multi-shift, 24 hour/day basis.

Crushed rock will be transported to the proposed stockpile areas, using Haulpack type dump trucks. Haulage operations will be carried out on a 24 hour/day basis. The existing haul road will be used for most of the route, however, a short extension of this haul road is required to avoid traffic disruptions in the vicinity of the gazetted King Bay and Port Authority roads. The proposed location of the haul road extension is illustrated in Figure 9.

Loadout of 50,000-80,000 tonnes of rock per week is anticipated. To support this, a large stockpile area will be required as quarrying rates will occassionally outstrip demand.

Rock may be supplied from one of a number of other locations. It may be delivered from a location remote to the Burrup Peninsula which has previously been approved for such use and separately covered by existing environmental approvals as a rock supply source.

Rock delivered from a local quarry will be loaded out from one or more of the following three locations:

- King Bay Supply Base (KBSB).
- Dampier Public Wharf (DPW).
- A temporary loadout facility in the vicinity of Holden Point.

In all cases construction or modification of facilities are required.

Option 1 – King Bay

If the KBSB is used, a number of alternatives are under consideration. Loadout of some rock could conceivably be carried out across the existing wharf. However, this would cause significant disruption and dislocation to the ongoing operations supporting Woodside production and exploration.

The area adjacent to the King Bay Supply Base potential jetty extension (Figure 9), is intended as a rock storage area for loadout. This area has been previously used for this function (during the construction of the first trunkline) and a small amount of quarriable rock remains that may also be utilised. Total land area allocated to rock storage adjacent to the loadout facility is 5.4 ha.

It is preferable that all rock be loaded out from the SE side of the Turning Basin. This will necessitate a loadout facility designed for two types of rock loadout.

Larger rock, above 300mm diameter will be loaded into side stone dumper vessels. Side stone dumper vessels are usually of shallower draft and are best loaded from a vertical wharf face using grabs or pivoting dumping vessels. Material smaller than 300mm will be handled by a side stone dumper vessel in the shallower waters of Mermaid sound and a fallpipe vessel in the deeper waters. A fallpipe vessel will require deeper water than exists in the present turning basin.

New construction required to accommodate loading of these vessels would therefore entail:

- Extension of the seawall adjacent to the turning basin by approximately 150m as the existing seawall/tug pen arrangement precludes mooring of vessels along this face as occurred in the past.

- Providing land backing behind the new seawall to facilitate short term rock storage and loading onto rock vessels. This land backing would extend across to the existing shoreline where Woodside's permanent lease exists.

- Dredging the channel approach to accommodate deeper draft fallpipe vessels. A channel depth of up to 8m below datum is envisaged with a pocket dredged into the SE corner of the basin possibly as deep as 9m below chart datum.

Seawall rock and land fill will be won from quarry operations that provide dump rock.

Soft dredging spoil will be removed to the spoil disposal ground in Mermaid Sound using a trailer dredge. Some hard dredge spoil (calcarenite) may be incorporated into the landfill process as the cutter dredge removes it. Alternatively this will also be removed direct to the spoil ground using a trailer dredge after temporarily being placed into the turning basin using the cutter dredge.

A further alternative under investigation is the use of a grab dredge to recover seabed material into a hopper barge for removal to a spoil ground.

If, as a result of dredging cost, it is found to be more practical to load the fallpipe vessel away from the reclaimed land used for side dump vessels, a temporary conveyor system will be constructed to the dredged pocket placed circa 250m further out in the approach channel. Subject to Dampier Port Authority concurrence, temporary conveyor loading facilities on the South East side of the KBSB turning basin may be left in place.

Option 2 – Dampier Public Wharf (DPW)

If the DPW is utilised for rock loadout similar loading methods will be adopted to those described above. A temporary conveyor loading system would be constructed, preferably on the north side of the DPW to bring the smaller size material from onshore stockpiles. These stockpiles would be placed on what is the current laydown area near the wharf abutment. The laydown areas are relatively small and it is likely these would need to be expanded by 50-100% in size. This may involve minor blasting work to achieve a balanced cut to fill operation using earthmoving plant.

This option is currently not favoured due to the difficulties of re-handling rock material.

Option 3 – Vicinity of No-Name Bay/Holden Point

A further option under consideration is to construct a temporary loading facility in the vicinity of Holden Point. This would enable deeper draft fall pipe vessels to load in deeper water than is available at KBSB. The conveyor would run direct from Holden Point (Figure 9) to a point where suitable water depth for the vessels under consideration is available. If it is economic to do so, the soft upper sediments may be removed by trailer dredge to reduce the length of conveyor run. Any spoil from such an operation would be disposed of at the spoil ground.

The jetty will be constructed utilising conventional pile driving techniques. Waste rock will be used to form an abutment from which the jetty platform (comprising a narrow walkway and conveyor belt) will be extended. A haul road would be constructed from the nearby quarries down to the stockpile area.

Rock stockpiling for Holden Point loadout would be both on the emerging quarry floor and on the sandy foreshore behind Holden Point, but within the area Woodside has applied for a long term lease. The topsoil overlying the area would be stripped to a depth of circa 300mm and stockpiled (for revegetation purposes) before hardstand was laid and the rock stockpiled on top.

At the conclusion of work it is intended that all temporary shipping facilities would be removed from Holden Point or the DPW.

2.5.3 Trunkline Installation

The trunkline will be placed on the seabed using conventional pipelay barge techniques. Typical pipelay barges are self contained, but serviced by supply boats. The weight coated pipe will be delivered to the pipelay barge by dedicated pipe barges.

For the pipe diameters under consideration there are two alternative pipelay vessel configurations for the deeper waters outside Mermaid Sound.

The first alternative is a dynamically positioned ship or semi-submersible barge. In this case there will not be a requirement for anchoring operations.

The second alternative is a barge or ship shaped vessel that relies on an anchor spread of 12 to 16 anchors to maintain position. In this case two tugs will support the pipelay operation by constantly running anchors to enable forward movement of the pipelay vessel. These anchors are positioned in a "spider-web" pattern to enable proper positioning of the vessel.

Due to the draught requirements of dynamically positioned vessels, pipeline installation in Mermaid Sound will need to be performed with an anchor spread type barge.

Delivery of pipe to the vessel will probably be performed using pipehaul vessels or large dumb barges towed by tugs. Two possibilities exist for the loadout of pipe:

- Pipe joints could be directly transported to the pipelay vessel from a South East Asian port where the weight coating was applied.
- The pipe could be road transported from the weight coating site (either the Burrup Peninsula site or elsewhere in WA) and loaded via the KBSB or Dampier Public Wharf.

Very large "third generation" lay vessels are likely to be utilised on the project, capable of laying up to 6 km per day of pipe. This rate will require a supply of 550-600 x 12m pipe joints per day.

This supply rate will only be achievable with a multi vessel haul operation working a 24 hour loading and transporting operation. Throughout the operation all personnel movements will be via helicopter.

Pipelaying is expected to commence immediately following the cyclone season. However, the effects of winter high pressure cells traversing the southern part of WA can be felt offshore. In the event of heavy weather, the pipeline will be lowered by winch cable to the seabed until the weather moderates. To prevent seawater ingress to the line a special head will be attached to permit easy recovery when work recommences.

With the pipelay vessel in position, the nominal 12m pipe joints are continuously placed at the lead end of the production or "firing" line. The joints are progressively welded together as they move down the firing line. At the end of the firing line, the joint welds are X-rayed and coated with an anti-corrosion wrap before continuing off the stern of the barge.

Specialised tractor track clamps and winches maintain tension in the pipeline. An articulated and adjustable ramp extends from the stern and controls the deflected shape of the pipeline as it descends to the seafloor. The shape of the deflecting pipeline is critical to the pipelay operation to ensure the pipe does not buckle prior to reaching the seabed.

Nearshore - Trunkline Initiation

The process to initiate the laying of the trunkline occurs from the pipelay barge anchored as near to the shore as the vessels draft allows (approximately 2-6 kms).

The pipeline is welded up on the firing line as usual (refer above section), but instead of the barge moving forwards the pipe is winched shoreward utilising a "pull-head" on the pipeline termination. To achieve this, flotation is attached to the top of the pipeline to reduce on-bottom pipeline weight and thus minimise friction with the seabed.

Once the pipeline reaches shore it is anchored into position and the flotation units removed. Standard pipelaying operations can then proceed with the vessel moving in the offshore direction.

Land disturbance due to the beach pull operation will not exceed 2.2 hectares.

2.5.4 Connection to Existing Platforms Offshore

The trunkline will be laid past or to an existing offshore platform. Once the initial pipelay is complete, the pipeline will be left with either a termination head or a "T" in place on the seabed.

Connection to the platform processing facilities will necessitate the installation of a tie-in between the trunkline and the base of the platform jacket together with a new riser on the platform, accomplished using a different vessel spread and divers.

The riser will be fabricated into as many as 2-3 sections which will be clamped and bolted to the platform jacket. The tie-in pipework will run from the pipeline to the installed riser. The tie-in pipework will be either hyperbarically welded or bolted together on the seafloor with the trunkline in flooded condition.

Platform process pipework will then be welded to the riser to provide a continuous pipe system from the jacket production facilities to the slugcatcher onshore.

2.5.5 Future Tie-ins

Included in this work will be provision for future tie-ins of other pipelines. This will probably comprise a 'T' fitted with high integrity subsea valves and a bolted blind for later connection without the need to flood the line. It is also likely that a Subsea Surface Isolation Valve (SSIV) will be included as part of the tie-in arrangements.

Depending on the selected pipelay vessel, this work could be supported by that vessel, a small anchored derrick barge or a large dynamically positioned Diving Support Vessel (DSV).

2.5.6 Shore Crossings

The shore crossing (from approximately 3 metres below chart datum to above the high water mark) will lie east and north of the existing trunkline on the existing OTP lease. Massive granophyre overlain by calcarenite is expected in this area and, as such, sheet piling and cofferdam methods are unlikely to be suitable.

Protection of the pipeline in this area requires the pipeline to be installed into a trench where it comes ashore.

The methods currently under consideration for the shore crossing are as follows:

- Construction of a tunnel across the granophyre hard rock to a point offshore where a trench can be dredged using conventional techniques. This is currently not the preferred option due to the high cost incurred with dislocation to the existing plant firewater intake and pond.
- Construction of a trench by the use of controlled drilling and blasting techniques with minimum ground vibrations.

For the construction of an open trench through the rocky foreshore, a 10m wide temporary work platform consisting of rock fill may be required in the area from the high water mark and extending some 100m seawards. This will allow access of onshore drilling and blasting equipment in the shallow nearshore waters which are inaccessible by offshore drilling and blasting equipment due to their draught. The rock fill material will be obtained from either earthworks around the TOT or the quarry providing the rock for the offshore pipeline stabilisation and protection. This berm will be removed after the trunkline is installed and the rock dumped as backfill.

Drilling and blasting operations on the foreshore will be closely controlled in view of their proximity to the existing LNG Plant.

The onshore portion of the trunkline will be installed using conventional land-based equipment. The trunkline will rest on supports designed to control the expansion and other stresses imposed on the trunkline and associated infrastructure. Excavation will be largely by means of mechanical equipment and all activities will be carried out under control of procedures developed to satisfy the operational and safety requirements appropriate to the OTP site.

2.5.7 Hydrotesting

On completion of the trunkline installation and tie-ins both Government regulators and Australian/International Standards and Codes require a hydrostatic pressure test.

The hydrotest water will consist of seawater introduced at the offshore end of the trunkline. The hydrotest water is commonly treated with approved chemicals - normally oxygen scavenger, scale inhibitor and biocide to prevent internal corrosion and bacterial formations. The chemicals are typically introduced at concentrations in the parts per millions. A dye may also be introduced to allow visual tracing of a leak.

The trunkline will most likely be tested as one complete section (although testing may be performed in two sections; Mermaid Sound and offshore.) Following the pressure test the treated water, up to 120,000m^3 will be released into the ocean adjacent to the platform(s).

If the onshore section is to be tested separately, the hydrotest water will be discharged into a bunded area within the OTP lease and allowed to evaporate.

2.5.8 Trunkline Drying

After the hydrotest the trunkline will be dried to a specified dewpoint to ensure that no moisture remains in the line. A sequence of pigs (plugs forced through the line by gas or hydrostatic pressure) will be used to clean the trunkline followed by vacuum drying. Sending slugs of glycol through the trunkline may facilitate the drying process. The glycol will be collected onshore, treated to remove water and recycled.

2.5.9 Maintenance Programme

Maintenance operations to be undertaken on the trunkline are currently under consideration. Along the offshore section, periodic external maintenance will consist of inspections by side-scan sonar from a surface vessel and after the first significant cyclone has passed directly over the trunkline. These sonar inspections will indicate if any sections of the trunkline have shifted. If trunkline movement is detected, visual inspections using a Remotely Operated Vehicle (ROV), equipped with television cameras and deployed from a surface vessel, may be undertaken. Assessment and execution of any necessary remedial works will then be performed.

Periodic external corrosion monitoring will also be carried out to confirm ongoing integrity of the corrosion coating and sacrificial anodes.

The WA Department of Minerals and Energy (DME) will specify a regime of internal trunkline condition monitoring in the Pipeline Licence Conditions. This is normally performed using "intelligent" monitoring pigs.

2.6 Trunkline Onshore Terminal and Domgas Debottlenecking

2.6.1 Trunkline Onshore Terminal - Facilities Description

The Trunkline Onshore Terminal (TOT) performs several functions, namely:

- To safely receive a two-phase mixture of gas and condensate which is produced at offshore facilities and which is transported to shore via a sub-sea trunkline.
- To separate the gas phase from the liquid phase for further processing.
- To accept and remove slugs of liquid from the trunkline, without disturbing downstream equipment.

The proposed new TOT will be similar in design to the existing TOT.

The Trunkline Onshore Terminal consists of the following major components::

- Slugcatcher
- Pig Receiver
- Safety Systems

These are described in more detail below.

Slugcatcher

The proposed slugcatcher consists of an elevated header pipe attached to a series of inclined large diameter pipes. The gas and liquid mix progresses from the trunkline into the header where it expands, allowing the liquid to drop out. The incline allows the liquid to proceed to the end of the slugcatcher where it is removed and sent to stabilisation for processing. Gas comes off in the header and flows to Domgas or LNG for processing. The slugcatcher is also designed to collect any "slugs" of liquid which may come ashore under certain operating and upset conditions.

Pig Receiver

The pig receiver will be required onshore to support commissioning operations and thereafter periodically receive inspection pigs passed through the trunkline.

Operational pigging may be required if the trunkline is sized to cater for future Domgas/LNG expansion. At, or close to, maximum throughput the gas velocity will be high enough to continuously sweep the liquid from the trunkline, without outside intervention. However, during the early operational period (approximately 3 to 4 years) the gas demand will be significantly lower and so the velocity in the trunkline may not be sufficient to adequately remove liquid accumulating in the trunkline. Under this scenario it may be necessary to run pigs through the trunkline, (possibly as often as daily) to sweep liquid from the trunkline. This process was used with the first trunkline until 1991.

Options for de-pressuring the pig receiver are currently under consideration. De-pressuring to a flare is likely if frequent operational pigging is required during the initial years of operation. If, however, only 5 yearly inspection pigging is required, then the pig receiver may be de-pressured to a vent. The ability to re-direct de-pressured gas from the pig receiver to the process trains is also under consideration.

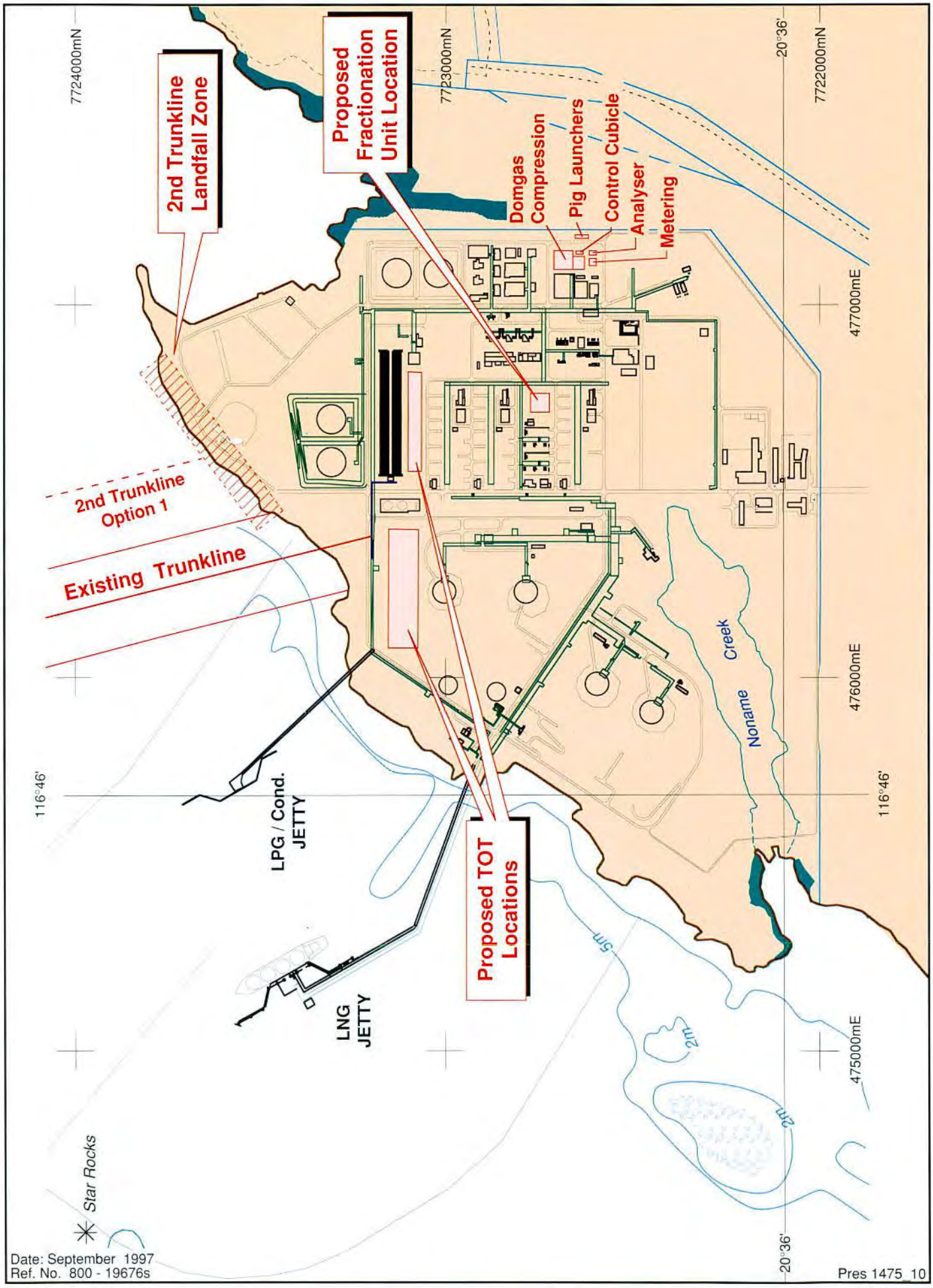


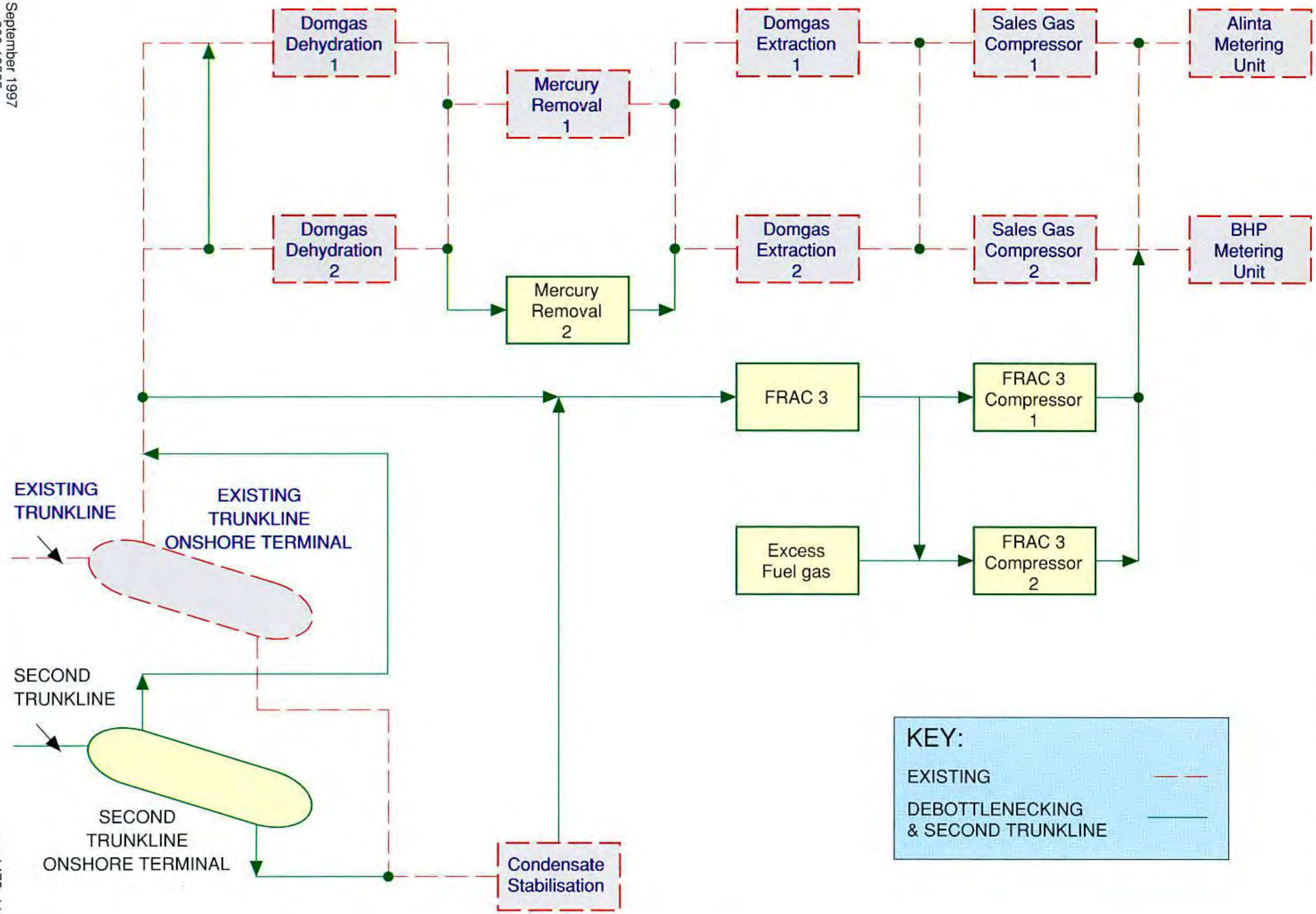
Figure 10 - Second Trunkline Project PER

WOODSIDE FACILITIES
ONSHORE GAS TREATMENT PLANT INFRASTRUCTURE LAYOUT

DOMGAS DEBOTTLENECKING PROJECT SCOPE

Figure 11 - Second Trunkline Project PER

Date: September 1997
Ref.No.: 800-19565s



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Safety Systems

The safety systems envisaged on the proposed Trunkline Onshore Terminal will, in general, be similar to those presently being used on the existing TOT. These safety systems include high reliability instrumentation to avoid over-pressure and the presence of safety relief valves for emergency depressuring of vessels and pipework. Disposal of gas from rare emergency depressurisation scenarios is currently under study. As the frequency of use is extremely low, the installation of a continuously operating flare for this purpose may not provide environmental benefits over infrequent venting to atmosphere.

The proposed new TOT is expected to require a plot of level land approximately the same size as the existing TOT, and as such potential sites are limited. The location of the proposed new TOT has not been finalised, however, the probable location is displayed in Figure 10.

2.7 Existing Domgas Plant - Facilities Description

The existing LNG plant and Domgas plant are both fed by gas from the existing slugcatcher. The liquid from the slugcatcher is processed in the stabilisers to remove volatile components including natural gas and LPG's prior to storage in condensate tanks from where it is offloaded into ships.

In the present design, the stream of gas which feeds the Domgas plant is mixed with the overhead stream from the stabilisers prior to treatment in the Domgas Plant. The Domgas plant is designed to remove some of the LPG and heavier components of the gas to meet product specifications. The existing Domgas specification places a narrow band on the Propane (C3) content, Butane (C4) content, Wobbe Index, and higher heating value (HHV) of the sales gas stream. The extracted LPG and heavier components are directed to fractionation for further processing.

The existing Domgas facility consists of two identical extraction trains of 300 TJ/d capacity and "bypass" pipework allowing a further 250 TJ/d of throughput. Cumulatively this gives each train a design capacity of approximately 550 TJ/d.

2.7.1 Domgas Debottlenecking - Proposed Scope

At this stage, it is expected that the existing and new facilities will have the ability to process gas and liquid from either or both slugcatchers. Refer to Figure 11 for a schematic of the process.

The present intention is to debottleneck the existing Domgas facility to provide increased capacity. It is envisaged that each Domgas train will be debottlenecked from the current design capacity of 550 TJ/d to allow the supply of 910 TJ/d (peak) through one train (in the main by allowing concurrent operation of the two bypasses.)

The design intent is that both of the existing Domgas trains will normally be in operation, each supplying in the order of 450 TJ/day. In the event that only one Domgas train is available, the modifications will allow the supply of 910 TJ/day (peak) through the other train and bypasses.

At this stage, it is not envisaged that a new flare will be required to support the Domgas debottlenecking options.

Debottlenecking of the Domgas trains involves piping modifications, provision of a new supervisory control system, the addition of a second mercury guard bed and increased sales gas compression, required to achieve the increased production rates.

Compression Options

Two alternatives for supplying the required sales gas compression are under investigation:

- If the Liquid Expansion Project (LEP) proceeds, then incremental compression to allow delivery of 910 Tj/d (max) will be supplied by an electrically driven compressor
- If the LEP does not proceed, the intention is to install a third sales gas compressor driven by a nominal 25 MW gas turbine generator.

2.7.2 Additional Fractionation Unit (Train)

There are two alternatives for LPG disposal if Domgas Supply increases are required:

- Maintain a low liquid feed from offshore and dispose of excess LPG to the Dampier-Bunbury pipeline for third party removal
- Install a fractionation unit similar to that proposed for the LEP project proposal. Details of the LEP fractionation unit are provided below.

The *Liquids Expansion Project* (LEP) is currently being assessed by the WA Government.

Additional fractionation will result in the doubling of daily LPG production capacity from approximately 2000 tpd to approximately 5000 tpd (technical maximum).

The new fractionation unit (train) consists of these equipment items:

- Molecular Sieve Dehydration Units - these units which will be similar to existing units in LNG and Domgas will be used to remove water from the stabiliser overheads feed to Fractionation. The regeneration gas of these molecular sieve beds will be heated using a furnace and/or using a waste heat transfer medium.
- Propane Refrigeration Cycle - at various points in the Fractionation process there is a requirement for streams to be cooled to assist distillation, compression, liquefaction or to maintain the liquid state of the products. The refrigerant used will be Propane.
- Propane Compressor - a large compressor is required for the Propane refrigeration cycle. This compressor may be powered by an electric motor.
- Three LPG extraction (distillation) columns, termed the de-ethaniser (ethane extraction), de-propaniser (propane extraction) and de-butaniser (butane extraction). In addition, a compressor (electrically powered) is required to re-compress de-ethaniser overheads back to the Domgas stream.
- Present expectation is for two extra power generation turbines to be installed, each nominally 23 MW each. These units are covered in the *Liquids Expansion Project* assessment. Power generation requirements will be significantly lower (1 additional power generation turbine) if the LEP does not proceed.
- Heat will be supplied to the columns for distillation of the LPG from an extension of the existing "closed loop" heat transfer system which uses pressurised hot water. The heat will be supplied from Waste Heat Recovery Units (WHRU) retrofitted to the new power generation turbines.

It is not expected that the installed equipment in this project will differ significantly from this description and is similar to that already installed.

2.7.3 Export Sales Gas Pipelines

Up to three additional export sales gas pipelines are proposed to be located adjacent to, and approximately parallel to, the existing Alinta line to the plant boundary fence. The pipeline operator will be responsible for any necessary environmental approvals from the plant boundary fence.

For maintenance and inspection purposes it is proposed that the two export sales gas lines for the BHP contract will each be provided with a pig launcher. These pig launchers will be used on an infrequent basis, with resultant infrequent de-pressurisation requirements. Venting will therefore be through a localised vent and not incorporated into the flare system. No operational pigging is, at present, considered necessary.

2.7.4 Miscellaneous Services Expansion

It will be necessary to tie into existing miscellaneous plant services, such as compressed air, nitrogen, water, fire water, electrical power, control systems, drains, etc. These services are able to meet the requirements of the debottlenecked facilities and it is not envisaged that any expansion will be required.

2.7.5 General Considerations Process Design & Operation

Design

The design philosophy of the proposed expansion will be equivalent to that used in the design of the existing facility and will be based upon the latest Australian and International codes and/or standards and Woodside's operating experience.

Safety and environmental considerations will form an essential and integral element of the design and operation of the facilities. Key environmental issues to be addressed in the design phase include energy efficiency, CO_2 & NO_x emissions, reduction of fugitive emissions, and potentially contaminated drainage.

Relief Systems

Relief systems are intended to provide emergency overpressure protection to protect personnel, equipment and the environment. Safety relief valves will employ proven technology to ensure safe operation; efficient disposal of gases and minimisation of hydrocarbon fugitive emissions. Specifications and maintenance will comply with the approved Onshore Safety Case. The Safety Cases will be suitably updated to account for the proposed plant modifications.

Precommissioning/Commissioning

An assessment of the precommissioning/commissioning activities will be undertaken in the detailed engineering design phase in order that design or procedure covers potential environmental issues. It is envisaged that some flaring will be required during precommissioning and commissioning activities but will be limited to these phases, and will not be required as part of normal operations.

Decommissioning & Abandonment

Abandonment of the additional onshore facilities will occur in an identical manner to the existing plant. On decommissioning the new trunkline will be cleaned of residual hydrocarbons and pressurised with inert nitrogen gas to accommodate potential future

use. The extensive rock berm emplacement, trenching and anti-corrosion coatings will ensure the long term stability and useability of the trunkline.

Should no further use of the trunkline be foreseen, it will be flooded with seawater to provide additional on-bottom stability. Given the extensive rock emplacement proposed over much of the trunkline, it is not considered possible on technical and economic grounds, nor environmentally desirable to attempt the removal of the trunkline.

3 EXISTING ENVIRONMENT

3.1 Physical Environment

3.1.1 Climate

The North West Shelf and adjacent Burrup Peninsula exists in an arid (mainly summer rain) subtropical environment with tropical cyclone activity from November to April. The summer and winter seasons fall into the periods September-March and May-July respectively. Weather is largely controlled by the seasonal oscillation of an anti-cyclonic belt. Winters are characterised by clear skies, fine weather and predominantly strong east to south east winds and infrequent rain. Summer winds are more variable, but west to south west predominates. Three to four cyclones per year can be expected, primarily in the December to March period, though cyclones have been recorded as late as June.

Woodside has collected extensive meteorological records from the NRA location since 1973. Parameters recorded include wind speed and direction, air temperature, barometric pressure, relative humidity, and direct and diffuse solar radiation.

3.1.2 Air Temperature

Mean air temperatures offshore are 28^0C in summer and 23^0C in winter. Inshore mean daily temperatures for winter are 23^0C (ranging from 14-35^0C). In summer mean daily temperatures are 31^0C, with a mean maximum of about 38^0C.

3.1.3 Rainfall

Rainfall is erratic from year to year with the average (for Dampier) of 315 mm per annum.

3.1.4 Wind

Winds are predominantly west south west from October to April and east south east from May to September. Average 10 minute wind speed in non-cyclonic conditions is 6 ms-1 with a 5% exceedence value of 12 ms^{-1}.

3.1.5 Cyclones

The cyclone season is November to April with the majority of cyclones moving down the north West Coast between 40-400 km offshore and at an average speed of 16 km per hour. During tropical cyclones, mean wind speeds of 56 ms^{-1} have been recorded with gusts up to 69 ms^{-1}. Cyclone activity for the North Rankin area has been estimated at 10.7 days per year.

3.1.6 Waves

Swells up to 2m can be expected year round offshore with April being the calmest month and June and January the roughest. Wave direction predominantly follows wind direction (E/SE in winter, W/SW in summer) except during cyclone or storm events. Extreme wave heights offshore, associated with cyclonic activity are in the order of 14m.

Mermaid Sound is protected from long period swell, except from the north and north west. The prevailing wave direction in the vicinity of Withnell Bay is from the north. Minor waves are generated by westerly wind activity in summer periods. The eastern shores of

the Burrup Peninsula and the islands to its north are protected from the persistent winter easterlies, which in Nickol Bay may result in wave heights reaching 3m.

Extreme wave heights inshore, associated with cyclonic activity are in the order of 7-8m.

3.1.7 Currents and Tides

Offshore there is a net surface drift of 0-0.15ms^{-1} due to summer westerlies and winter easterlies. Tides are semi-diurnal and generally flow onshore-offshore with peak neap and spring speeds of 0.3ms^{-1} and 0.65ms^{-1} respectively. The mean spring tidal range at NRA is 2.4m.

The tidal range in Mermaid Sound ranges from -0.5m [Lowest Astronomical Tide (LAT)] to 4.8m [Highest Astronomical Tide (HAT)]. The currents within Mermaid Sound are composed of tidal and drift currents. Maximum current speed directions are parallel to the coastline with tidal flood currents to SSW and ebb currents to the NNE. Maximum tidal velocities within Mermaid Sound are in the order of 0.5ms^{-1}, though they generally do not exceed 0.5 knots (~0.25ms^{-1}).

The drift currents result from the action of the wind and general ocean circulation. The drift current is superimposed on the tidal current. The net water movement is parallel to the coast line of Mermaid Sound either SSE or NNE. Drift rates average 2-5 km per day during the neap tidal cycle, and 2-10 km per day during the spring tidal cycle.

3.1.8 Water Temperature

Offshore near surface water temperatures range from 30^{0}C maximum in summer to 22^{0}C minimum in winter. Near bottom temperatures range from 22^{0}C to 24^{0}C year round.

Inshore water temperatures in Mermaid Sound range from 19^{0}C in July or August to 32^{0}C in March or April.

3.1.9 Seabed Surface Features and Bathymetry

An extensive geophysical survey has been undertaken along the proposed trunkline routes in both the inshore and offshore environments. This work, which included piston coring, vibro-coring, swathe and single beam bathymetric mapping, side-scan sonar mapping and sub-bottom profiling is still undergoing analysis.

Preliminary data has been extracted, however, to provide provisional surface and near-surface seabed feature descriptions along the preferred route options (Option 1 to NRA and Option 1a to GWA). A preliminary summary of the seabed conditions along the second trunkline routes are provided in Appendix 2 and illustrated in Figures 13a and 13b.

Inshore - Mermaid Sound

At the shore crossing point adjacent to the OTP [Kilometer 0 (KP0)] igneous material (Gidley granophyre) occurs, forming a sloping boulder shoreline through the intertidal and shallow subtidal zones. At the base of the slope, rocky calcarenite pavement overlain with thin sediment predominates. At KP1.0, sediment cover over the pavement increases to greater than 2m, however, sediment cover shallows again and calcarenite begins to outcrop between KP3.6 and KP7.3, west of Conzinc Island.

Between KP7.3 and 20.0, flanking Angel and Gidley Islands, sediment cover is generally greater than 2m deep. Shallowing occurs over a short distance as the trunkline route traverses a spur of rocky pavement to the south of Hammersley Shoal.

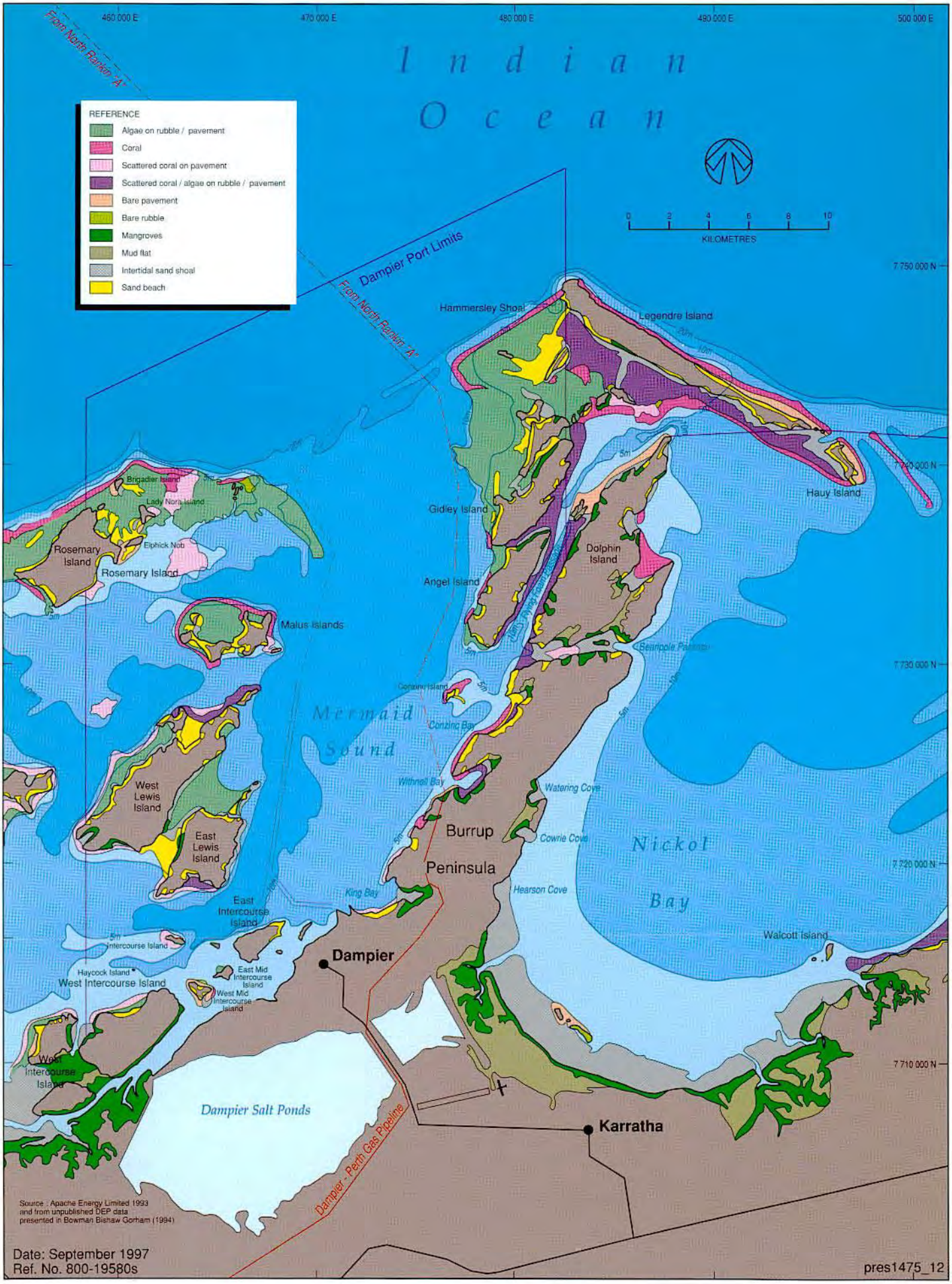


Figure 12 - Second Trunkline Project PER

SHALLOW MARINE HABITATS OF THE DAMPIER ARCHIPELAGO

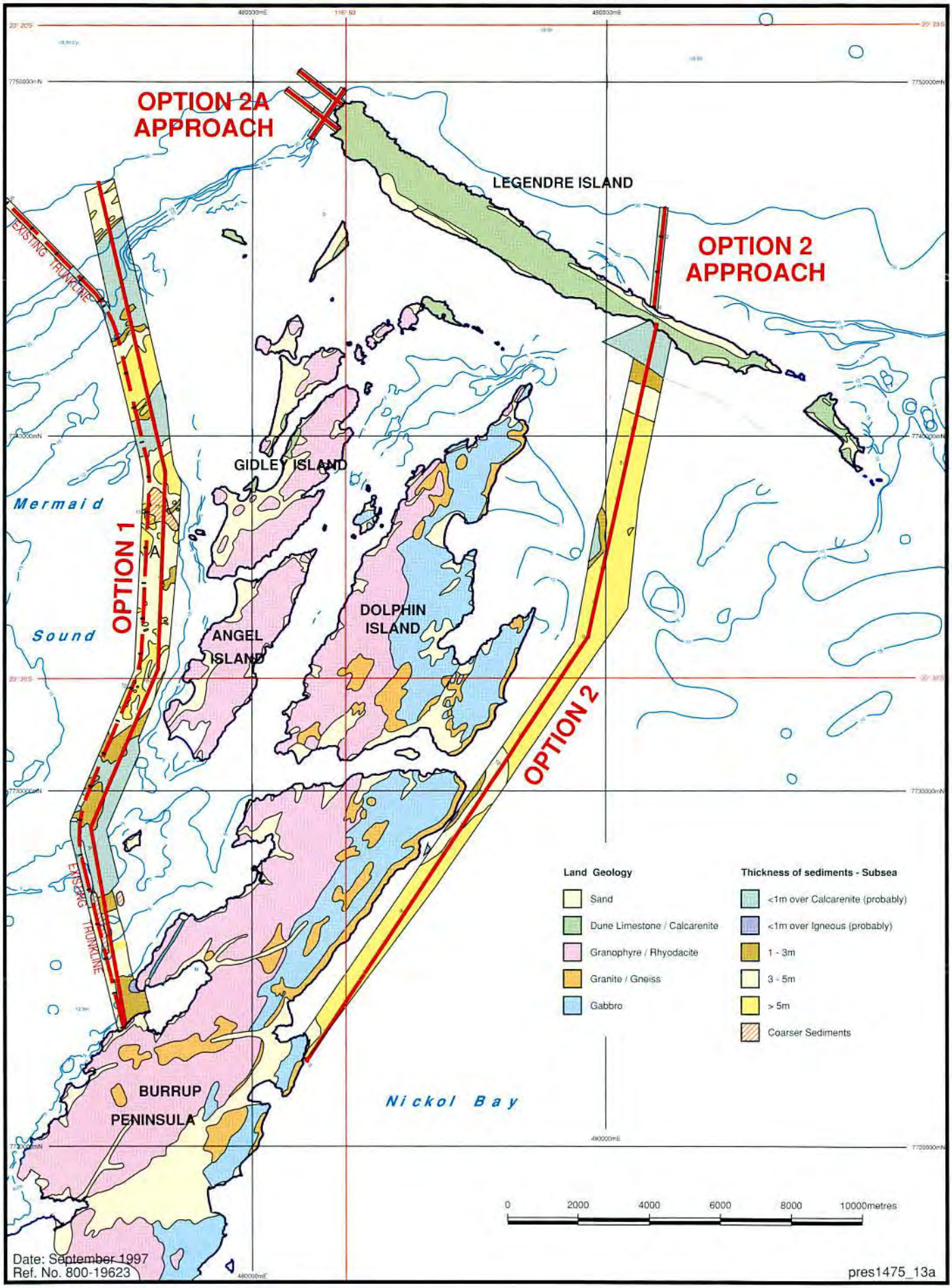


Figure 13a - Second Trunkline Project PER

SURFACE SEABED FEATURES - INSHORE

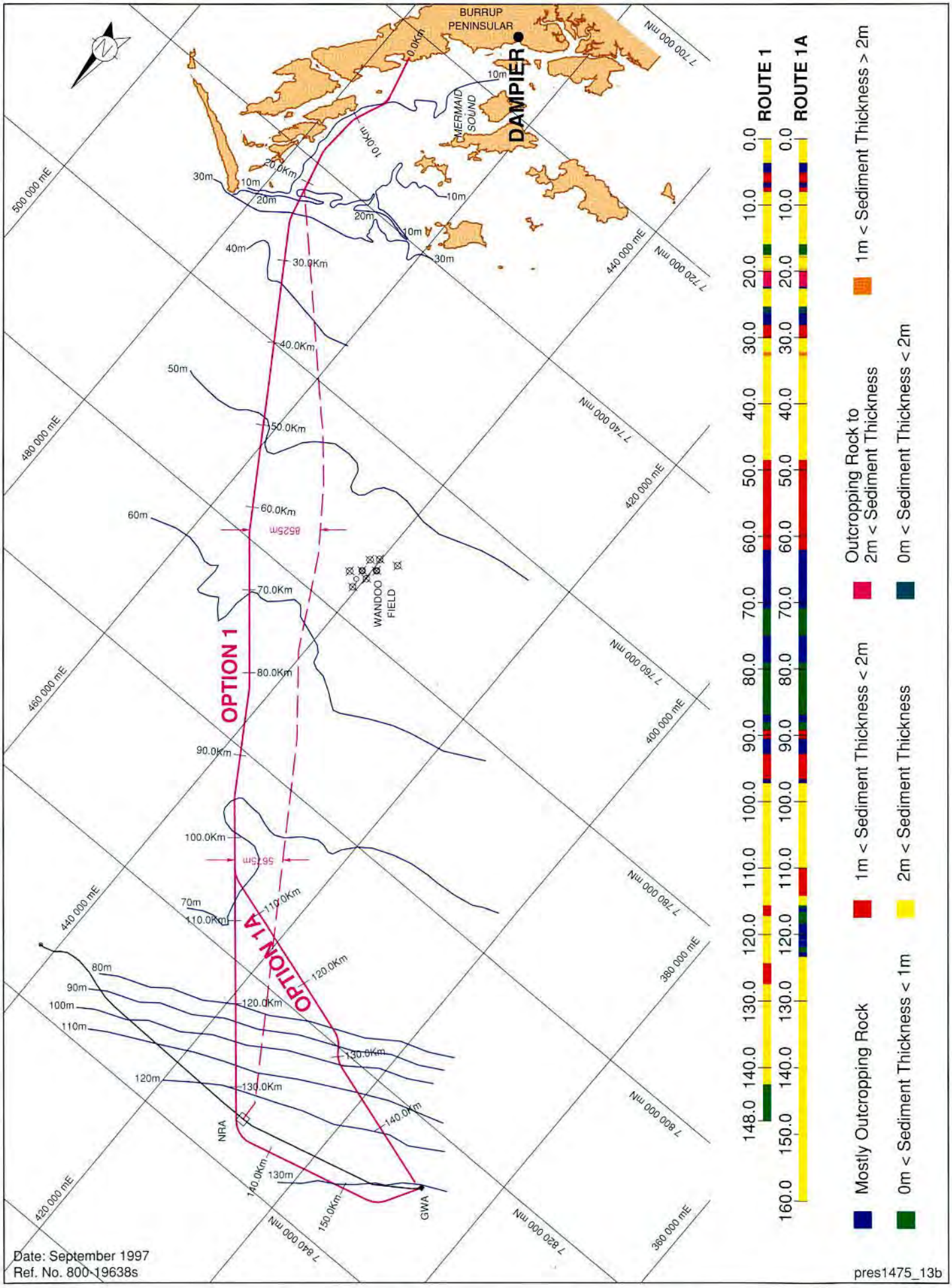


Figure 13b - Second Trunkline Project PER

SURFACE SEABED FEATURES

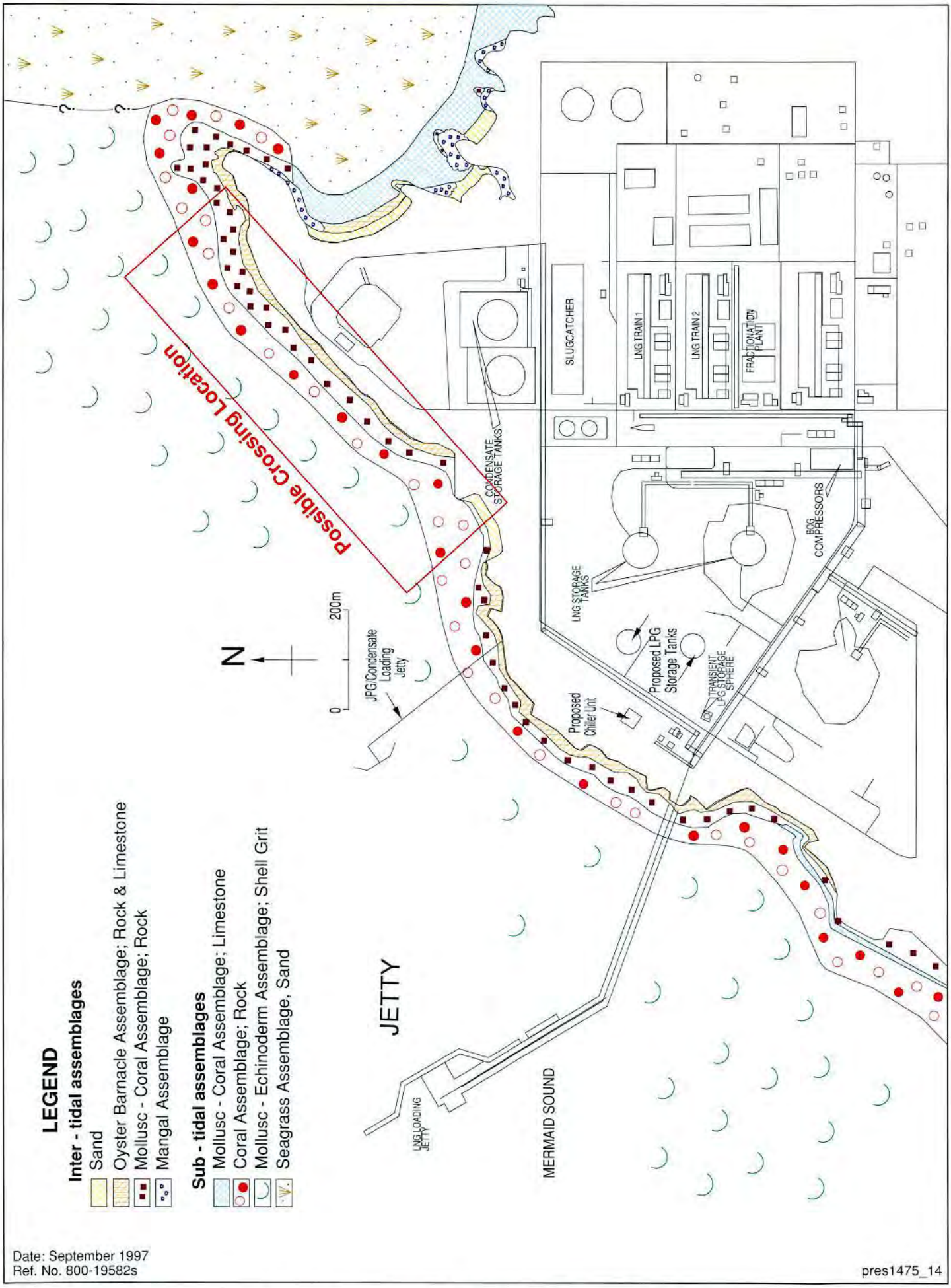


Figure 14 - Second Trunkline Project PER

MARINE ASSEMBLAGE - SHORE CROSSING POINT

Sediment shallowing and occasional areas of exposed calcarenite outcropping occur between KP20 and KP22.6. This area, to the west of Hammersley Shoal, equates to the northern edge of the Dampier Archipelago where water depths increase relatively rapidly from about 12-26m (LAT).

Between KP22.6 and KP28.1 water depth increases gradually from 26-35m (LAT). Sediment cover is variable from 0->2m and some areas of rock outcrop occur.

Offshore

The seabed slopes gently from KP28.1 in 35m water depth (LAT) out to the production platforms - NRA 124.3m and GWA 132m. Seabed surface features along the offshore route (Option 1) consist of three broad categories as indicated below in Table 3-1.

Table 3-1: Offshore Seabed Surface Features - Route Option 1

Surface Features Offshore	Area Along Trunkline Route (Km & %)
Overlaying soft sediment	75.5 (63.0%)
Overlaying soft sediment with areas of rock outcrops	28.2 (23.5%)
Predominant rock outcropping	16.2 (13.5%)

Unconsolidated soft sediments ranging from ~0.5->2m depth overlaying rock pavement are the dominant surface seabed feature along the route.

Areas of exposed rock occur principally in four locations - between KP62 and KP70.8; KP75 and KP79; KP86.9 and KP88; and KP90.5 and KP92.8. Interspersed between these areas of rock outcrop are areas where sediment cover thickness is variable and where occasional rock outcrops occur. These areas occur along the route between KP50 and KP90.5.

Sediments in the inshore, inner and midshelf regions of the North West Shelf are comprised of coarse to fine calcareous sands with silt fractions ranging from 5-20%. In the deeper offshore regions calcareous sediments are finer and comprised of sandy silts.

3.2 Marine Environment Offshore (>30m)

3.2.1 Unconsolidated Sediments

Woodside has collected 233 biological grab samples from the NWS seabed at the North Rankin, Goodwyn, Cossack and Wanaea fields. 176 of these samples have been obtained using the Triton Remotely Operated Vehicle (ROV) in combination with a purpose built grab sampler. A summary of the sampling programme and results are indicated in Tables 1-5, Appendix 3.

Sampling has consistently shown that the soft sediments of the NWS support a low abundance, high diversity invertebrate fauna comprised largely of burrowing polychaete worms and crustaceans. Echinoderms and molluscs also contribute significantly to the faunal composition of the area.

The general taxonomic composition of fauna from soft sediments in the offshore areas of the proposed 2nd trunkline route is expected to be very similar, however, species differences are expected to occur, consistent with the inherent diversity of the area.

3.2.2 Calcarenite Outcrops

Areas of calcarenite outcrop have been identified along the proposed 2nd trunkline route during the scouting geophysical investigations. The outcrops occur in water depths between 50 and 123.8m. Similar areas are known from the existing trunkline route, with outcrop widths ranging from 0.26-3.9km (average width ~1km). The largest outcropping so far identified occurs approximately 14 km SE of the NRA platform. A 4km x 19.3km block in this area, spanning the existing and proposed trunkline, was surveyed for surface and shallow subsurface seabed features in 1995. The survey identified a prominent scarp, delineated by the 75m water depth contour (Racal, 1995). This was defined by Anthorpe *et al.* (1988), as part of the late Pliocene to early Pleistocene Australian mainland.

Approximately 30km^2 (~35% of surveyed surface area) of calcarenite scarp, outcrops and subcrops have been identified within this block. A similar area (30km^2) of outcropping and subcrops is also known from the Wanaea and Cossacks fields, approximately 30km ENE, in water depths of 70-85m.

In 1993, 1.75km of seafloor videography was obtained by ROV from two areas of calcarenite outcropping in the Wanaea field. Sub-samples of this videography were later analysed by LeProvost Dames & Moore (1994) and a report prepared, describing the fauna associated with these seabed features.

The main findings from that report, were that the surveyed areas of calcarenite ridges (outcrops/subcrops) supported an epibenthic community comprised predominantly of sponges, soft corals and gorgonians. Reef fishes and invertebrates were expected to be associated with the features, though survey methods generally restricted observations to non-cryptic sessile macrofauna >10cm in size. The diversity of the fauna was found to be similar to that recorded in the shallower water (15-20m) epibenthic communities of sand veneered limestone pavement habitats elsewhere on the NWS, with the noticeable exclusions (due to the greater depth) of scleractinean (hard) corals and macrophytes.

Macrofauna was found to be patchily distributed along the surveyed ridges with abundance inversely related to the thickness of sand veneer overlaying the hard substrate.

Calcarenite outcrops along the proposed 2nd trunkline route are expected to support similar epibenthic communities as those identified in the Wanaea Field.

3.3 Marine Environment Inshore

The marine environments of the Dampier Archipelago have been discussed extensively in the *North West Shelf Development Project, Draft Environmental Impact Statement and Environmental Review and Management Programme* (Woodside,1979). Since this time a number of other studies - including long term monitoring programmes, associated with various aspects of the NWS Project, have been conducted. As a result the general marine environment, particularly within Mermaid Sound, can be regarded as relatively well known.

The broad marine habitat distribution within the Dampier Archipelago is displayed in Figure 12.

The proposed 2nd trunkline route (Option 1) will run parallel and to the east of the existing trunkline but may be offset in places by up to 500m to facilitate pipe-laying operations. The trunkline will be installed through soft substrates for most of its passage through Mermaid Sound. At the entrance to Mermaid Sound and to the west of Conzinc Island,

however, it will cross relatively shallow (7-10m) algal covered pavements; and at the proposed shore crossing, a narrow limestone pavement and rocky boulder slope.

Soft substrates in Mermaid Sound have been previously investigated by commercial and experimental trawling and grab sampling (Meagher & LeProvost, 1979) and found to support crustaceans, fish and a variety of invertebrates dominated by echinoderms (holothurians, asteroids, crinoids, ophuroids) and molluscs.

Investigations in 1993, of soft substrate fauna from depths of 15 m (LAT) adjacent to spoil Ground A/B (refer Figure 4 for location), using airlift techniques, documented an abundant and diverse infauna dominated by polychaetes, crustaceans and molluscs (LeProvost, Dames & Moore, 1995).

Areas of subtidal limestone pavement, investigated during the 1978 study were found to support corals, sponges and sea whips in addition to fish, crustaceans and echinoderms. Observations made on the pavement to the south of Hammersley Shoal (T.D Meagher and Associates,1984) for Woodside during an investigation to assess the effects from the installation of the original trunkline support these observations. The pavement was found to be sand veneered with sediment depth variable but generally increasing with increasing depth. In the area where the proposed 2nd trunkline is expected to cross this pavement brown algaes were estimated to contribute 5% cover and corals 5-10%. Large sea fans, sea whips and some soft corals were also present. In shallow subtidal areas, closer to the islands, red and brown algaes become seasonally dominant with cover varying between 1 and 90%. In deeper areas, where sediment cover over the pavement increases, large epibenthic life forms become scarce.

Observations made during the same study, to the west of Conzinc Island, where the 2nd trunkline is proposed to cross, indicate a platform with overlaying sediment to 10cm depth and boulder and rubble strewn patches. Algal cover over the pavement was estimated at 5% and sea whips, occasional sponges and patches of seagrass were noted. No hard corals were observed.

The proposed trunkline shoreline crossing adjacent to the OTP boundary will cross sparse subtidal coral assemblages and intertidal coral/mollusc and oyster/barnacle assemblages on igneous rock. The main biotic assemblages in this area are displayed in Figure 14.

Subtidal coral assemblages in this vicinity have been extensively studied as part of Woodside's marine monitoring programme, ChEMMS (Chemical & Ecological Monitoring of Mermaid Sound), since 1983. Fifty seven (57) coral species from 26 genera have been recorded (LeProvost Environmental Consultants, 1991). Based on the frequency of colonies recorded on belt transects, the most dominant genera in the area are:

- Turbinaria
- Favites
- Favia
- Porites

These genera are typical of turbid water coral habitats and are relatively tolerant to high sediment loads.

Coral cover in the area proposed for the shore crossing is measured annually as part of the ChEMMS programme and is typically in the order of 15-25%.

3.4 Terrestrial Environment Burrup Peninsula

3.4.1 Geology and Topography

The geology and topography of the Burrup Peninsula has been extensively described in the original North West Shelf Development Project EIS/ERMP (Woodside, 1979); and in the Burrup Land Use and Management Plan (O'Brien Planning Consultants, 1994).

The Burrup is mainly comprised of a Proterozoic igneous rock outcrop known as the Gidley Granophyre. At its base is a coarse grained gabbro. Dolerite dykes which have weathered more rapidly than the granophyre and gabbro have resulted in the formation of valleys which bisect the Burrup.

The Burrup has a rugged topography dominated by steep bare rock piles and narrow valleys. The main topographic features to be disturbed by the proposed expansion are the massive rock pile and scree slope formations to the south of the OTP (preferred quarry sites; see Figure 9) and to the north of the King Bay Supply Base.

3.4.2 Vegetation

The vegetation of the Burrup Peninsula has been previously described and mapped and is reported in the original North West Shelf Development Project EIS/ERMP (Woodside, 1979).

Vegetation surveys have been conducted in all areas where land disturbance is to take place to ascertain existing vegetation units, whether any priority flora or restricted or unique communities could be affected; and to determine the current distribution of weeds. A detailed description of these elements, including vegetation unit maps, is provided in Appendix 5. Summary data is provided below.

3.4.3 Quarry Site

The preferred quarry sites (Refer Figure 9) include rocky hills with rock piles and outcrops, stony plateaux and both shallow and deep drainage gullies. There is a diverse range of species over the entire area and a number of priority species have been recorded.

The rock pile and outcrop areas of the proposed quarry support an open low woodland with sparse open dwarf scrub and very sparse open grass. The most frequent woodland species are *Terminalia suprantifolia* and *Brachychiton acuminatus.* Rock figs (*Ficus platypoda*) and desert almonds (*Pittosporum phylliraeoides*) are less frequent. Low scrub occurs in soil pockets and include *Dichrostachys spicata* and *Rhagodia eremaea.* The sparse grass cover includes native lemon grass (*Cymbopogon ambiguus*) and "spinifex" *Triodia epactia.*

High stony plateaus that occur on the site between the rocky hills and outcrops are vegetated with mid-dense *Triodia epactia* grassland, sparse mixed shrubland and very sparse low woodlands. Shrubs include *Grevillea pyramidalis*, *Hakea suberea* and *Acacia holosericea.*

Deep drainage gullies between the rockpiles support dense *Triodia angusta, T. epactia* grassland and low woodlands of *Eucalyptus victrix*, *Terminalia canescens* and *Acacia coriacea.*

An ephemeral water hole present within the proposed quarry site, supports *Cyperus cunninghammii*, *Stemodia grossa* and *Sesbania cannabina.*

Haul Road

The majority of the proposed haul road extension runs through undisturbed rock piles, gullies and high plateau. The vegetation units supported by these landforms are as described above.

Pipe Weight Coating Area

The environmental features of the preferred sites are detailed below:

Hearson's Village

The Hearson's village site (approximately 90ha) was used as a construction camp during the NWSGP Phase II LNG construction. The area was rehabilitated in 1991 with variable success across the site. The dominant vegetation unit over the site is buffel (*Cenchrus ciliaris*) grassland supporting sparse to mid dense *Acacia bivenosa* scrub and Kapok bush (*Aerva javanica*).

Regrowth progress is best in low lying areas, where either adequate top soil was retained, (or possibly not stripped) and adjacent to undisturbed pockets of natural vegetation.

Original Pipe Weight Coating Site

This site occupies approximately 51ha (approximately 25 ha were disturbed) and was rehabilitated in 1981 with limited success, possible due to 'top dressing' of the site with coastal marine sands. The dominant vegetation unit over to site is buffel grassland with *Acacia bivenosa* scrub.

Rock Storage Area

Option 1

The proposed rock storage area near the King Bay Supply Base has been previously used for this purpose. *Paspalidium tabulatum* and *Triantlema turgidifolia*, a low succulent shrub, are the predominant colonising species in this area.

The additional area of undisturbed land which may be required adjacent to this site (approximately 5.4ha) supports small areas of undisturbed rock piles, rock slopes and both shallow and deep drainage gullies. Priority tree species are present on the rock piles. The drainage gullies support *Acacia spp* and grassland comprised of Buffel grass and *Triodia angusta*.

Option 2

The proposed Rock loadout facility at Holden Point will cover an area of sandplain to the South of No-Name Bay, within the proposed extensions to the Plant lease. The area is composed of two basic vegetation associations. The seaward side of Holden Point is a granophyre/granite ridge in an exposed location and contains vegetation typical of these locations along the Burrup.

The vegetation is classed as Open Low Woodland B (2-10%, <5m) with sparse Open dwarf Scrub C (2-10%, 0.5-1m) and Very Sparse Open grass. There are three priority species present in low density. These are *Brachychiton acuminatus, Terminalia suprantifolia* and *Triumfetta appendiculata*.

The sandplain area is degraded in some areas, where vehicle tracks and camping sites occur. Generally the vegetation is composed of Mid dense Grassland (30-70%) of *Triodia epactia and Spinifex longifolius* and Dwarf Scrub D (10-30%, 0-0.5m) of *Aerva javanica*.

There is a significant amount of the introduced weed *Aerva javanica*, but little buffel grass *Cenchrus ciliaris*. The dwarf scrub, which is typical of Pilbara hind dunes, contains *Scaevola cunninghamii* and *Salsola khali*.

3.4.4 Fauna

A number of fauna surveys have been undertaken on the Burrup Peninsula (Tingay, 1979; Butler, 1983, 1987; Dinara, 1990, 1993; Woodside, 1994, 1995). The fauna is considered as relatively well known. The Pilbara Olive Python (*Morelia olivacea barroni*) is the only rare fauna species known from the Burrup Peninsula, though disused Pebble Mouse (*Pseudomys chapmani*) mounds are present. Nine mounds recently located on the rocky alluvial flats near the Mt.Wongama / Withnell Bay road showed no evidence of activity.

3.5 Environmental Significance

The Dampier Archipelago has been recognised by the Department of Environmental Protection (DEP) as an Environmentally Sensitive Locality (DCE, 1984). Many of the islands are nature reserves, vested in the National Parks and Nature Conservation Authority (NPNCA) for the protection of flora and fauna. Recommendations have been made for these islands' purpose to be changed to national park (Morris, 1990). Recommendations have also been made for the waters and islands of the Dampier Archipelago to become a marine park (Wilson, 1994).

The Dampier Archipelago has been listed as an "indicative" place on the Register of the National Estate. The area is recognised for encompassing an unusually wide range of marine habitats. These support a diverse range of marine flora and fauna, including: 338 species of fish, over 500 species of molluscs, 216 species of corals, 7 species of marine mammals, 4 species of turtles 23 species of migratory waders (all protected under international agreements), breeding habitat for 16 species of seabirds and 6 species of mangroves.

Important environmental resources in the vicinity of the proposed trunkline route options include:

- Fringing coral reef (Hammersley Shoal).
- Coral assemblages (Gidley, Angel and Conzinc Islands).

With respect to rare flora and fauna the following terrestrial species are noted:

The Pilbara olive python (*Morelia olivacea barroni*), listed as a Schedule 2 species under the WA Wildlife Conservation Act and therefore in need of special protection, is known to occur on the Burrup Peninsula.

No flora listed as rare under the WA Wildlife Conservation Act are known from the Burrup Peninsula. Four species of Priority flora, *Brachychiton acuminatus* (P4), *Terminalia supranitifolia* (P4), *Triumfetta appendiculata* (P3) and *Corchorus trilocularus* (P1) are known from the Burrup Peninsula. P4 flora have restricted (known) distributions. Both P4 species are, however, widespread on the Burrup Peninsula; and *B. acuminatus* is currently under consideration for de-listing (V.Long, Astron Engineering, pers. comm.). The priority 1 species, a small inconspicuous plant, has previously been observed on the Hearson's Village site and is not known to be widely spread beyond the Burrup Peninsula.

No terrestrial species listed as endangered or vulnerable under the Commonwealth Endangered Species Protection Act are known from the Burrup Peninsula.

In marine waters the following species are noted:

- The Loggerhead Turtle (*Caretta caretta*), the Blue Whale (*Balaenoptera musculus*) and the Humpback Whale (*Megaptera novaeangliae*), listed as endangered under the Endangered Species Protection Act; the Green Turtle (*Chelonia mydas*) and the Hawksbill Turtle (*Eretmochelys imbricata*), which are listed as vulnerable under the same Act.
- The WA Wildlife Conservation Act lists the Blue Whale and the Humpback Whale as rare and the Dugong (*Dugong dugon*) as in need of special protection.

The Burrup Peninsula is recognised as an area supporting significant environmental and heritage values. These values have been extensively discussed in the Technical Appendices of the *Burrup Land Use and Management Plan,* a report prepared by O'Brien Planning Consultants for the Burrup Peninsula Management and Advisory Board.

Key attributes recognised in that report include:

- High floral diversity, with 393 known taxa and 33, as yet unidentified taxa.
- Complex and varied vegetation - 5 vegetation associations and 28 communities, including three rarely occurring communities.
- Largely weed free vegetation communities, north of Hearson's Cove and Conzinc Bay.
- Diverse terrestrial vertebrate fauna, including 20 mammals, 121 birds and 54 reptiles.

All project related disturbance on the Burrup Peninsula falls within areas identified for industrial development by the Burrup Land Use Plan and Management Strategy (Burrup Peninsula Advisory Board, 1996).

3.6 Social Environment

3.6.1 Aboriginal Heritage

The Burrup Peninsula is recognised internationally as an area containing significant Aboriginal rock art, archaeological and ethnographic sites.

A comprehensive Aboriginal site survey was conducted over a wide area of the Burrup Peninsula by the WA Museum (1979) with the objective of identifying potential constraints to development of the North West Shelf Gas Project. The Department of Conservation & Land commissioned a subsequent survey.

The extent of existing survey coverage on the Burrup Peninsula from these two studies, along with areas either listed or nominated for protection under the Register of the National Estate, are displayed in Figure 20.

Aboriginal heritage surveys will be conducted on any unsurveyed land, proposed for disturbance and Woodside will comply with the requirements of the WA Aboriginal Heritage Act, 1972.

The area is currently under claim by two groups of Native Title claimants representing the Ngulama Injibandi and Yaburara Mardudhunera groups respectively. Woodside is negotiating with both groups under an agreed process.

3.6.2 Burrup Peninsula Land Use

The Burrup Peninsula Draft Land Use and Management Plan (O'Brien Planning Consultants, 1994) notes that the [Burrup] Peninsula is one of the most important industrial and port sites in Australia. Industries such as Woodside Offshore Petroleum, Hamersley Iron and Dampier Salt contribute approximately 20 percent of Western Australia's total export earnings and make the Port of Dampier the largest tonnage port in Australia.

Approximately 17.3% or 15.3km^2 of the Burrup Peninsula land area is utilised by existing industrial development, with the remaining 72.9km^2 being vacant crown land held as a Temporary Reserve (O'Brien Planning Consultants, 1994).

Recognising the potential for heritage, conservation, recreational and industrial conflicts on the Burrup Peninsula, the Western Australian Government commissioned a land use management plan to be prepared through a community consultative process. The final plan, known as the *Burrup Peninsula Land Use Plan and Management Strategy*, was released in 1996 and has been ratified by the State Government Cabinet. The plan identifies industrial and conservation, heritage and recreation areas. The plan allocates 5,400ha (62%) of the Peninsula for conservation, heritage, recreation and associated activities. The Burrup Peninsula Land Use Plan is reproduced in Figure 21.

3.6.3 Population Centres

The nearest population centres to the proposed onshore project activities are in the towns of Dampier and Karratha. Other towns in the Roebourne Shire include Wickham, Roebourne and Point Samson. A 1991 Shire of Roebourne Census indicates a regional population of 17,291, with the largest population centre being Karratha - 11,315 persons (O'Brien Planning Consultants, 1994). However, preliminary data from the 1996 ABS Census suggests the population in the Roebourne Shire may have declined. Based on the place of enumeration (ie where people are counted, rather than usual place of residence) the Shire population was 14,954.

While Karratha remains the largest centre, its population may too have declined, however, official figures are not available at this time.

3.6.4 Recreational Activities

The waters of the Dampier Archipelago are an important recreational resource for the residents of the Shire of Roebourne. With high boat ownership in the shire, as many as 151 boats have been known to be using the waters of the Dampier Archipelago at any one time (Morris, 1990). Favoured activities include fishing, diving and island beach visitation for swimming and picnicking.

The beaches south of Holden Point (refer Figure 16) are accessible by 4WD and are utilised for recreational activities. Other beaches on the Burrup Peninsula (e.g. Hearson Cove and Withnell Bay) are utilised for recreational activities, however, these will not be impacted by the proposed development activities.

3.6.5 Tourism

Currently the main focus for tourists visiting the Burrup Peninsula is the Woodside Visitor Centre which hosts up to 25,000 visitors annually. The Burrup Peninsula and waters of Mermaid Sound presents a number of possibilities for tourism including eco-tourism and Aboriginal cultural tours, however, at this stage commercialised tourism of this nature is not occurring.

3.6.6 Sites of Historical Significance

No sites of historical significance or identified shipwrecks are known in the vicinity of the proposed second trunkline route or in the areas proposed for disturbance onshore.

3.6.7 Commercial Fisheries

The locations of the major fisheries in the vicinity of the 2nd trunkline are displayed in Figure 22.

Pilbara Fish Trawl Fishery

Zone 1 of the Pilbara Fish Trawl Fishery consists of a small area in the west of the fishery to which only 1 boat has access. Zone 2 extends from 116^0 E to 120^0 E on the seaward side of a line which approximates the 50m depth contour, to a line approximating the 200m isobath. The area inshore of the 50m isobath is excluded from the trawl fishery to protect juvenile commercial fish and to exclude trawlers from recreational fishing areas.

Nine boats operate within the fishery, with the highest fishing effort occurring between September and May. The bulk of the catch consists of small low value fish (spangles, flagfish, threadfin bream), however, larger and more valuable fish such as red emperor, jobfish and rankin cod, make up a significant proportion of the catch (P. Stephenson, Fisheries Department of WA, pers. comm.).

The total catch for 1996 was 3,378 tonnes, significantly higher than the previous 5 year average of 1,851 tonnes.

The highest catch and catch rates occur in the west of the fishery, with 40% of the 1995 effort concentrated between 116^0 00'E and 116^0 40'E.

An additional trunkline exclusion zone may inconvenience trawl fishing activity, but may also provide a refuge for commercial fish species.

Other Fisheries

Other fisheries in the area include the Pilbara Trap Fishery which involves 15 licensed vessels, operating principally from Onslow; and the North Coast Shark Fishery, which utilises both pelagic and demersal gill netting and pelagic longlining and droplining. Eleven vessels have access to the fishery. The Nickol Bay Prawn Fishery operates within Nickol Bay between the months of March and November, targeting Banana, King and Tiger prawns. Commercial gill netting for Barramundi and Salmon also occurs, periodically, within Nickol Bay.

These fisheries are not expected to be disrupted by the proposed trunkline installation and operation.

3.6.8 Aquaculture

An aquacultural lease for the growing of the winged pearl *Pteria penguin* and two pearling leases for the production of *Pinctada maxima* are maintained in Flying Foam Passage. The location of the Pearling Act leases are displayed in Figure 23. Installation of the trunkline is not expected to effect water quality within Flying Foam Passage, nor affect pearling operations.

3.6.9 Petroleum Resources

The offshore waters of the North West Shelf sustain Australia's most prospective and productive hydrocarbon province.

Within Australia, there are estimated to be 98 Trillion cubic feet (Tcf) of recoverable gas reserves. The Carnarvon Basin off the North West Shelf or WA hold approximately 52 Tcf or 53% of these reserves.

The North Rankin field holds approximately 11 Tcf and the Goodwyn field about 3 Tcf, making these reserves approximately 14% of the estimated national reserves at this time.

These fields are sufficient to maintain production from the North west Shelf Gas Project into the next century and cater for expansion by the development of existing and new reserves.

This development will not impact to any appreciable degree gas resource levels in Australia.

4 POTENTIAL ENVIRONMENTAL EFFECTS

4.1 Overview

Installation and stabilisation of a pipeline requires seabed and/or ground disturbance and for a project of this nature, potentially provides the most significant source of environmental impact. The 2nd trunkline route which has been proposed, avoids directly impacting significant areas of coral reef and maximises buffers to minimise risk to corals from indirect impacts arising from sedimentation and reduced water quality. The trunkline crosses directly onto the OTP lease boundary, avoiding disturbance to areas of natural vegetation and landscape. The proposed route also avoids potential disruption to commercial fishing and aquaculture activity in the western and eastern parts of the Dampier Archipelago and disturbance to Aboriginal sites. By mirroring the existing trunkline route (inshore), where extensive monitoring has previously been undertaken, it also enables a relatively high degree of confidence in predicting the expected level of environmental impact.

4.2 Marine Effects

4.2.1 Pipeline Construction - Offshore

The potential methods of offshore (platform to 30m contour) pipelay and stabilisation have been described in detail in Section 2.5 and are illustrated in Figure 6a.

Temporary sediment disturbance will result from the positioning and retrieval of the laybarge anchors, the laying of the trunkline onto the seabed and the passage of the marine plough. Sediment will also be disturbed if a specialised trench excavation unit is used and during rock dumping or concrete mattress placement.

The ploughing or rock trenching operation will result in a trench approximately 4m wide and 1.5m deep, with spoil berms either side of the trench. The area of soft sediment habitat disturbed by offshore ploughing represents only a small fraction of the total area available of similar habitat in the region. In time the trenches will infill and can be expected to be recolonised by the pre-existing fauna.

Ploughing or trenching operations can be expected to result in the formation of sediment plumes, causing temporary and localised increases in water turbidity and sedimentation. Prevailing tidal currents are expected to move sediment plumes predominantly in the NW and SE directions - approximately parallel to the trunkline. Significant sedimentation effects on the adjacent fauna, such as smothering, are expected to be restricted to within 100m of the trunkline corridor.

Beyond this zone sedimentation is unlikely to exceed that arising from natural sediment redistribution events from internal wave activity and tropical storms.

The trunkline route will traverse a number of surface or near surface hard calcareous rock outcrop in the offshore section. These outcrops are believed to be widespread on the North West Shelf and are known to support relatively sparse epibenthic assemblages dominated by sponges, soft corals and gorgonians. Due to the depth and light attenuation, they do not support hard coral, seagrasses or macroalgae.

Trunkline stabilisation in areas of rock outcropping will be achieved by rock dumping or concrete mattress placement. This will result in a hard substrate approximately 18m wide and 2.5m high overlaying the calcareous rock. The rock or concrete mattress will provide

a suitable habitat for colonisation by a similar assemblage of species to that occupying the calcareous rock and will provide food and refuge for demersal fish.

Similar stabilisation techniques will also be required in selected offshore areas of soft sediment to achieve stability and to provide additional protection. This will permanently alienate areas of soft substrate habitat, whilst providing a similar area of additional hard substrate which can be expected to be colonised by assemblages typical of hard substrate habitats on the North West Shelf.

These operations will also result in localised and temporary increases in turbidity, similar to that arising from ploughing.

4.2.2 Pipeline Construction - Inshore

The methods of inshore (30m contour to shore) trunkline pipelay and stabilisation have been described in detail in Section 2.5 and are illustrated in Figure 6b. The proposed timing is detailed in Table 4-1 (below).

Table 4-1: Proposed Timing of Inshore Trunkline Construction

Task	Proposed Period - 2nd Trunkline
Pretrenching	Oct-Mar: Year 1-2
Blasting	Nov-Mar: Year 1-2
Shore pull	May: Year 1
Pipelay	May-August: Year 2
Ploughing/Offshore Trenching	July-November: Year 2
Rock dumping	Oct-May: Year 2-3

NB: At this stage it is anticipated Year 1 will be 1998.

The environmental effects which may be associated with inshore installation and stabilisation are essentially the same as those for offshore and arise from seabed disturbance, habitat alienation, sedimentation and reduced water quality.

Ploughing operations will result in the disturbance of soft substrate within Mermaid Sound. In these areas, were sediment depth greater than 2m, little, if any, large epibenthic fauna - such as gorgonians, sponges and soft and hard corals - are expected to occur. The predominant fauna will include burrowing polychaetes, crustaceans, echinoderms and molluscs and in shallower areas sparse seagrass.

Areas of soft sediment disturbed by pipelay will be permanently alienated following stabilisation activities. In time the rock or concrete mattress structures can be expected to be colonised by biota typical of the hard substrates and will provide food sources and refuge for demersal fish.

A trench will be excavated in Mermaid Sound in areas where limestone pavement or shallow sediments (<2m) occur. Areas of limestone pavement will support biotic assemblages characterised by gorgonians, sea whips, sponges, soft and hard corals, macroalgae and seagrasses. The cover of this epibiota will depend to a large degree on the depth of sediment veneering the pavement and the prevailing water quality and wave energy regimes. Cover in the southern portion of Mermaid Sound can be expected to be relatively sparse (<15% cover) whilst areas to the north may support cover up to 75%. Where relatively deep sediment (>30cm) overlays limestone pavement, biological assemblages more typical of the deeper soft sediments are likely to occur.

Colonisation by hard substrate biota can be expected to occur following rock or concrete mattress emplacement.

Indirect effects resulting from sedimentation and reduced water quality can be expected from the construction processes, especially dredging. As the methods proposed for the installation of the 2nd trunkline are essentially the same as those used for the installation of the original trunkline and as the 2nd trunkline will run parallel and close (50-500m east) to the existing trunkline, relatively robust predictions can be made as to the level of environmental impact which can be expected.

The original trunkline monitoring programme was designed to assess gross changes to benthic habitats and water quality due to all aspects of trunkline construction. Three surveys were conducted; the first in August 1981 (preceding excavation), the second in September/October 1982 (after trenching operations) and the third in September/November 1983 (after rock backfill was completed).

Water quality parameters measured included suspended sediment load and water clarity. Changes in seafloor habitat were also monitored. Environmental monitoring and analysis of results was conducted by T.D. Meagher & Associates, Industrial Ecologists and reported in T.D Meagher & Associates (1984). A summary of the methodology and major findings are provided below.

Sampling methods included:

- A detailed photographic record of seafloor habitat along the trunkline route within Mermaid Sound.
- Placement of sediment traps along the trunkline route to record variations in suspended sediment load carried in the water column.
- Recording variations in water clarity by taking measurements of light attenuation and percentage light transmission along pipeline transects and other various points.

Major findings included:

- No statistically significant difference could be found in the rate of sediment re-suspension between the three periods in which the monitoring was conducted. The average rates of sediment re-suspension calculated for each survey period were respectively 116gm/m^2/day, 98gm/m^2/day and 106gm/m^2/day.
- Natural short term variation greatly outweighed variation induced by pipeline installation.
- The mean grain size of sediment collected in the sediment trap array showed no significant trend during the study period.
- Water transparency in Mermaid Sound varies predominantly in response to factors such as re-suspension of sediment and plankton density. The combined averages of accumulated measurements of photosynthetically active radiation (PAR) for each of the sample periods were 64% PAR transmitted in 1981 and 1982 and 75% in 1983. These results indicate that Mermaid Sound was more turbid prior to pipelaying activities.
- The average results obtained during the turbidity measurement programme indicated that light transmission was 67% transmittance per metre in 1981 and 1982 compared to 78% in 1983. These results compliment those for PAR.
- The photographic record indicated that in some areas there was discernible evidence of deposition of material from either dredge spoil disposal or pipeline installation. These effects were restricted to within approximately 500 m of the trunkline; and in all

cases there was evidence of rapid and adequate re-colonisation and rehabilitation by the final survey in 1983.

- Dragging anchor chains attached to the pipelay barge damaged some areas of hard coral. However, it was anticipated that these hard coral areas would recover within a few years.

The results of the monitoring programme indicated that there were no significant short-term impacts on the marine environment of Mermaid Sound (both water quality and benthic ecology) as a result of pipeline construction and that there were no permanent changes in water clarity of the Sound from 1981-1983.

It is expected that environmental impacts from the construction of the 2nd trunkline will be of a similar magnitude.

4.2.3 Pipeline Construction - Indirect Effects

Indirect effects from trenching operations - increased sedimentation and reduced light penetration can result in a range of detrimental impacts on corals. The mechanisms by which these effects can be realised include smothering by silt, abrasion, reduced light penetration and the prevention of settlement of coral planulae on silt covered surfaces.

Potential effects include reduced growth and reproduction rates, coral bleaching, partial or complete coral colony mortality and the prevention of coral larvae settlement.

The areas at most risk from the indirect effects from trenching would be coral assemblages in the vicinity of Conzinc Island and Hammersley Shoal (for location see Figure 4) . Whilst it is intended to maximise the offset from these areas, the 2nd trunkline may, by necessity, approach to within 500m of these areas and trenching will be required because of surface and near surface rock outcropping.

The trenching process is relatively slow and an extended period of reduced water quality will occur. Resulting sediment plumes (up to 1.5km long) can be expected to be affected by tidal currents in a predominantly north south direction, however, prevailing summer westerly winds may on occasion move the plume towards Conzinc Island and Hammersley Shoal.

Given the buffer maintained between the 2nd trunkline and these areas (500m) and the findings from the previous monitoring programme into the effects of trunkline installation (Meagher & Associates, 1984), no significant impacts are expected for the coral assemblages at Conzinc Island and Hammersley Shoal. Based on sediment trap data collected as part of the 1994 LPG Jetty and Ship Turning Basin Dredging Marine Monitoring Programme (LDM, 1995), elevated sediment loads in the water can be expected to return to background levels within two weeks or less following the completion of trenching operations.

Corals fringing Angel and Gidley Islands (Refer Figure 4) are not expected to be at risk from sedimentation and reduced water quality given the short duration of the pipelay and ploughing operations and the absence of dredging operations in their vicinity (refer Figure 6b).

Coral cover on the igneous boulder shores and adjacent limestone apron in the vicinity of the shore crossing near the OTP boundary is relatively low (15-25%) and predominated by sediment tolerant species from the *Favites*, *Favia*, *Porites* and *Turbinaria* genera. Extensive monitoring of these assemblages before and after dredging for the LPG Jetty and Ship Turning Basin Dredging Project in 1994 (LDM, 1995) and subsequent annual

monitoring (Woodside Offshore Petroleum, 1995; 1996) has demonstrated the capacity of these inshore corals to sustain high sediment loads.

Findings from the 1994 LPG Dredging Marine Monitoring Programme (LDM, 1995) were that coral mortality due to dredging plumes was minor and spatially limited to locations less than 1.5 km from the ship turning basin where extended and intense dredging was undertaken. Minor increases in coral colony partial mortality were insufficient to produce a decline in hard coral cover that could be detected visually by divers or quantitatively from the video records.

Limited coral impact is expected in the vicinity of the shore crossing at the OTP from the indirect effects associated with sedimentation and reduced water quality.

4.2.4 Spoil Disposal

It is intended to use the existing Mermaid Sound Spoil Ground A/B to dispose of dredge spoil in excess of that required for trench back fill. The spoil ground, located to the west of Conzinc Island was established in 1986 to accommodate Woodside's LNG shipping Channel Dredging Programme. The spoil ground has been used on two subsequent occasions, in 1989 for maintenance dredging and in 1994 for the construction of an LPG ship berthing pocket. In total approximately 9.5 million m^3 of spoil has been disposed of at the spoil ground.

Monitoring has been undertaken on and in the vicinity of the spoil ground on two occasions to determine (1) whether fauna re-colonisation occurs following deposition and (2) whether coral assemblages closest to the spoil ground are affected as a consequence of disposal operations and possible sediment re-suspension.

The most recent monitoring was undertaken to support the 1994 LPG Jetty and Ship Turning Basin Dredging Programme, in which some 700,000m^3 of dredge spoil was deposited in Spoil Ground A/B between 1 March and 16 May 1994.

Re-colonisation of Spoil Ground A/B was assessed in 1993 by examining the seafloor sediments and the benthic fauna which had recolonised the ground since its last major use in 1986/87; and by comparing the abundance and character of those assemblages with those sampled from nearby control sites. Findings from the study, reported by LeProvost Dames & Moore (1995), were:

- The range of surface substrate characteristics and the distribution and abundance of epibenthic organisms was not markedly different from the situation in comparable but unaffected control sites.

- The range of abundance, taxonomic richness and composition of benthic infauna collected from the spoil ground was very similar to that of the undisturbed control sites.

Coral communities at Conzinc, Angel and High Point Islands were also examined between 1993 and 1994 to determine whether any decline in living hard coral cover could be determined and attributed to the LPG spoil disposal operations. Findings from that study (LDM, 1995) were that there were no detectable coral mortalities either during, soon after or seven months after the spoil disposal operations.

The findings from the 1994 LPG Dredging Marine Monitoring Programme enable confident predictions to be made that re-colonisation of the spoil ground by biota comparable to that from neighbouring areas in Mermaid Sound will occur following spoil

deposition; and that sensitive coral communities fringing nearby islands will not be impacted by spoil disposal operations.

4.2.5 Marine Blasting

Blasting will be required in inshore areas of Mermaid Sound where water depth is less than 20m depth and where surface or shallow rock is encountered with material strength greater than 20-30 Mpa. Geotechnical investigations indicate that such areas exist in the first few hundred metres from the OTP land fall. Other areas may be encountered during trenching operations which will require blasting. Detailed blasting methods are not yet defined but are likely to involve the use of a drill and blast spread, with charges confined within pre-drilled holes. Blasting will most likely involve the detonation of 4 holes with delays between each hole. Approximately 17kg of explosive would be contained within each hole. Surface shape charges may be required at the entrance to Mermaid Sound, where deep water >20m (LAT), prevents the use of a drill and blast spread.

The extent of mortality and injury from blasting depends on the size and depth of charge, composition of explosive used, water depth, bottom composition, distance and depth of individual from explosion centre and size and type of species concerned.

The main cause of damage to fish as a result of the explosives detonated for marine blasting operations (WBM Oceanics, 1993) relates to the high peak pressure, rapid rise times and rapid decay to below ambient hydrostatic pressure.

Injuries sustained to fish from marine blasting operations include haemorrhaging, gross damage to the kidney, rupture to the swim bladder and/or body cavity. Fish mortality is predominantly caused by rupture of the swim bladder.

Larval fish are less sensitive to the effects of shock waves than eggs or postlarval fish in which a swim bladder has developed (Wright, 1982). Spiral curling of the embryo and disruption/deformation of egg membranes has also been observed for fish species as a result of small (50gm) charges of TNT (from Kotyucheko, 1973 (in) WBM Oceanics, 1993).

The principal effects of explosives for marine mammals concern damage to the lungs. In some instances, whilst charges may not be sufficient to cause death, there may be sublethal damage to auditory systems (e.g. ruptured ear drums).

No specific information is available on the risk to marine reptiles from marine blasting. They can be expected, however, to have similar physiological risk as mammals.

The birds most at risk from marine blasting would be diving species. To minimise injury to seabird species, it is important that any dead fish on the surface of the water after a blast are collected; otherwise this may attract seabirds and result in bird injuries or mortality from successive blasts.

In the immediate vicinity of blasting operations there will be fatalities or severe injuries to bottom fauna. In addition there will be disturbance to the bottom, such as the deposition of displaced material and smothering of resident bottom fauna. Blasting would also entail a short-term relatively localised increase in turbidity.

It is intended to use packaged explosives in the trench blasting operations. Packaged explosives are all similar in composition, comprising a fuel (usually a heavy hydrocarbon based oil such as paraffin or wax) in a plastic sheath. Aluminium oxide may be added as an extra fuel in some brands. Nitrate salt is also added as a source of concentrated oxygen to produce the combustion process. The explosion is initiated with a detonator.

Detonation processes are generally complete however sometimes a small portion of the explosive (generally a wax) may remain following detonation (WBM Oceanics, 1993).

Products of packaged explosive are almost exclusively gaseous and mostly include nitrogen, carbon dioxide and water vapour. Some carbon monoxide and nitrous oxide are also produced, however, these are usually at trace levels (i.e. hundreds of parts per million). The only metals involved in the blasting process are aluminium oxide and lead azide which forms part of the detonator (100-200mg lead azide per detonator).

It is unlikely that blasting processes using packaged explosives would be of concern in relation to the production of toxic chemicals or substances, taking into account the following:

- The components of the explosives (heavy hydrocarbon oils and nitrate salts) are non toxic to aquatic fauna in the concentrations likely to remain following their detonation.
- Detonation is usually complete.
- The products of the explosive process are gaseous, mainly carbon dioxide, nitrogen and water, all of which are unlikely to occur in toxic concentrations.
- No heavy metals, other than aluminium oxide and small amounts of lead azide are involved in the blasting technique.
- The explosive process would include considerable dilution and dispersion of detonation by-products.

Lethal Ranges

Estimates of lethal ranges and safe distances for fish and other marine animals can be determined using a technique determined by the Canadian Department of Fisheries (CDF); or by a method developed by ICI Australia. Calculation methods for both processes are described in Section 4.0 of Appendix 7.

Unlike the ICI method the CDF technique takes into account animal weight and target depth and may be considered to be more accurate. There are, however, many other variables including, size, species physiology, orientation of the animal to the shock wave and bottom type, which make either method at best only a general indicator of safe and lethal ranges.

Table 4-2 below shows effect ranges calculated using the CDF technique for 10kg fish from a generalised marine blasting operation in Mermaid Sound. Basic assumptions for the calculations are that the fish are demersal, water depth is 10m, and the blast weight is 78kg. The estimated mortality ranges would appear to be conservative given the findings from a study conducted by McAnuff and Booren (1989) on caged fish, which estimated probable 100% and 10-20% fatality radius, using charge weights of up to 270kg, as 20-50m and 45-110m respectively.

Table 4-2: Estimated Blast Effect Zones for 10kg Marine Fish (demersal fish from a 78kg Confined Charge Marine Explosion in 10m water Depth.)

Fish Body Weight	10kg
No Injuries	860m
1 % Mortality	301m
50 % Mortality	215m

Table 4-3 provides estimates of effect ranges calculated using the CDF technique for marine mammals diving beneath the surface from a generalised marine blasting operation in Mermaid Sound. Basic assumptions for the calculations are that the mammals are near bottom, water depth is 10m, and the blast weight is 78kg.

Table 4-3: Estimates of Blast Effect Zones Calculated for Marine Mammals (78kg Confined Charge Marine Explosion in 10m Water Depth.)

Distance	Effects
387m	No mortality. High incidence of moderately severe blast injuries, including eardrum rupture. Animals should recover on their own.
645m	High incidence of slight blast injuries, including eardrum rupture. Animals should recover on their own.
1075m	Low incidence of trivial blast injuries. No eardrum ruptures.
1720m	Safe level. No injuries.

Estimates of lethal ranges and physiological damage for marine mammals have also been derived from the ICI method (Table 4.-3 and 4.1, Appendix 7). This technique indicates lethality would be restricted to 50m for (100kg) charges confined in a blast hole. For unconfined charges the lethality distance would be approximately doubled.

4.2.6 Hydrotest Discharges

A hydrostatic pressure test of the completed trunkline is required by Australian and International Standards and Codes. Seawater with agreed chemical treatments will be introduced into the trunkline and pressure tested to confirm pipeline integrity. Chemical treatments are likely to comprise a corrosion inhibitor (oxygen scavenger), biocide and a dye and are designed to protect the trunkline from corrosion and bacterial formations whilst it is full of seawater. Following the pressure test, the treated water (approximately 130,000m^3) would be released into the ocean.

Two release scenarios are possible;

- the hydrotest water will be released at one or both platforms, or
- if an interim pressure test of the Mermaid Sound portion of the trunkline is required , the hydrotest water will be released at the entrance to Mermaid Sound.

The discharge will be designed such that near field turbulent mixing of the test water at the point of discharge will rapidly reduce chemical concentrations to below effect levels and no significant environmental impact is expected. Alternatives may include spraying the discharge into the sea from NRA or GWA or discharge to the mid water column at about 60m depth.

4.2.7 Waste Discharges from Pipelay Vessel

The pipelay vessel will accommodate a work force of up to 350. Discharges of treated sewage, grey water and macerated food scraps will result in minor and localised increases in turbidity, nutrients and biological oxygen demand (BOD). Rapid dilution of the discharges will ensure that no adverse environmental effects result. Oily wastes generated aboard the vessel will either be stored in slops tanks prior to discharge, or bought ashore for recycling. All other wastes will be brought ashore for recycling or appropriate disposal.

4.2.8 King Bay Wharf Extension

Provision of a new rock loadout wharf by sheeting and rock back fill will alienate a small area of soft seabed sediments. Maintenance dredging of a berthing pocket to accommodate rock dump vessels will disturb an additional small area of soft sediment habitat. The potential for indirect effects of the dredging operation is unlikely to be significant as sediment loads and turbidity are sustained at high levels within the supply base due to the high frequency of vessel movements and the fine nature of the existing sediments. Sediment loads and turbidity in King Bay itself are also high due to the natural re-suspension of fine sediments from tidal movement and wave action.

4.3 Terrestrial Effects

4.3.1 Trunkline Shore Crossing

The proposed 2nd trunkline crosses directly onto the OTP lease boundary, avoiding disturbance to areas of natural vegetation and landscape. The area will be recontoured following trunkline installation.

4.3.2 Onshore Process Facilities

All proposed new facilities associated with the Domgas debottlenecking and TOT will be accommodated within the existing plant boundary, where landforms and vegetation have previously been extensively disturbed.

4.3.3 Pipe Weight Coating Area

Approximately 50-65 ha of land on the Burrup Peninsula may be required to accommodate pipe weight coating and storage. The favoured area is on land previously used for the Hearson's Village Construction Camp. This area was rehabilitated in 1991 and supports a wide variety of plants, including numerous *Acacia* species and Eucalypts. The area is dominated, however, by the introduced buffel grass *Cenchrus ciliaris*. Buffel grass is widespread on the Burrup Peninsula, throughout the Pilbara and wider arid Australia. Originally introduced as a pastoral fodder crop and landform stabiliser, its ability to colonise disturbed land and the current lack of long term effective control techniques makes it preferable to reuse disturbed land wherever possible. A detailed description of the vegetation units currently supported at this site is provided in Appendix 5.

The area used for pipe weight coating and storage for the construction of the original trunkline was also under consideration. This area offers similar advantages in that it has been previously disturbed, however, due to the longer line length for the second trunkline, it does not provide sufficient land in itself and would need to be supplemented with some additional areas of adjacent undisturbed land. This site is therefore considered as a second choice for a weight coating site.

Land disturbance will include clearing of existing vegetation and topsoil which will be stockpiled for subsequent replacement. Windrows will be created using either *in situ* material, or imported fill, to provide support for coated pipes. This material will be either removed or re-spread prior to deep ripping and the replacement of topsoil and vegetation. As the proposed pipe coating and laydown area is relatively flat, no significant erosional impacts are anticipated. Consideration will be given to trialing a variety of rehabilitation techniques at the pipe weight coating area to assess whether there are options which discourage weed invasion.

No rare or endangered flora occur within either the Hearson Village or the old pipe weight coating areas. Fauna monitoring at the rehabilitated Hearson's Village site, five years after rehabilitation (Woodside, 1995) has demonstrated that successful fauna re-colonisation occurred within a relatively short space of time. Fauna species richness and abundance at Hearson's Village is comparable, if not greater, to that from nearby undisturbed locations supporting similar habitats (Refer Table 4-4, below)

Table 4-4: 1995 Fauna Monitoring Results - Hearson's Village Rehabilitation Area (HVR) [and Nearby Controls - Hearson's Village Turn-Off (HVT) and North East Creek (NEC)].

Trapping results 1995	Hearson's Village Rehab. Site	Control (HVT)	Control (NEC)
Total reptile individuals	36	19	19
Total reptile species	8	8	6
Total mammal individuals	32	7	7
Total mammal species	2	2	2
Additional species sightings			
Mammals	1	1	2
Birds	9	8	13
Total species	**20**	**19**	**23**

4.3.4 Rock Storage & Loadout

Option - KBSB

The area proposed for rock storage adjacent to the King Bay Supply Base has been previously used for this purpose, as well as for rock extraction and remains as a Woodside lease. An additional area of land (approximately 5.4ha) may be required to the south of this lease. This will necessitate vegetation removal and landform modifications. A description of the vegetation units at this site is provided in Section 3.4.2. No rare or endangered flora is present in this area, which is within the zone identified for industrial development by the Burrup Land Use Plan & Management Strategy. Two species of priority flora (*Brachychiton acuminatus* and *Terminalia supranitifolia*) are, however, known to occur within this area and a number of individuals may be destroyed. Disturbance to this additional land area is not considered to impact significantly on the ecological values of the Burrup Peninsula. The area will be left in a condition suitable to accommodate any subsequent industrial development options which may arise.

Option – Vicinity of Holden Point

In the short term the development of the sandplain behind Holden point will result in the removal of most of the existing vegetation from this area. In addition, small amounts of

vegetation will be removed where the jetty abutments and haul roads penetrate the rocky seaward ridge.

As previously indicated, the overlying topsoil and sand layer will be stockpiled separately and reinstated, if required by government after this temporary use.

The vegetation associations of the area are typical of similar environments along the Burrup Peninsula and are well represented elsewhere. Although priority flora or fauna have been recorded in the location, the species concerned are widespread in the region and occur at low density. It is possible a number of individuals of priority species may have to be removed during this development.

Further invasion by introduced weed species may occur in areas of disturbance. The area has already been colonised by the introduced Kapok weed (*Aerva javanica)*, and the potential exists for further introductions of buffel grass (*Cenchrus ciliaris)* and ruby dock (*Rumex spp)* from surrounding infected areas. Weed control measures, such as vehicle washdown facilities will be addressed in the quarrying EMP.

Coral cover on the igneous boulder shores in the vicinity of Holden Point is relatively low (15-25%) and predominated by sediment tolerant species from the *Favites*, *Favia*, *Porites* and *Turbinaria* genera. The marine communities of Holden Point have been by the mobilisation of dredge spoil and natural sediment from the No-Name Bay area. This coast is also exposed to high seasonal suspended particulate loads and as a result these communities are not very diverse, being comprised of organisms with a high tolerance to turbidity. The influence of a trestle jetty and rock loadout operations on these communities is expected to be minor.

The long term environmental impact on the ecological values of the Burrup Peninsula by development of rock stockpile and loadout facilities on Holden Point is not expected to be significant.

4.3.5 Rock Quarrying & Transport

Two potential quarry sites have been identified to the south of the OTP within the area designated for industrial development by the Burrup Land Use Plan & Management Strategy.

The areas comprise rocky hills with rock piles and outcrops, stony plateaus and both shallow and deep drainage gullies. The vegetation units supported by the topographic features are summarised in Section 3.4.2 and detailed in Appendix 5. The vegetation units present are widespread on the Burrup Peninsula and are well represented in the conservation zones. The loss of these units due to quarrying is not expected to impact significantly on the ecological values of the Burrup Peninsula. No rare or endangered flora are present in the proposed quarry locations, however two species of priority flora (*Brachychiton acuminatus* and *Terminalia supranitifolia*) occur on the rock piles and a number of individual plants will be destroyed by quarrying activities.

Landform and drainage will be permanently altered by quarrying activities. These changes are not expected to result in any impact beyond the immediate area of disturbance, however they will be addressed in the quarrying EMP.

The area will be left in a condition that does not compromise future industrial development.

4.3.6 Haul Road

The exact location for the extension of the haul road has not yet been determined, however, it is unlikely to be more than 1km in length. It will intersect undisturbed rock piles, gullies and high plateaus, supporting flora species similar to that at the quarry location. No rare or endangered flora will be destroyed by the road construction, however, some priority flora (*Brachychiton acuminatus* and *Terminalia supranitifolia*) may be destroyed.

Woodside is discussing with the WA Government whether some or all of the haul road extension could be used to facilitate possible future project developments. Some of the road might be retained and those parts of the road not retained for future use would be rehabilitated by Woodside. A final decision is to be made in the near future.

The potential for erosion will be controlled by appropriate road cambers and drain placement and design. The impact of the haul road extension on the ecological values of the Burrup Peninsula is not considered to be significant.

4.3.7 Fill and Gravel Sources

Fill and gravel required for road surfacing and ground preparation will be sourced from either locally operating quarries or from the proposed Project quarry.

4.3.8 Dust

Rock quarrying, crushing and grading, hauling, stockpiling and loadout will generate dust which has the potential to impact native vegetation and disrupt adjoining land users.

Observation of road side vegetation on the Burrup Peninsula, and elsewhere in the Pilbara, would suggest that native vegetation is tolerant of moderate dust loadings. Given this and the relatively short duration of quarrying, loadout and associated activities, no significant impacts on native vegetation are anticipated from dust.

Dust nuisance to the workforce and adjoining land users (King Bay) will be assessed during operations and control measures instigated if necessary. This would generally involve road dampening using water trucks &/or stockpile mist spraying.

4.3.9 Vessel Quarantine

A number of specialised vessels will be mobilised to site to undertake trenching and pipelaying operations. Such vessels provide some risk of introducing exotic organisms. Dredges in particular may contain residual sediment sustaining exotic marine species and propagules which, if they were to become established, could adversely impact the marine ecosystem of the Dampier Archipelago.

4.3.10 Pickle Liquors

Small diameter piping installed as part of the onshore plant modifications will need to be "pickled" prior to commissioning. The fluid most likely to be used is ammoniated citric acid. To avoid possible environmental impact, pickle liquor will be recovered for reuse or appropriate disposal.

4.3.11 Potentially Contaminated Drainage

Spills of lubricants, oils and condensate could occur from the proposed infrastructure to be installed on the OTP. These spills, if unconfined, could contaminate soils, ground water and pass through to the marine environment.

Areas where there is potential for such spillage will be bunded with drainage directed to the plant oily contaminated water system for treatment and hydrocarbon removal (to 30 mg/L or better) prior to discharge into Mermaid Sound toward the end of the LNG loading jetty.

4.4 Atmospheric Emissions

4.4.1 Greenhouse Gases

Emissions from proposed facilities

The major emissions of greenhouse gases from the existing OTP are Carbon dioxide (CO_2), Nitrous oxide (N_2O) and Methane (CH_4). CO_2 and NO_x are emitted as combustion products from the various heaters and turbines used to power the processing facilities. Methane is emitted from process or inadvertent venting of natural gas.

The impact of these gases on global warming can be illustrated by the use of Global Warming Potential (GWP) indices (Refer Table 4-5 below):

Table 4-5: Global Warming Potentials of Selected Greenhouse Gases

Gas	GWP
Carbon dioxide	1.0
Methane	24.5
Nitrous oxide	290.0

The mass of the particular gaseous emission can be multiplied by the GWP to express the emission as "CO_2 equivalents" (CO_{2e}).

The existing OTP emits approximately 5.5 million tonnes of CO_{2e} per annum, approximately the size of a medium sized (500 MW) power station.

Extra fuel burning facilities proposed for the Domgas Debottlenecking Project are limited to 3 gas turbine/generator sets of nominal 25 MW capacity. These sets are required to service the additional compression loads imposed by Domgas and Fractionation.

Although three machines may be installed, the sparing philosophy means that actual use will be equivalent to 2 full time units running at approximately 80% capacity. Emissions from this operating regime will increase CO_{2e} emissions from the OTP by approximately 4.5-5%.

Greenhouse Gas emissions during construction are expected to be minimal in the context of the entire Project.

Indirect Emissions

While the second trunkline is being developed to enable additional domestic gas supply, which will cause a minimal increase in greenhouse gases, it has the potential to facilitate

other future projects (eg other Direct Reduced Iron (DRI) Plants, petrochemical facilities, Domgas or Liquified Natural Gas (LNG) developments).

The expansion of LNG on the North West Shelf is entering the feasibility stage and is dependent on suitable market opportunities being captured. Should a LNG expansion Project occur it will be subject to a separate environmental approvals process, which will consider greenhouse effects in a detailed manner. The lack of a suitable LNG plant technical definition at this time makes it impossible to forecast emissions accurately. Improved technology for LNG production has the potential to produce LNG with significantly lower emissions than the existing LNG Plant. It is anticipated however, that a doubling of LNG production capacity by the North West Shelf Venture will increase CO_{2e} emissions by 2-3 million tonnes per annum or approximately 50-60%.

Emission abatement

Waste Heat Recovery Units (WHRU) will be installed in the proposed new power generation units to increase the energy efficiency of power generation by utilising this heat, otherwise lost, to provide process heating (hot water) for fractionation.

Woodside (as operator of the NWS Venture) is a signatory to the Commonwealth Government's *Greenhouse Challenge* Program through a Greenhouse Co-operative Agreement between the *Australian Petroleum Production and Exploration Association* (APPEA). Woodside is currently working with the Greenhouse Challenge Office regarding the potential for a Co-operative Agreement for the NWSGV.

As part of the Co-operative Agreement process, an annual inventory is submitted to the Commonwealth and action plans for emission abatement are investigated and implemented on a "no regrets" basis. Measures currently being studied for feasibility by Woodside for application to this and other future projects such as LNG, are:

- Reduction of Methane venting from process and fugitive sources
- Energy efficiency programs and technology applications
- NOx reduction measures

Global Impacts

The increased utilisation of Natural Gas is a primary means for abatement of greenhouse emissions globally without excessive economic hardship. Studies by CSIRO have illustrated that on a lifecycle basis, mass emissions from LNG are approximately half those of competitor fossil fuels such as oil and coal. Greenhouse emissions from Domestic gas are expected to be even lower on a lifecycle basis as relatively little energy is used in processing.

Whilst the processing of gas on the North West Shelf does result in an increase in greenhouse emissions for Western Australia and Australia generally, increased domestic gas substitution for alternative fuels should produce a better emissions performance for the country overall. In addition, LNG provides a proven global benefit on a lifecycle basis over competitor fossil fuels.

4.4.2 Flaring

Flaring primarily occurs from depressuring via relief valves during operational upsets or in emergency situations. It is not expected that flaring at the OTP will increase significantly from the new facilities due to the installation of improved pressure control instrumentation and operational procedures.

4.4.3 Nitrogen Oxides (NOx)

NOx emissions occur wherever air/fuel combustion occurs at high temperature, ie gas turbine combustors. NOx, in combination with Volatile Organic Compounds (VOC) and ultra-violet light are known to produce photochemical smog and contribute to elevated tropospheric ozone concentrations. Elevated Ozone levels are not expected to be a major health issue due to the remote nature of the Burrup Peninsula location.

The existing OTP produces 6000-7000 tonnes per annum of NOx (as NO_2) and the incremental effect of the proposed new gas turbines is expected to be less than 5% on a mass basis. The small increase in NO_x emissions is not expected to significantly impact air quality over the Burrup Peninsula.

4.4.4 Fugitive Emissions

Inadvertent releases of hydrocarbons from leaking equipment (fugitive emissions) may occur. A 1995 study performed over the existing OTP facilities indicated the magnitude of fugitive emissions as < 50 tpa. These are expected to increase negligibly with the extra hardware to be installed for the Project, in light of recent improvements in fields such as seal technology.

5 RISK MANAGEMENT

5.1 Introduction

Risk analysis is being performed as part of the Domgas Debottlenecking and 2nd Trunkline Project. This work is being conducted to meet both a number of internal Project and external Government requirements.

5.2 Risk Studies

A number of risk analyses have been performed for Woodside on both the existing trunkline and the new facilities. Synopses of these studies which have been widely quoted in this section of the document are provided below:

- Risks of damage to the existing trunkline have been previously quantified in a report titled *Study and Development of a Contingency Pipeline Repair System Phase II - Risk Management Study Report (*R.J Brown-CMPS Offshore Engineers, 1994). This report contained incident probability analyses of credible accident event scenarios which could result in damage to the trunkline, necessitating repairs.
- The incident probabilities discussed in the above report have recently been updated by Kvaerner R J Brown Pty Ltd (1997); and are provided below in Table 5-1 for the various sections of the existing trunkline.
- A report, *Second Trunkline Project - External Impact QRA* has been prepared by DNV Technica and develops risks to the trunkline from incidents such as ship grounding, anchors dragging and internal failure.
- A *Preliminary Risk Analysis of the Second Trunkline Onshore Terminal* has been developed by Stratex Worley Pty Ltd and develops a risk analysis for operation of the second TOT.
- Woodside's Risk Engineering Department has developed a *Preliminary Risk Assessment for the Liquids Expansion Project.* This report can be used to demonstrate the risk generated by process equipment, such as fractionation.

An analysis of the consequences generated by various condensate/diesel spill scenarios has been evaluated from the above documents and included below.

Methodology

All Quantitative Risk Assessments (QRA) and Preliminary Risk Assessments (PRA) performed have used accepted methodologies.

The risk assessment process consists of:

- Hazard Identification
- Frequency analysis
- Consequence analysis (of unwanted outcomes, such as loss of life)
- Calculation of risk (probability per annum)

The risks calculated are compared with the DEP criteria as expressed in DEP Bulletin 611. The criteria in this bulletin are consistent with other criteria used by industry, such as the *National Standard for the Control of Major Hazard Facilities (NOHSC:101, 1966)* and

the *National Code of Practice (NOHSC:2016, 1996).* Risk criteria expressed in DEP Bulletin 611 require that:

"risk levels at the site boundary of industrial facilities should not exceed $50x10^{-6}$per annum and; cumulative risk level imposed on an industry should not exceed a target of more than $100x10^{-6}$ per annum".

The above criteria apply to residential areas outside the Plant boundary. It should be noted that the nearest residential area (Dampier) is approximately 15 km from the Plant Boundary.

5.3 Risk From the Second Trunkline

The ecological risk due to the second trunkline primarily arises from a loss or partial loss of trunkline contents (gas or liquid under pressure) to the marine environment by various means.

Two broad classes of incident can be recognised in the trunkline lifecycle. Firstly, hydrocarbon releases associated with the trunkline installation and, secondly, the scenarios associated with trunkline ruptures during operation or startup.

5.3.1 Risks of Condensate/Hydrocarbon Releases from the Second Trunkline.

Hazard Identification

Potential hydrocarbon spills during the **installation of the trunkline** could occur from:

- Refuelling transfer incidents
- Hydraulic line failures
- Tuptures or leaks of oil drums
- Leaks from header/day tanks or lines
- Cyclone/weather damage

The following hazards were considered for **trunkline operation** in the various studies:

- Vessel sinking
- Vessel grounding (under power and drifting)
- Anchor drag
- Direct anchor impact
- Anchor abrasion
- Corrosion
- Dropped objects (Close to offshore installations)

Excluded were very low probability scenarios including third party interference, fire/explosion, aircraft accidents, marine salvage, dredging, trawling activities and third party exploration drilling.

Storm damage to the trunkline

Storm damage to the trunkline can arise when movement occurs beyond the design envelope. For the purposes of this analysis the probability of storm damage can be considered in three discrete sections of the trunkline:

- KP0 – approx KP22
  In this region water depth limits the wave height and therefore the potential for trunkline movement. In is considered that an entrenched trunkline would not be damaged by any conceivable storm generated waves in Mermaid Sound.

- Approx KP22 – KP50
  It is considered for this section of trunkline that a very low frequency return storm (eg a 1000 yr storm) might propagate waves capable of moving a trunkline stabilised to a lesser frequency return storm.
  Woodside will reduce the risk of trunkline rupture from these low frequency events by designing trunkline stabilisation to As Low As Reasonably Practicable (ALARP) priniciples.

- Approx KP50 – end of line
  In this section, the water depths are such that even a low frequency return storm is not expected to affect the trunkline. The consequences of a rupture causing condensate loss during such a storm are minor due to the weather induced dispersion and remoteness from the Pilbara coastline.

Corrosion

The data used for determining probability for trunkline corrosion rates is based on PARLOC 92 North Sea data, which includes both oil and wet and dry gas pipelines. Both the existing and proposed 2nd trunkline will normally operate in a dry mode (ie the trunkline contents are dried offshore by glycol to very low water contents) reducing substantially the likelihood of corrosion. The event probability for corrosion can therefore be regarded as conservative. It should be noted that there have been no corrosion-induced incidences of loss of containment in gas pipelines over 2km in length in the North Sea (R.J.Brown-CMPS, 1994).

Frequency Analysis of Trunkline releases

For the existing trunkline the following table (Table 5-1) presents frequency of incidents calculated as causing damage (not necessarily loss of containment) to the trunkline.

Table 5-1: Probable Frequency of Incidents – North Rankin A Trunkline (events per annum)

Probable Causes of Repair Incidents	Armour Rock (22.8km)	Stabilisation Rock (40.6km)	Unburied (71.7km)
Corrosion	$1.35\ E^{-5}$	$2.40\ E^{-5}$	$4.23E^{-5}$
Vessel Sinking	N/A	$1.75\ E^{-6}$	$3.09E^{-6}$
Anchor Impact	N/A	$2.48\ E^{-5}$	$4.37E^{-5}$
Anchor Drag	N/A	$2.43\ E^{-4}$	$4.28E^{-4}$
Dropped Objects	N/A	N/A	$4.60E^{-5}$

Note that the Mermaid Sound sections of the existing trunkline from KP0 to KP23 are rock armoured for protection, effectively reducing the risk from accident event scenarios with the exception of corrosion to negligible levels.

The frequency of **damage causing loss of containment** has been calculated for various diameter classes of pipelines and is presented below as Table 5-2.

Table 5-2: Loss of Containment Frequency (Anchoring and Impact Incidents along Pipeline Mid-line)

Type of Pipeline	Diameter	Experience (Pipeline km Years)	Number of Incidents	Failure Frequency ($x10^4$ km years)		
				Lower bound	Best Estimate	Upper Bound
Steel Lines	2-8"	13669.1	3	0.6	2.19	5.67
	>10"	110084	1	0.005	0.091	0.431
	10-16"	15243.4	0	-	0.454	1.95
	18-24"	21289.4	1	0.24	0.47	2.23
	26-36"	73371	0	-	0.095	0.409
Flexibles	All	808.9	1	0.618	12.4	58.6

It should be noted that there has never been a similar size gas trunkline "loss of containment" incident and therefore the frequencies for this type of incident are extrapolated from available data.

The above historical data has been combined with regional and trunkline specific data to predict the frequency of external events on the second trunkline. Data sources consulted in this study were:

- Mermaid Sound Port and Marine Services (Woodside vessel movements)
- Dampier Port Authority (other marine movements, historical incidents, port controls etc)
- Pilbara Development Corporation (future regional development)
- BRK (regional meteorological/oceanographic data)
- DNV (Prince William Sound Risk Assessment data)
- Previous NRA trunkline QRA work (see section 5.2)

The calculated frequency differs with location along the trunkline and provided below in Table 5-3.

Table 5-3: Trunkline Location vs Expected Spill Frequency

TRUNKLINE LOCATION (Km)	SPILL FREQUENCY (per km per annum)
KP 0-6	$7x10^{-8}$
KP 11-12	$2x10^{-7}$
KP 25-30	$3x10^{-6}$

Summaries of event frequencies and QRA results from the DNV Technica Study can be found in Appendix 10.

5.3.2 Modelling of Condensate & Diesel Spills from the Second Trunkline

To determine the consequences and therefore, the ecological risk of a condensate or diesel spill it is necessary to model its behaviour in a number of possible release cases. This was done in the following manner:

- Selection of trunkline release point
- Selection of rupture size, detection time and release quantities
- Meteorological & oceanographic parameters
- Characterisation of hydrocarbon type
- Input to model
- Interpretation of model results

The following assumptions were used in setting the model parameters:

Trunkline release points

Kilometre 0-8 (KP0-KP8)
This section of trunkline is adjacent to the Onshore Treatment Plant. It has a calculated expected spill frequency of $7x10^{-8}$ per km per year which is regarded as very low. It is assumed however, that most spillage from this location would result in some condensate or diesel beached on the western Burrup Peninsula with a high level of consequence to affected environmental receptors.

Kilometre 10 (KP10)
The 10 kilometre point (KP10) of the trunkline is located slightly west of Angel Island. It is inside the rock armoured section of the existing trunkline and the frequency of damage at this location causing spillage is estimated at $2x10^{-7}$ per km per year which is regarded as very low (refer Table 5-3). However, should a spill occur it may result in a high consequence level due to the proximity of the islands of the eastern Dampier Archipelago, especially during summer wind patterns.

Kilometre 30 (KP30)
From modelling done for the Wanaea-Cossack development and the Wandoo Proposal CER (Ampolex, 1995), it has been estimated that spills of condensate from KP40 to KP135 will have <1% chance of contacting the Dampier Archipelago and are therefore not considered further in this document.

The highest risk point of the trunkline was determined as approximately 30 kms (KP30) from the OTP. At this point the trunkline is more vulnerable to possible anchor damage from heavy shipping using the outer anchorage adjacent to Rosemary Island.

The increase in risk at KP25-30 is illustrated in Table 5-3. Hydrocarbon releases from KP30 have the potential to make a relatively quick landfall (distance to nearest land is 10

km). The frequency of trunkline damage causing spillage from KP30 is estimated at $3x10^{-6}$ and is therefore considered a low frequency point.

Hole size, Detection Time and Release Quantity

The three trunkline hole sizes considered were:

- 5mm (small hole – risk as for corrosion pitting)
- 50mm (medium hole)
- 1000mm (full bore rupture)

Because of the very low risk of damage the 1000mm rupture is not considered credible for the region KP0 to KP25, however risk from this event to Dampier Archipelago environmental receptors is presented to allow risk comparisons. In the analysis of risks to various environmental receptors (Tables 5-13 to 5-20), the risk for impact causing rupture at various trunkline sections (Table 5-3) is assumed to be distributed in the following manner:

- KP10: Medium hole 0.95; full bore 0.05
- KP30: Medium hole 0.95; full bore (7000t) 0.025 full bore(14000t) 0.025

A summary of the release quantities is provided in Table 5-4.

Small/medium hole scenarios
In the first two hole size scenarios, the released quantity is heavily dependent on time to detection. For the 5mm hole it has been assumed such a hole could remain undetected instrumentally for up to 5 days and would probably be detected by daily helicopter overflights of the trunkline.
A 50mm hole would be detected by pressure drop in the worst case after 6 hours.

Full Bore Rupture
The full bore rupture scenario assumes a guillotine type break in the trunkline at KP30 only.

While the risk of a full bore rupture at KP30 is also very low ($3x10^{-6}$), the scenario is included for completeness. Such a rupture could only occur if a heavy vessel was to sink and settle over the trunkline. Anchor drag would not cause this type of rupture.

The quantity of condensate released from such a rupture is difficult to estimate. The methodology to model a release in such a large (40-42") pipeline over 135 km is not fully developed. Studies done by Norske Shell on the Norwegian Troll Pipeline (30" pipeline over 66 km) indicate that a large rupture would cause an extended initial blowdown period. For the proposed second trunkline this period is estimated to be up to 5 hours.

It is estimated that in the case of the full bore rupture, it could take up to 5 minutes before action was initiated to isolate the trunkline. Isolation of the trunkline would be achieved by activating emergency shutdown valves and would take approximately 30 seconds. It is not likely that the trunkline would be depressured at this stage from either onshore or offshore, although the facility exists to do so.

The amount of production entering the trunkline in the period before isolation is judged to be insignificant when compared with the static trunkline inventory.

The next phase of release would occur over a longer time period (days to weeks) and involves gradual water entry to the trunkline (assuming no preventative measures are taken) and a displacement of the remaining lighter condensate.

The liquid hold-up (inventory) of the second trunkline under "normal" operating conditions is expected to be 22000 m^3 (approx 14000 tonnes). The scenarios selected assume 50% (7000 t) and 100% (14000 tonnes) of this condensate might escape in the initial release.

For trunkline installation activities volumes from the above scenarios range from 205 litres for an un-contained drum leak to 1,000 litres (diesel) for a refuelling incident.

In the unlikely event of a support vessel, dredge or pipelay vessel grounding during cyclones or other severe weather, the possibility exists for rupture of fuel storage tanks. Volumes spilled from such incidents could be between 700-10,000 litres.

The scenario selected for modelling involved a 1000l diesel spill from a pipelay vessel at KP10 winter wind patterns, since dredging will occur primarily through this season.

Meteorological/oceanographic conditions

The meteorological/oceanographic conditions simulated by the model were the surface currents driven by winds typical for the region in Winter (June-July 1997) and Summer (December 1996-January 1997). Wind data utilised in the model was 3 hour data collected over the monitoring period by the Bureau of Meteorology's station on Legendre Island, approximately in the centre of the area of interest.

Sea Surface temperatures used were 22°C during winter and 28°C during summer. Bathymetric data used was from published hydrographic charts and unpublished data and has a 100m resolution within the model.

Tidal amplitude and phase data was extracted from gauging station data throughout the Northwest Shelf region.

An example of data generated by meteorological/oceanographic modelling is presented in Appendix 9.

Condensate spill modelling methodology

The spill model used was the Oiltrack/Oilmap model run by Global Environmental Modelling Services (GEMS). The model uses Oiltrack to simulate surface currents, driven by tidal and wind influences over a specified time period for the region (Dampier Archipelago, Burrup Peninsula and Nickol Bay).

The model then uses the Stochastic sampling function of the Oilmap model to simulate 100 distinct trajectories of condensate spills occurring randomly in time along the oceanographic (tide/wind) series thus determining the fate of the spilled condensate. To enable the fate to be described, condensate composition was input to the model and weathering rates of the light hydrocarbon fraction calculated. The resultant weathering curves were verified against existing laboratory data (See Figures 15-17).

The outputs from the model were estimates of:

- risks to different locations in terms of probability of contact with oil contours
- minimum time of travel to contact contours

- maximum quantities of stranded oil on contact points (600m^2 grids)

All modelling runs assumed no action was taken to divert or reduce the amount of condensate/diesel within the spillage, although diversionary or cleanup action would certainly be taken by Woodside as soon as possible after the spill.

Table 5-4: Hydrocarbon Release Scenarios Modelled for Second Trunkline

Scenario number	1	2	3	4	5	6	7	8	9	10	11	12	13
KP(km)	10	10	10	10	10	30	30	30	30	30	30	30	30
Hole size	5	5	50	50	N/A	5	5	50	50	1000	1000	1000	1000
Release rate (kg/s)	0.1	0.1	10	10	N/A	0.1	0.1	10	10				
Mass released (tonnes)	43	43	216	216	1000 litres	43	43	216	216	7000	7000	14000	14000
Season	Summ	Wint	Summ	Wint	Wint	Wint	Summ	Wint	Summ	Wint	Summ	Wint	Summ

A complete set of modelling results are attached to this Document as Appendix 11. The model results illustrate the probability contours for Scenarios 1,2,5,6,7, 10,11,12 and 13 and are included as Figures 18a-18i.

Spill Characteristics and Fate of Condensate/Diesel

Condensate

The composition of condensate is displayed in Table 5-5 (overleaf). The data shows that about 90% of the hydrocarbon material is lighter than C15. Low molecular weight hydrocarbons (<C15) are known to evaporate rapidly from the sea surface (Kagi et al., 1988).

Table 5-5: Composition of Condensate

Carbon No.	Weight %	Cumulative Weight %
C4	1.6	1.6
C5	10.7	12.3
C6	11.9	24.2
C7	17.0	41.2
C8	10.9	52.1
C9	6.5	58.6
C10	7.0	65.6
C11	5.2	70.8
C12	4.7	75.5
C13	4.5	80.0
C14	4.0	84.0
C15	3.3	87.3
C16	2.9	90.2
C17	2.1	92.3
C18	1.9	94.2
C19	1.7	95.7
C20+	4.1	100.0

Predicted evaporation rates of condensate at sea surface temperatures typical of Mermaid Sound and the North West Shelf (20°C, 26°C and 30°C) are displayed in Figures 15-17. A summary of volume loss vs time and closed cup flash point is provided in Table 5-6.

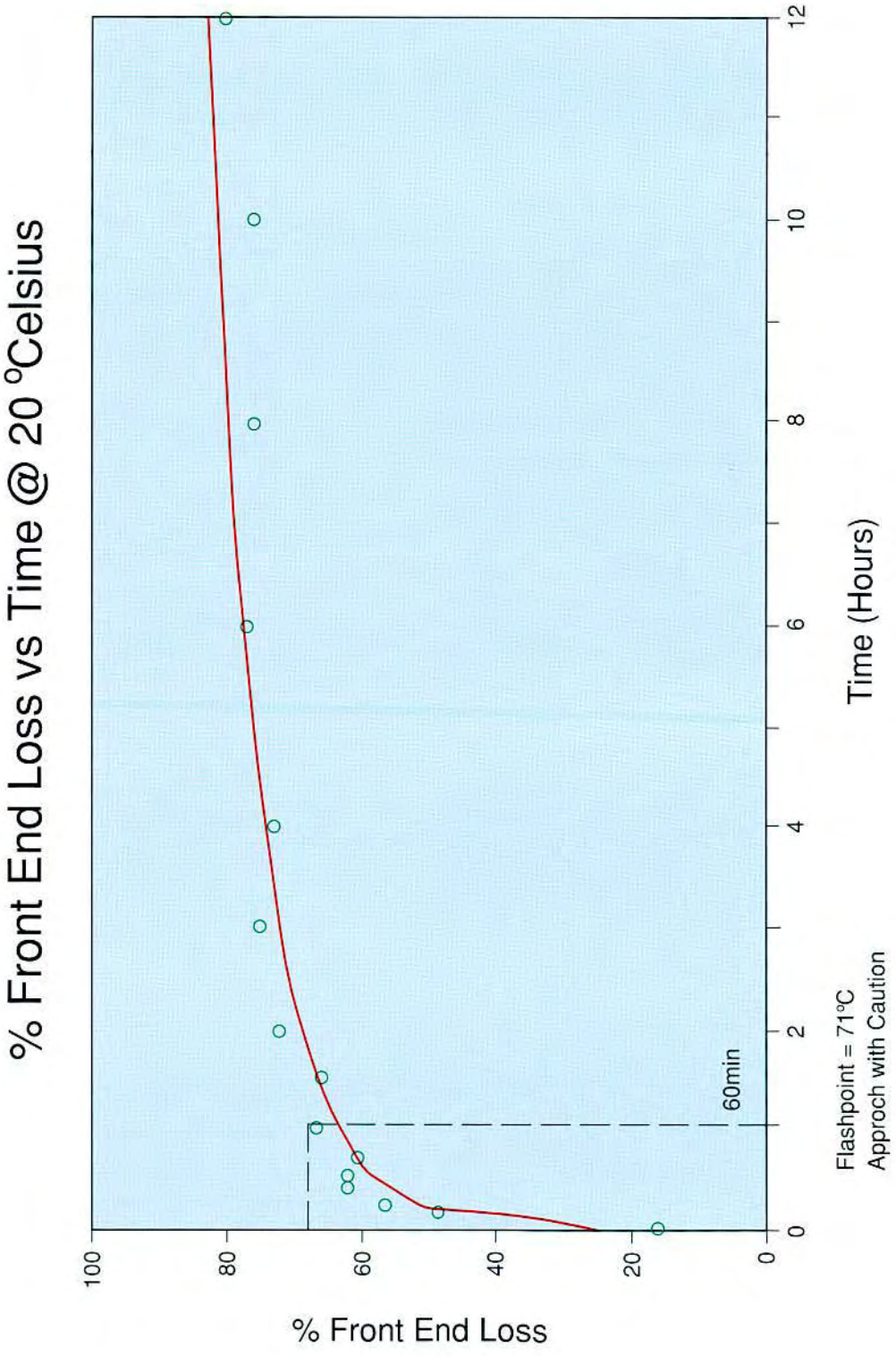
Table 5-6: Condensate Flash Points & Volume Loss

Approx. Time (minutes) at each tested temperature (°C)			Approx. % Volume Loss	Closed Cup Flash Point
20°C	26°C	32°C		
<5	<5	<5	20%	< -23°C
<5	<5	<5	40%	< -23°C
<5	<5	<5	40%	- 3°C
5	5-10	5-10	55%	+ 26.5°C
60	45	30	72%	+ 71°C

Evaporation of condensate from the sea surface is rapid under both summer and winter conditions, with 55% of the volume being lost in less than 10 minutes and 72% of the volume lost within 60 minutes.

The low flash point of condensate (refer Table 5-6) is significant as initially it prevents the safe approach of vessels due to the risk of ignition. When the flash point reaches + 71°C, after 30-45 minutes in summer and 60 minutes in winter it can be considered safe to approach.

Following the initial rapid evaporation of the lighter hydrocarbon fractions the condensate weathering process slows, however, after approximately 6 hours less than 10% of the original mixture remains. Weathering of this more resistant fraction proceeds over time through the processes of dissolution, biodegradation, photo-oxidation and sedimentation.



Date: September 1997
Ref. No. 800-19567s

pres1475_15

Figure 15 - Second Trunkline Project PER

% FRONT END LOSS OF CONDENSATE VS TIME @ 20°CELCIUS

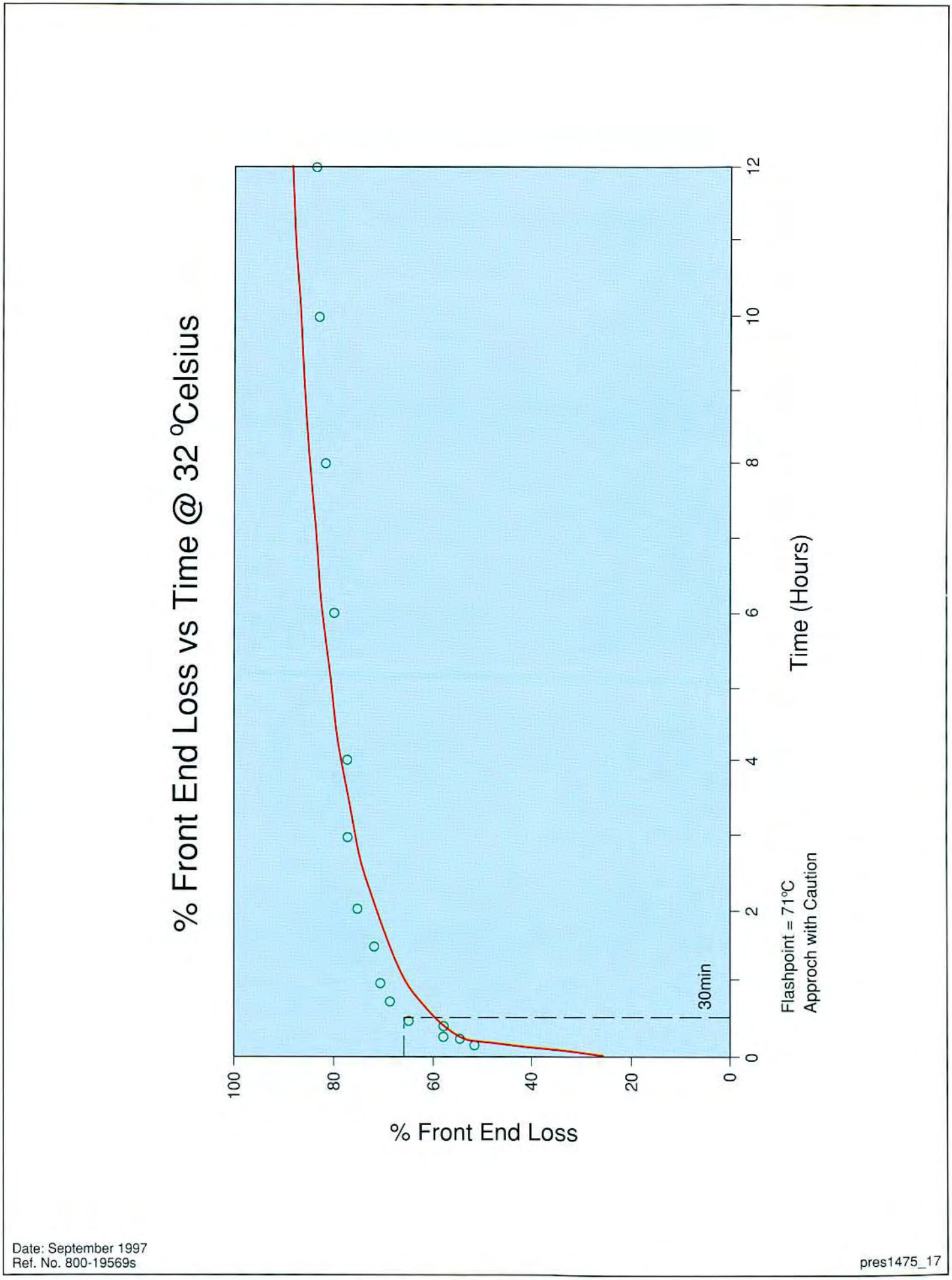


Figure 17 - Second Trunkline project PER

% FRONT END LOSS OF CONDENSATE VS TIME @ 32°CELCIUS

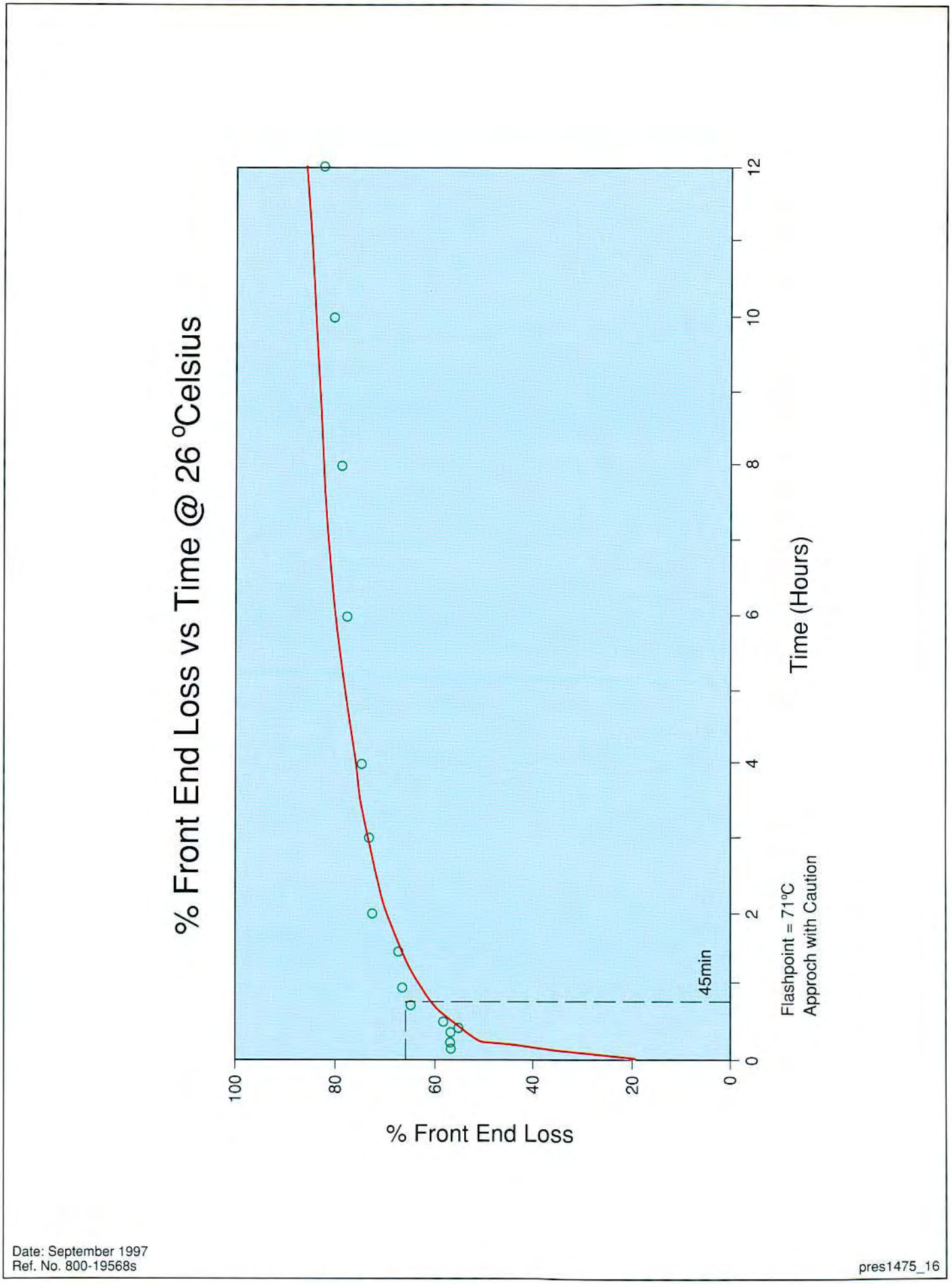


Figure 16 - Second Trunkline Project PER

% FRONT END LOSS OF CONDENSATE VS TIME @ 26°CELCIUS

Higher sea surface temperatures and increased wave agitation can increase the rate of evaporation of hydrocarbons. Kagi *et al.*, (1988) cite a field study conducted by Harrison *et al.*, (1975) where evaporative volume losses increased by a factor of 5-10 at the onset of "extensive whitecapping". Sea state conditions in Mermaid Sound will generally favour accelerated dispersion and evaporation. Winds above 5 knots occur 88% of the time and winds above 15 knots (which produce extensive whitecapping) occur 15% of the time.

The frequency distribution of wind speeds for Mermaid Sound and NRA are provided in Tables 5-7 and 5-8.

Within Mermaid Sound, predominant wind direction frequencies are from the west, south west and north west which occur 48% of the time, whilst winds from the east, south east and north east occur for 36% of the time.

Table 5-7: Frequency Distribution of Wind Speeds (Mermaid Sound.)

Direction	% time for Wind Speeds in Knots						
	0/5	5/10	10/15	15/20	20/25	25+	Total
North	0.2	1.7	2.1	0.8	0.1	-	4.8
North East	1.0	3.1	2.8	0.3	0.1	0.1	7.3
East	0.9	4.2	5.4	2.7	0.4	-	13.6
South East	2.3	6.7	4.6	1.3	0.1	0.1	15.1
South	3.1	5.5	1.7	0.5	-	-	10.8
South West	2.6	9.6	10.2	3.7	0.2	-	26.2
West	1.0	3.9	4.5	2.3	0.7	-	12.4
North West	0.6	4.1	4.3	0.7	-	0.1	9.8
Total	11.6	38.7	35.7	12.2	1.6	0.3	

Table 5-8: Frequency Distribution of Wind Speeds (NRA.)

Direction	% time for Wind Speeds in Knots						
	0/5	5/10	10/15	15/20	20/25	25+	Total
North	1.6	0.7	0.9	-	-	-	3.2
North East	1.3	1.7	0.9	0.6	-	-	4.5
East	2.7	3.1	2.6	1.0	1.0	-	10.4
South East	3.4	3.9	3.3	0.9	2.0	1.3	14.8
South	3.1	3.9	2.3	0.9	0.9	-	11.1
South West	5.4	9.7	7.9	4.4	1.4	1.0	29.8
West	3.7	5.6	4.4	2.4	1.2	-	17.3
North West	2.4	2.4	1.7	-	-	-	6.5
Total	23.6	31.0	24.0	10.2	6.5	2.3	

Diesel

The evaporation rate of diesel under typical Mermaid Sound conditions is provided in Table 5-9. Rates are significantly less than that for condensate, however after approximately 6 hours, approximately 50% of all the material will have evaporated, including 80% of the light-end aromatics. After 40 hours only 20-30% of the heavy-end constituents would remain. According to Kagi (1983) this residual fraction would, for small spills, disperse rapidly, primarily by adsorption onto particulates and subsequent sedimentation. For larger spills small tarry globules could be expected to form.

Table 5-9: Evaporation Rate of Diesel

Time (minutes)	20	60	120	360	600	1200	2400
Approx. % of original Material Remaining	97	88	79	60	48	35	27
Approx. % of Napthalene Derivatives (C11-C15) Remaining	95	80	70	37	20	5	2

5.3.3 Risk to Sensitive Areas of the Dampier Archipelago

A list was compiled of potentially sensitive receptor areas within the Dampier Archipelago (See Table 5-10 below and Figure 12) and the probability of oiling to the area interpreted from the condensate or diesel spill contours for each release case.

Table 5-10: List of Identified Dampier Archipelago Environmental Receptor Areas

Location	Status	Environmental Features
Keast Is	C class reserve	• Intertidal rock pavement with Scattered Coral • Seabird nesting/roosting area • Seagrass beds • High density use by marine mammals and turtles • Adjacent coral reef areas
Cohen Is	C class reserve	• Intertidal rock Pavement – scattered coral • Seabird nesting/roosting
Flying Foam Cp Brugieres Collier Rocks	N/A C class reserve	• Pearl oyster leases at Northern end • Heavy recreational (fishing) use • Scattered Mangrove communities • Extensive coral/coral pavement areas • High density of Marine Turtles and mammals (Dolphins, Dugongs)
Legendre Is	VCL/Lease Vested in Minister for Resource Dev	• Extensive, well developed fringing reef on Northern side • Coral & Pavement on Southern side • Heavy recreational use of surrounding waters and reef • High density turtle nesting area
Sailfish reef Rosemary Is Lady Nora Is Bare Rock	N/A A class C class reserve	• Heavy Recreational use of adjacent waters (prime big game fishing area) • Well developed fringing coral reef • Seabird nesting/roosting • High density marine turtle nesting beaches
Angel Is Gidley Is	C class reserves	• Scattered coral on pavement with some well developed reefs • Heavy recreational use of surrounding waters. • Low density Turtle nesting beaches. High density use of adjacent waters by marine mammals (Dolphins and Dugongs)
Conzinc Is	C class reserve	• Extensive fringing reef and sand spit areas • Seabird roosting and low density turtle nesting areas
Western Burrup (Withnell & Conzinc bays, Searipple Passage)	VCL Vested in various Govt Agencies	• Scattered mangrove areas • Scattered Coral reefs/scattered coral on rock pavement • Large areas of sandy beach • Low Density turtle nesting • High density use of adjacent waters by marine mammals & turtles • Seabird nesting and roosting

Table 5-11 and 5-12: Probability of condensate/diesel contact with sensitive areas (%)

KP10	Summer					Winter		
Location	**Status**	**5mm hole**	**50mm hole**	**Diesel (1000l)**	**5mm hole**	**50mm hole**	**1000mm hole**	**Diesel (1000l)**
Keast Is	C class reserve	No contact	No contact	1-10	1-10	1-10	11-20	11-20
Cohen Is	C class reserve	No contact	No contact	1-10	11-20	1-10	11-20	21-30
Flying Foam Cp Brugieres Collier Rocks	N/A C class reserves	1-10	1-10	1-10	1-10	1-10	1-10	1-10
Legendre Is	VCL/Lease	No contact	No contact	No contact	1-10	1-10	1-10	11-20
Sailfish reef Rosemary Is Lady Nora Is Bear Rock	A class Reserve C class reserves	No contact	No contact	No contact	No contact	No contact	No contact	No contact
Angel Is Gidley Is	C class reserves	21-30	1-10	21-30	41-50	41-50	41-50	41-50
Conzinc Is	C class reserve	No contact	No contact	No contact	No contact	1-10	1-10	1-10

KP30	Summer					Winter			
Location	**Status**	**5mm hole**	**50mm hole**	**1000mm hole (7000 tonne)**	**1000mm hole (14000 tonne)**	**5mm hole**	**50mm hole**	**1000mm hole (7000 tonne)**	**1000mm hole (14000 tonne)**
Keast Is	C class reserve	No contact	No contact	No contact	No contact	No contact	No contact	No contact	No contact
Cohen Is	C class reserve	No contact	No contact	No contact	No contact	No contact	No contact	No contact	No contact
Flying Foam Cp Brugieres Collier Rocks	N/A C class reserves	No contact	No contact	No contact	No contact	No contact	No contact	No contact	No contact
Legendre Is	VCL/Lease	No contact	No contact	No contact	No contact	No contact	No contact	No contact	
Sailfish reef Rosemary Is Lady Nora Is Bear Rock	A class Reserve C class reserves	No contact	No contact	1-10	1-10	No contact	No contact	No contact	
Angel Is Gidley Is	C class reserves	No contact	No contact	No contact	No contact	No contact	No contact	No contact	
Conzinc Is	C class reserve	No contact	No contact	No contact	No contact	No contact	No contact	No contact	

NB: It should be noted that whilst contact probabilities for condensate on Dampier Archipelago environmental receptors exist, the actual probability of such a spill occurring in the first place is extremely low.

Tables 5-11 and 5-12 (over page) summarise the probability of contact of the sensitive areas with condensate or diesel in each of the release cases.

For the Western Burrup region, the probability of contact was assumed to be 1.0 at KP0 decreasing to zero at KP10 (modelling at this point indicates no probability of contact is <0.01). Probabilities of contact were then assigned in a linear fashion to each kilometre along the line KP0-KP8 and finally, annual risk was calculated according to the following methodology.

From the trunkline failure rates generated during the various risk assessment studies(refer section 5.3.1) and the modelled transport probabilities, the annual and lifetime risk to the various environmental receptor areas can be calculated.

The methodology for this analysis involves subdividing the annualised kilometre failure frequencies into a winter and summer component. It was assumed the summer wind patterns occupy 60% of the year and winter wind patterns occupy 40%.

The resulting seasonal accident frequency rate was then multiplied by the transport risk for each hole size and season (from modelled oil spill frequency contours) to calculate a seasonal risk.

Because the annual risk represents risk over a 1 km length of the trunkline the *interaction distance* must be determined. This parameter represents the length of trunkline over which a spill will pose a threat to a receptor. The interaction distance was estimated from existing models in a very conservative manner utilising the following assumptions:

- From KP0 to KP8 the condensate spill will affect the western shore of the Archipelago
- From KP8 to KP 25 the condensate spill probability contours are similar;
- From KP25 to KP40 the condensate spill contours are similar; and
- For the KP10 & KP30 cases the probability contour is translocated along the trunkline axis.

Using these assumptions, interaction distances of 16 km and 15km respectively were used for the KP10 and KP 30 scenarios respectively. Interaction distance does not apply over the KP0-KP8 length of trunkline as the risks are integrated over this discrete distance.

The seasonal risks were then summed and multiplied by the interaction distances to determine the annual risk to a receptor from a condensate spill from the second trunkline.

The resulting receptor risk tables are presented below as Tables 5-13 to 5-20

Figure 18a

DAMPIER ARCHIPELAGO
Type: ***Condensate Spill – 5mm hole***
Location: ***KP10***
Season: ***Summer***
Graph Type: ***probability of oiling***

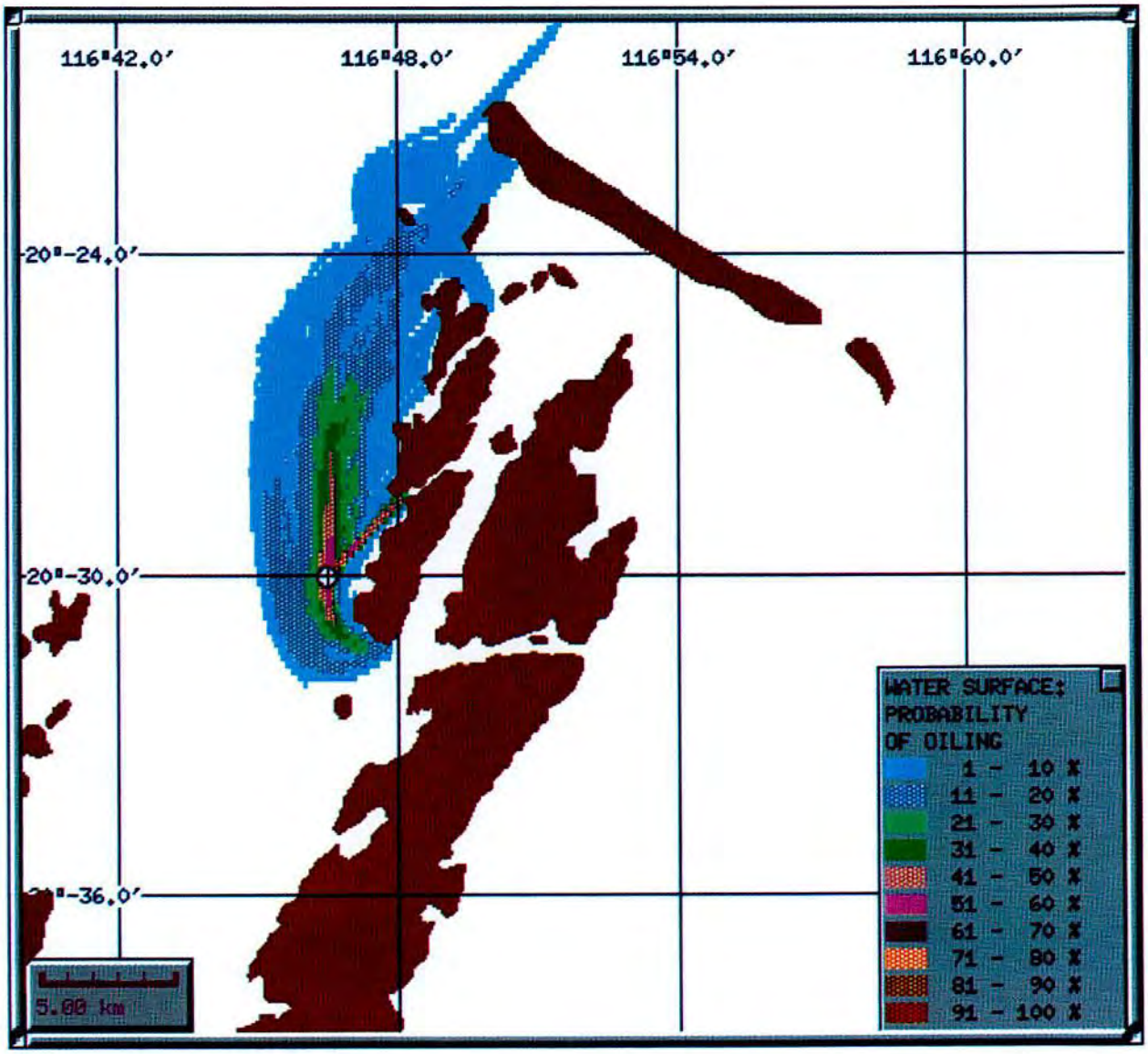


Figure 18b

DAMPIER ARCHIPELAGO
Type: ***Condensate spill – 5mm rupture***
Location: ***KP10***
Season: ***Winter***
Graph Type: ***Probability of Oiling***

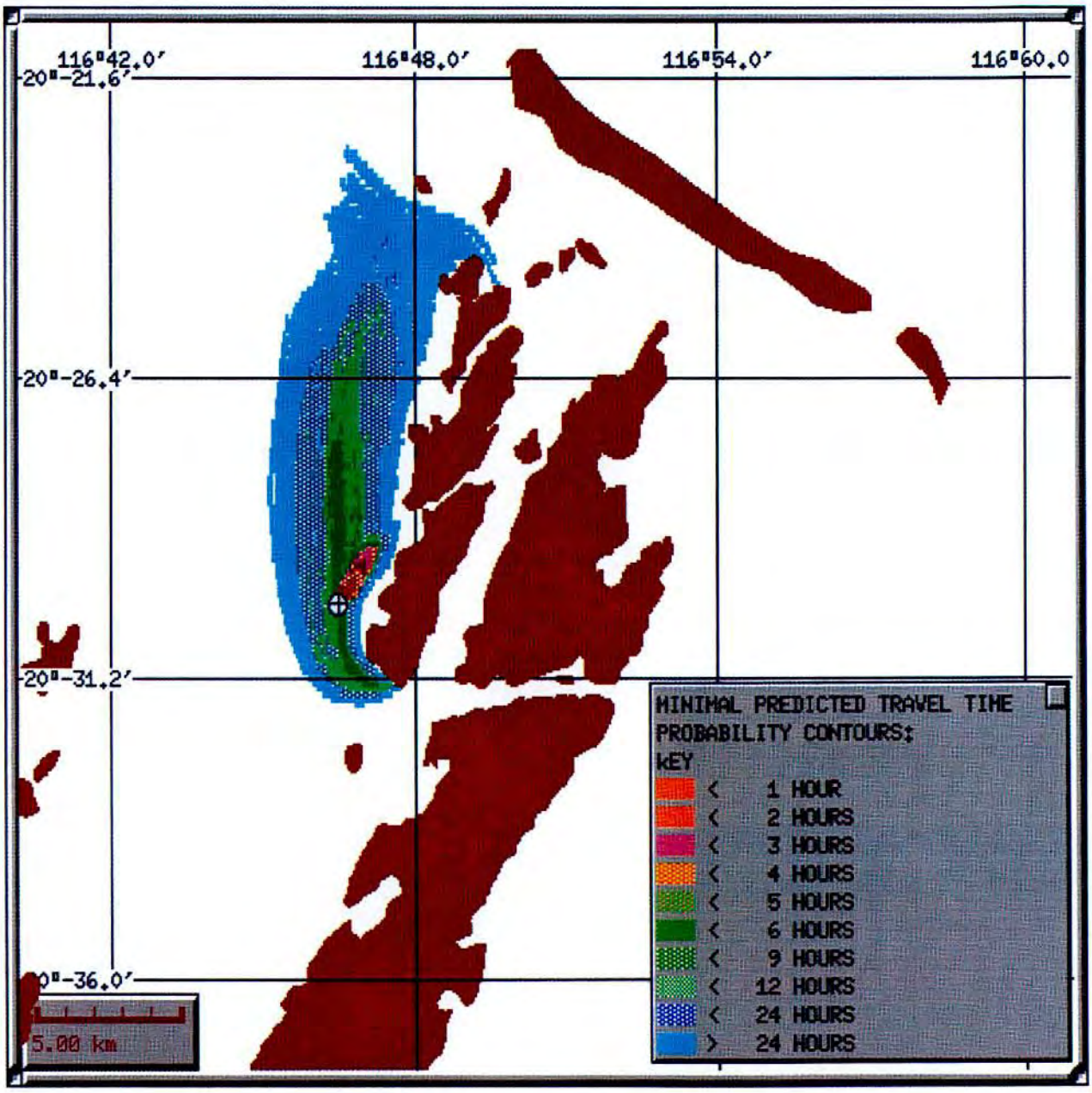


Figure 18c

DAMPIER ARCHIPELAGO
Type: ***Diesel spill***
Location: ***KP10***
Season: ***Winter***
Graph Type: ***Probability of Oiling***

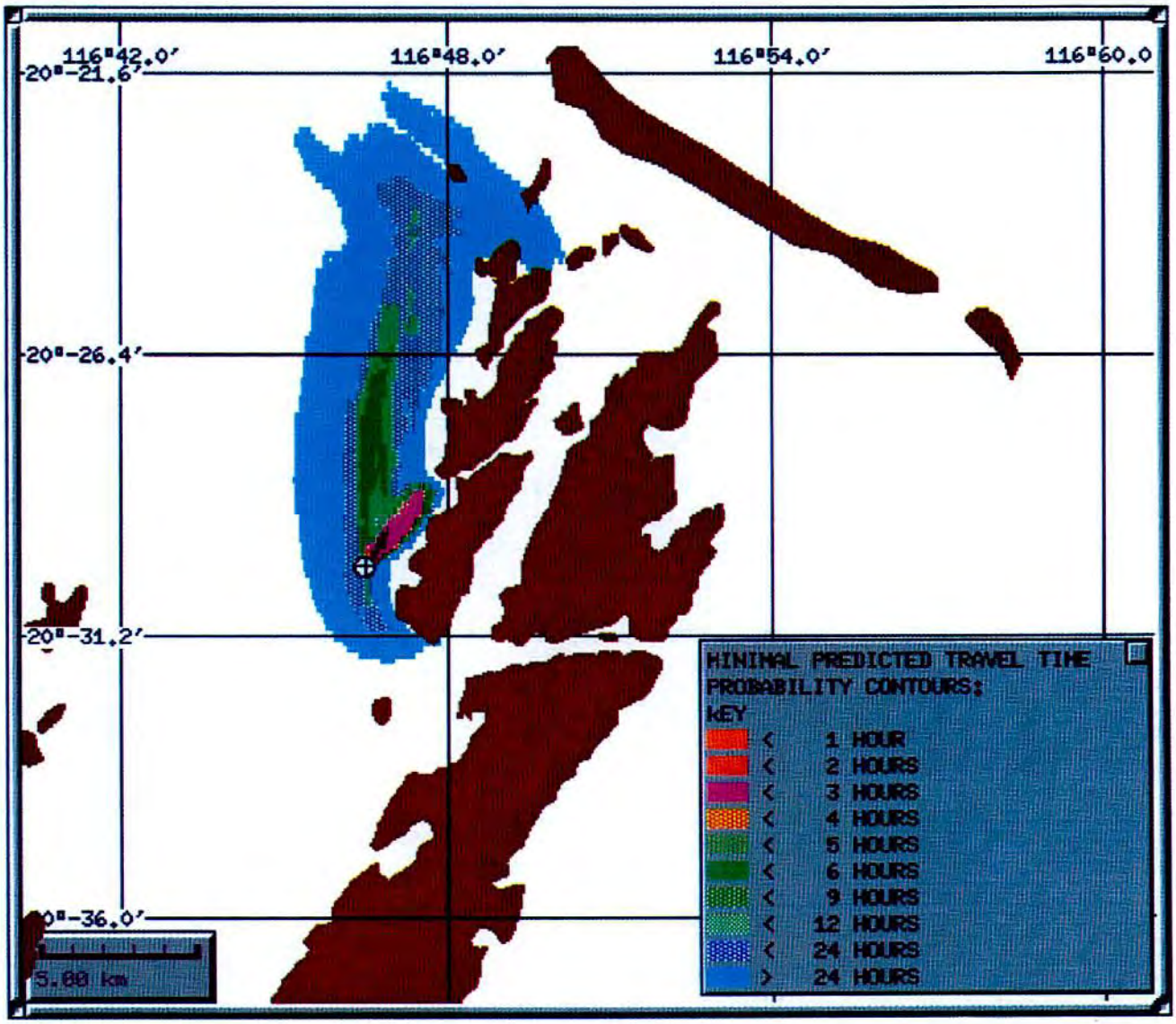


Figure 18d

DAMPIER ARCHIPELAGO
Type: ***Condensate spill – 5mm rupture***
Location: ***KP30***
Season: ***Winter***
Graph Type: ***Probability of Oiling***

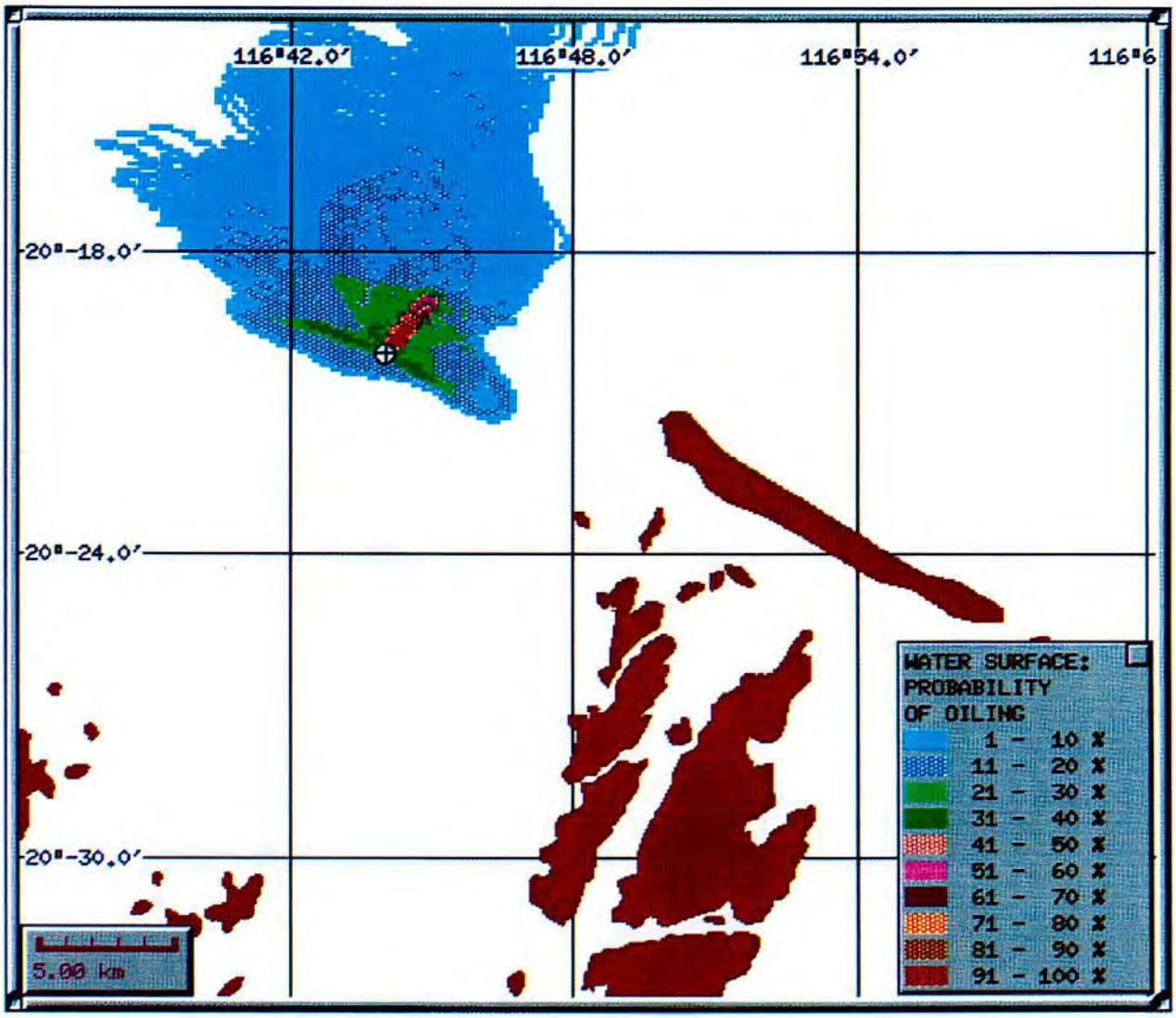


Figure 18e

DAMPIER ARCHIPELAGO
Type: Condensate spill – 5mm hole
Location: *KP30*
Season: *Summer*
Graph Type: *Probability of oiling*

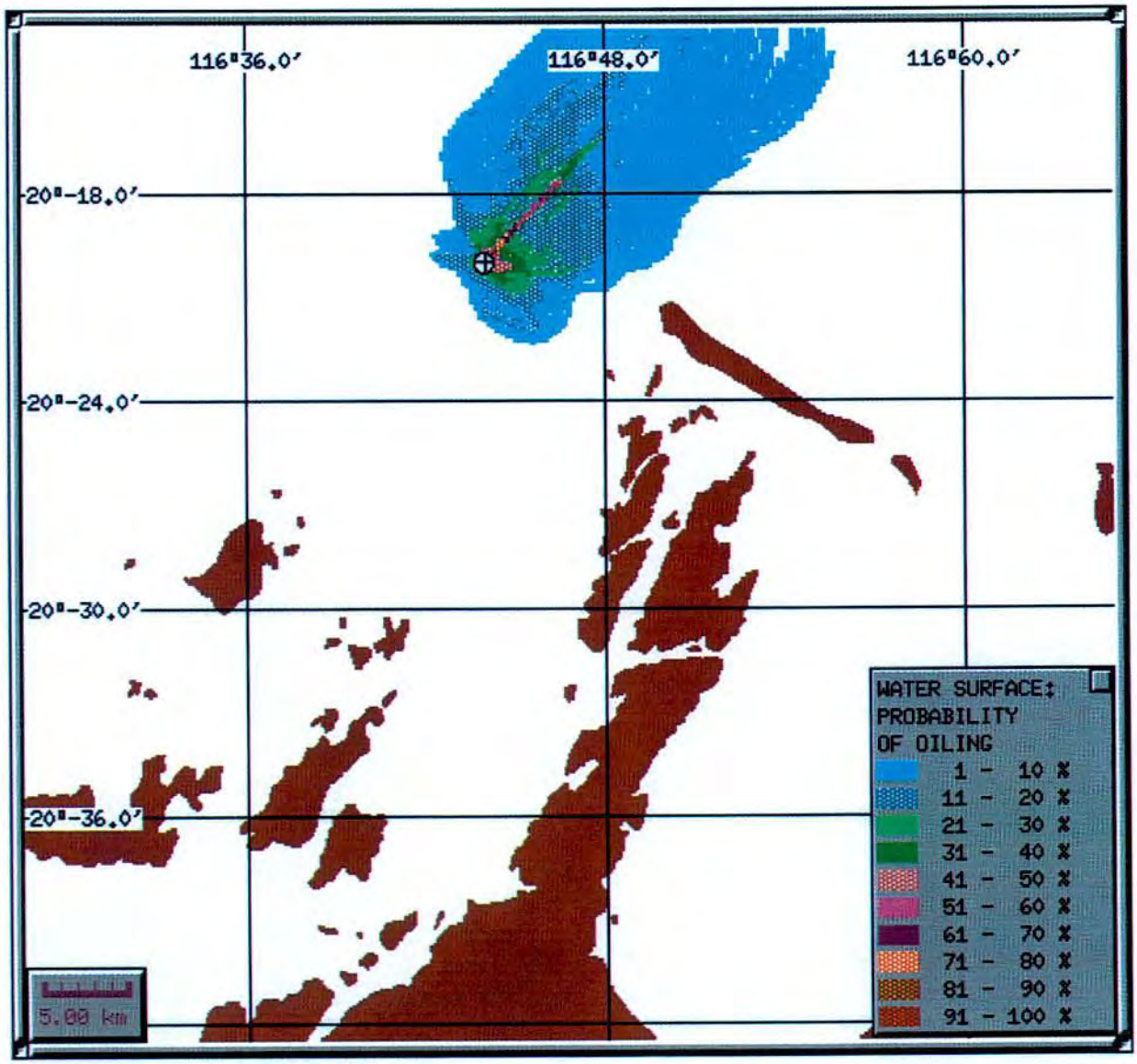


Figure 18f

DAMPIER ARCHIPELAGO
Type: ***Condensate spill – 7000t (Full Bore Rupture A)***
Location: ***KP10***
Season: ***Winter***
Graph Type: ***Probability of Oiling***

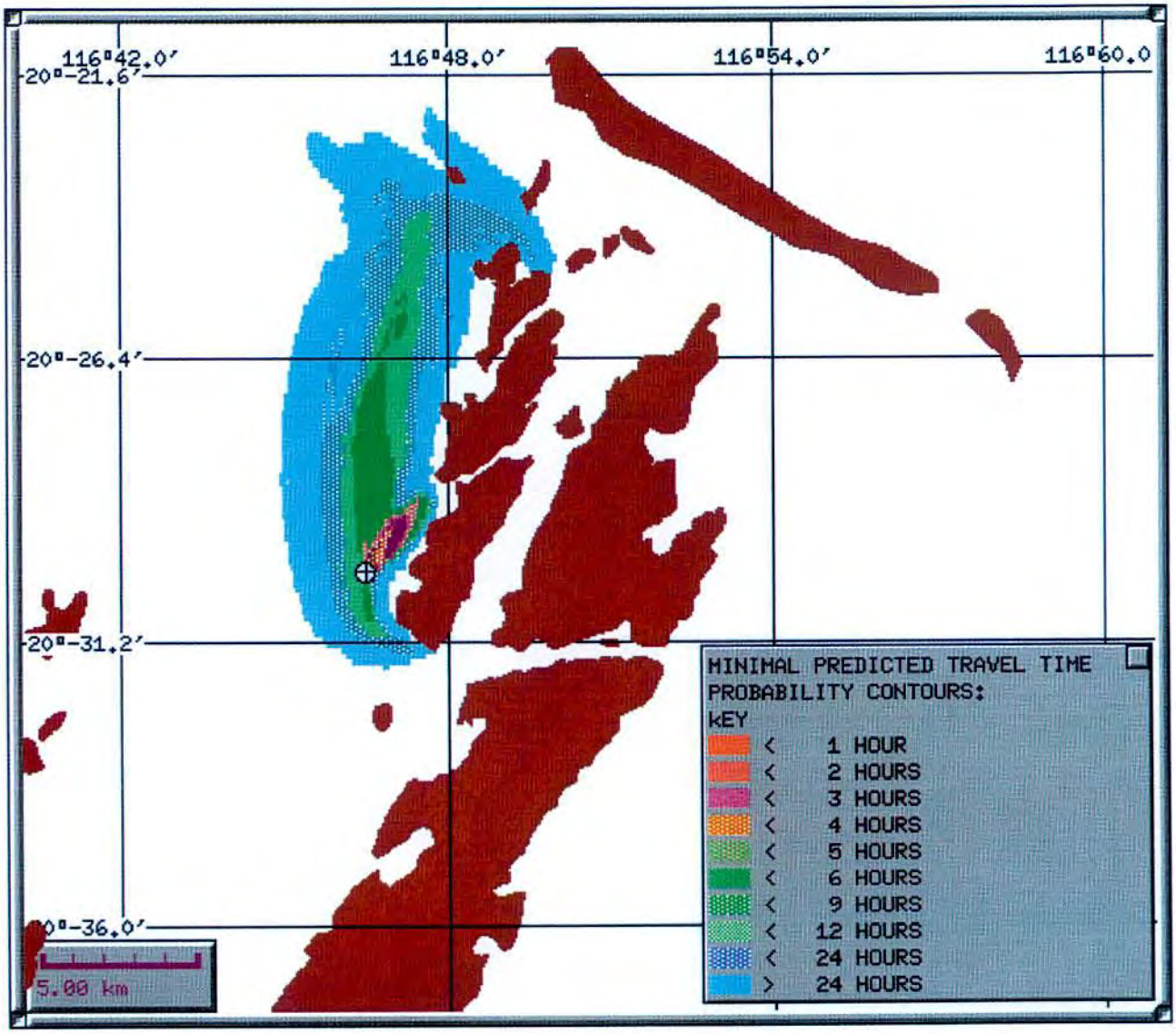


Figure 18g

DAMPIER ARCHIPELAGO
Type: ***Condensate spill – 7000 tonne (Full bore rupture A)***
Location: ***KP 30***
Season: ***Summer***
Graph Type: ***Probability of Oiling***

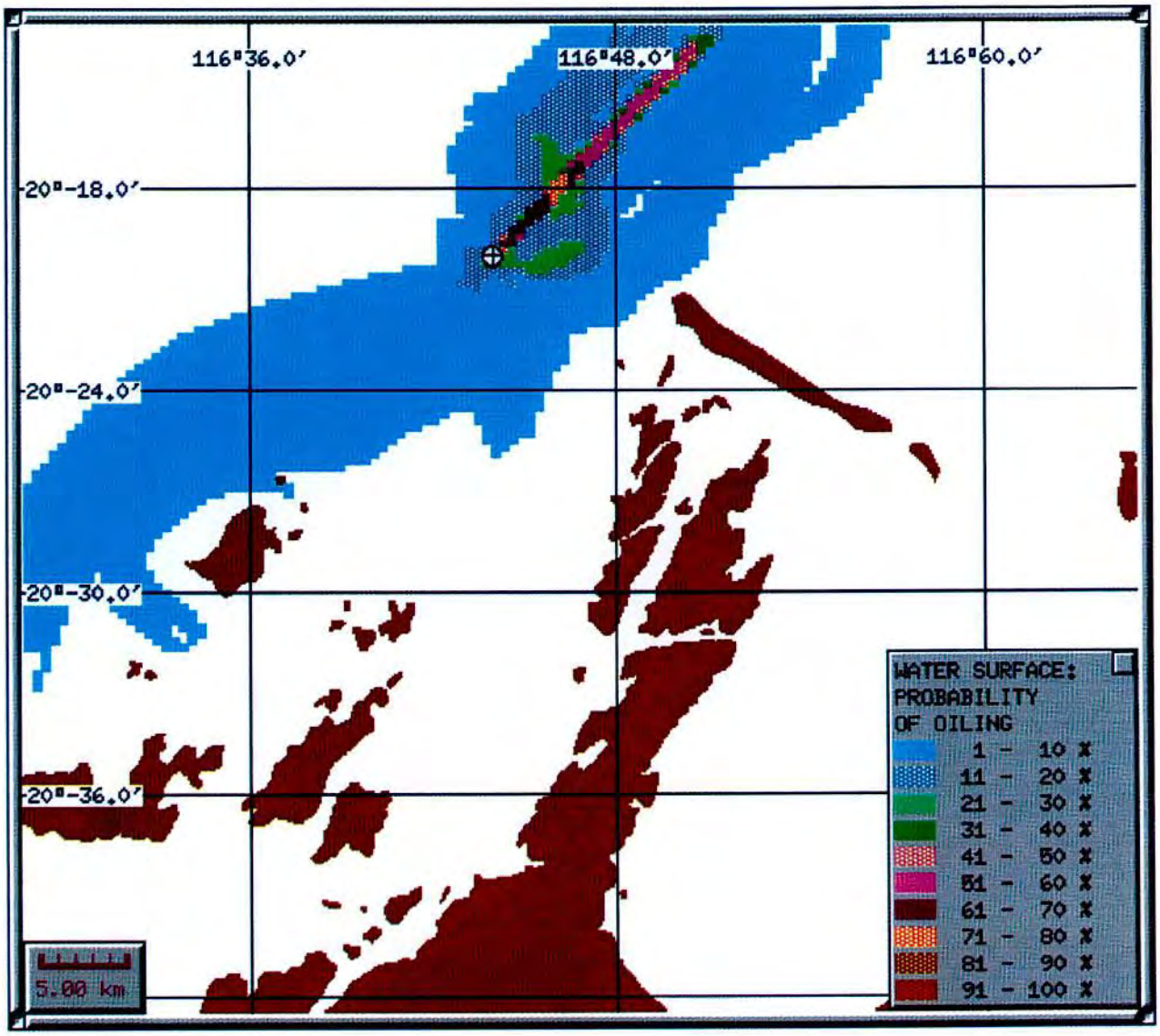


Figure 18h

DAMPIER ARCHIPELAGO
Type: ***Condensate Spill – 1000mm rupture (14000 t)***
Location: ***KP30***
Season: ***Winter***
Graph Type: ***Probability of Oiling***

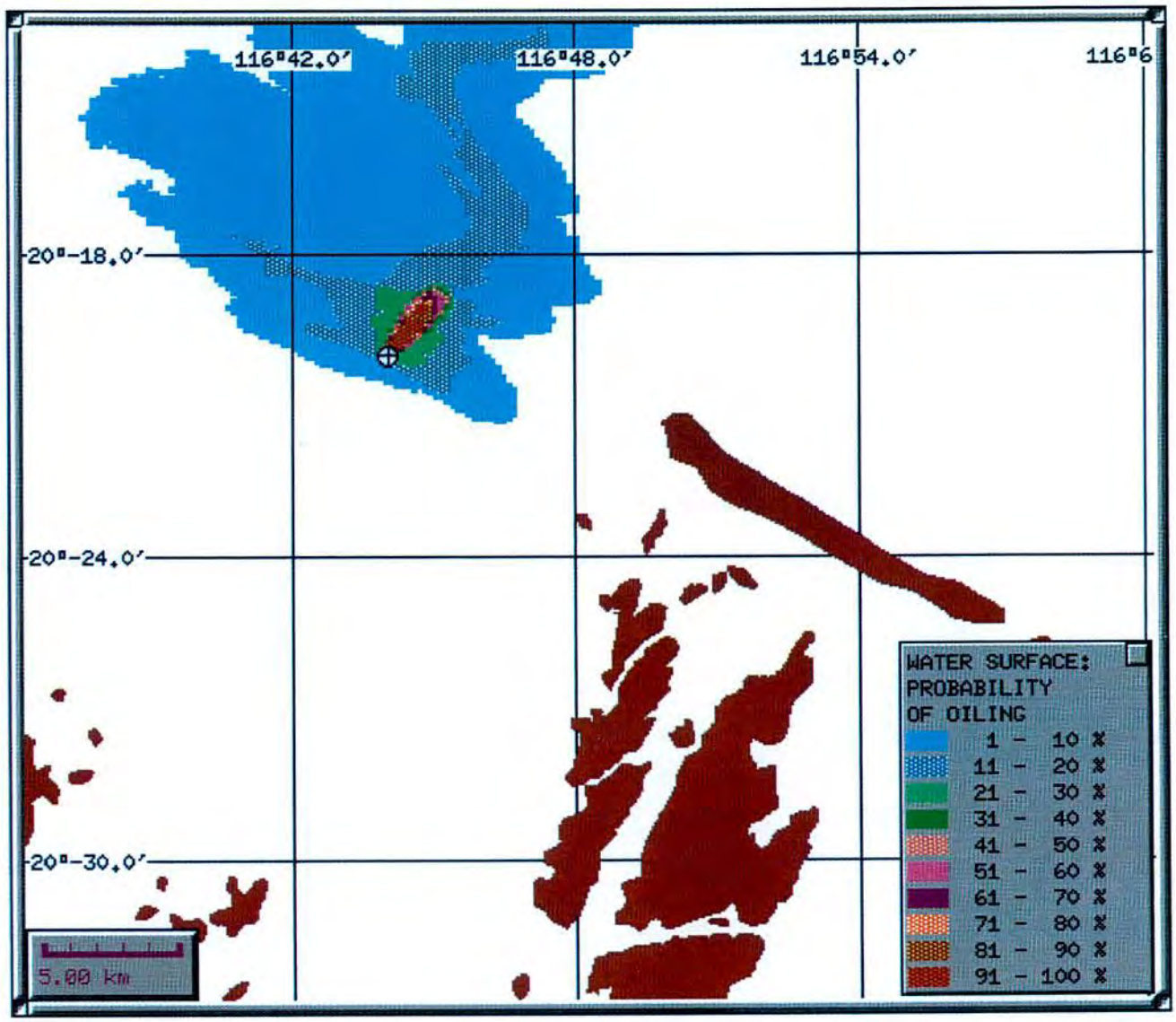


Figure 18i

DAMPIER ARCHIPELAGO
Type: ***Condensate Spill - 1000mm rupture (14000 t) (Full bore rupture B)***
Location: ***KP30***
Season: ***Summer***
Graph Type: ***Probability of Oiling***

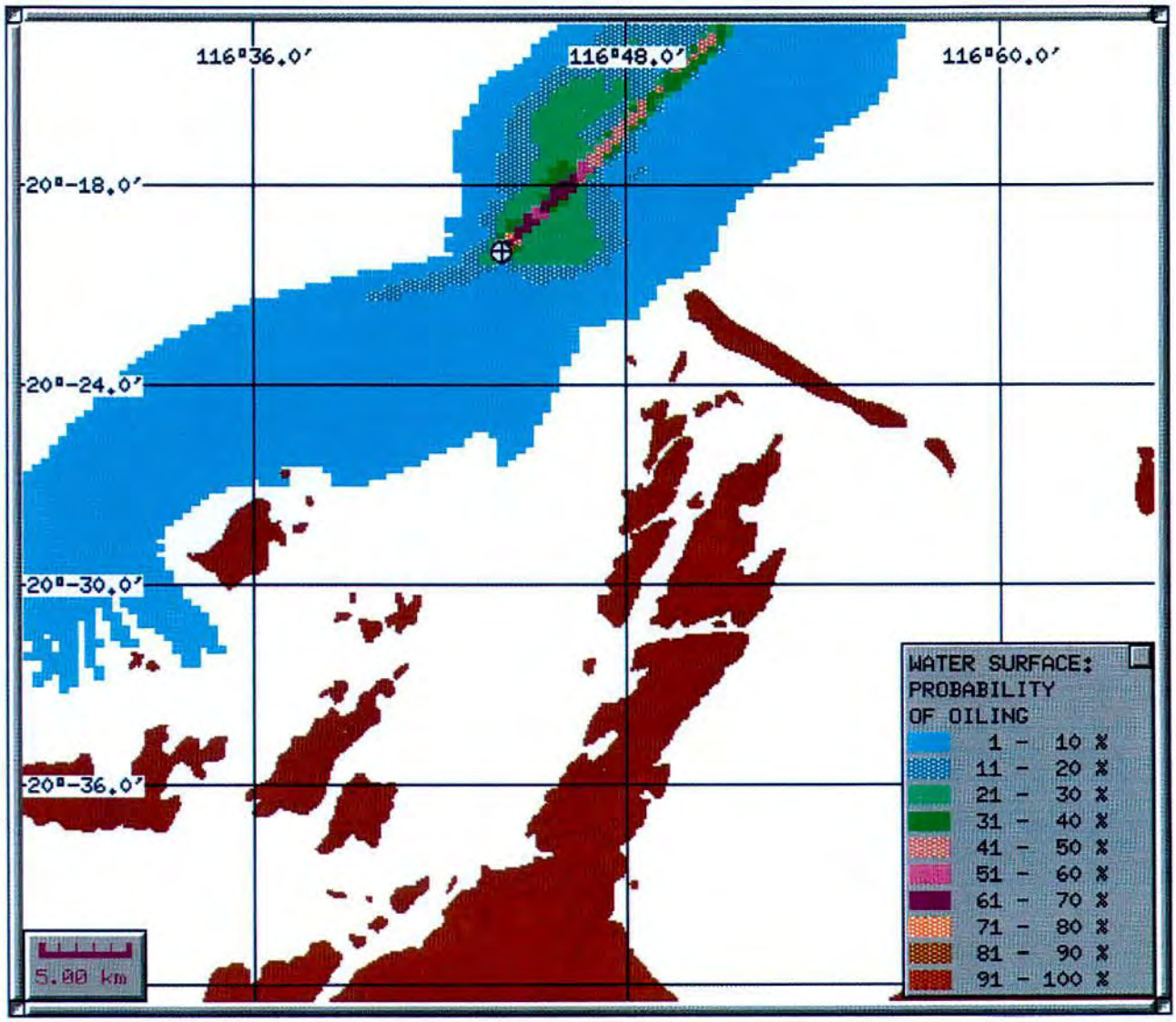


TABLE: 5-13

Receptor: Flying Foam/Cape Brugieres/Collier Rocks

KP10	*Summer*			*Winter*				
	Accident frequency	Transport probability	Seasonal Risk	Accident frequency	Transport probability	Seasonal Risk	Interaction distance (km)	Annual risk
Corrosion 5mm hole)	$3.55x10^{-7}$	0.1	$3.6x10^{-8}$	$2.4x10^{-7}$	0.1	$2.4x10^{-8}$	16	$9.6x10^{-7}$
Medium hole (50mm)	$1.1x10^{-7}$	0.1	$1.1x10^{-8}$	$7.6x10^{-8}$	0.1	$7.6x10^{-9}$	16	$3x10^{-7}$
Full bore (a) (7000 tonne)	$6x10^{-9}$	0.1	$6x10^{-10}$	$4.0x10^{-9}$	0.2	$4x10^{-10}$	16	$1.6x10^{-8}$

Receptor: Flying Foam/Cape Brugieres/Collier Rocks

KP30	*Summer*			*Winter*				
	Accident frequency	Transport probability	Seasonal Risk	Accident frequency	Transport probability	Seasonal Risk	Interaction distance (km)	Annual risk
Corrosion 5mm hole)	$3.55x10^{-7}$	No Contact		$2.37x10^{-7}$	No Contact		15	
Medium hole (50mm)	$1.7x10^{-6}$	No Contact		$1x10^{-6}$	No Contact		15	
Full bore (a) (7000 tonne)	$4.5x10^{-8}$	No Contact		$3x10^{-8}$	No Contact		15	
Full bore (b) (14000 tonne)	$4.5x10^{-8}$	No Contact		$3x10^{-8}$	No Contact		15	

TABLE:5-14

Receptor:Angel Island/Gidley Island

KP10	Summer			Winter				
	Accident frequency	Transport probability	Seasonal Risk	Accident frequency	Transport probability	Seasonal Risk	Interaction distance (km)	Annual risk
Corrosion 5mm hole)	$3.6x10^{-7}$	0.5	$2x10^{-7}$	$2.37x10^{-7}$	0.3	$7x10^{-8}$	16	$6x10^{-6}$
Medium hole (50mm)	$1.1x10^{-7}$	0.5	$5.5x10^{-8}$	$7.6x10^{-8}$	0.1	$8x10^{-9}$	16	$1.3x10^{-7}$
Full bore (a) (7000 tonne)	$6x10^{-9}$	0.5	$3x10^{-9}$	$4.0x10^{-9}$	0.3	$1.2x10^{-9}$	16	$1.9x10^{-8}$

Receptor: Angel Island/Gidley Island

KP30	Summer			Winter				
	Accident frequency	Transport probability	Seasonal Risk	Accident frequency	Transport probability	Seasonal Risk	Interaction distance (km)	Annual risk
Corrosion 5mm hole)	$3.6x10^{-7}$	No Contact		$2.37x10^{-7}$	No Contact		15	
Medium hole (50mm)	$1.7x10^{-6}$	No Contact		$1.1x10^{-6}$	No Contact		15	
Full bore (a) (7000 tonne)	$4.5x10^{-8}$	No Contact		$3x10^{-8}$	No Contact		15	
Full bore (b) (14000 tonne)	$4.5x10^{-8}$	No Contact		$3x10^{-8}$	No Contact		15	

TABLE: 5-15

Receptor: Sailfish Reef/Rosemary Island/Bare Rock

KP10	Summer			Winter				
	Accident frequency	Transport probability	Seasonal Risk	Accident frequency	Transport probability	Seasonal Risk	Interaction distance (km)	Annual risk
Corrosion 5mm hole)	$3.55x10^{-7}$	No Contact		$2.4x10^{-7}$	No Contact		16	
Medium hole (50mm)	$1.1x10^{-7}$	No Contact		$7.6x10^{-8}$	No Contact		16	
Full bore (a) (7000 tonne)	$6x10^{-9}$	No Contact		$4.0x10^{-9}$	No Contact		16	

Receptor: Sailfish Reef/Rosemary Island/Bare Rock

KP30	Summer			Winter				
	Accident frequency	Transport probability	Seasonal Risk	Accident frequency	Transport probability	Seasonal Risk	Interaction distance (km)	Annual risk
Corrosion 5mm hole)	$3.55x10^{-7}$	No Contact		$2.37x10^{-7}$	No Contact		15	
Medium hole (50mm)	$1.7x10^{-6}$	No Contact		$1.1x10^{-6}$	No Contact		15	
Full bore (a) (7000 tonne)	$4.5x10^{-8}$	0.1	$4.5x10^{-9}$	$3x10^{-8}$	No Contact		15	$6.8x10^{-8}$
Full bore (b) (14000 tonne)	$4.5x10^{-8}$	0.1	$4.5x10^{-9}$	$3x10^{-8}$	No Contact		15	$6.8x10^{-8}$

TABLE: 5-16

Receptor: Cohen Island

KP10	Summer			Winter				
	Accident frequency	Transport probability	Seasonal Risk	Accident frequency	Transport probability	Seasonal Risk	Interaction distance (km)	Annual risk
Corrosion 5mm hole)	$3.55x10^{-7}$	0.2	$7.1x10^{-8}$	$2.4x10^{-7}$	No Contact		16	$1.1x10^{-6}$
Medium hole (50mm)	$1.1x10^{-7}$	0.1	$1.1x10^{-8}$	$7.6x10^{-8}$	No Contact		16	$1.8x10^{-7}$
Full bore (a) (7000 tonne)	$6x10^{-9}$	0.2	$1.2x10^{-9}$	$4.0x10^{-9}$	0.1	$4x10^{-10}$	16	$2.6x10^{-8}$

Receptor: Cohen Island

KP30	Summer			Winter				
	Accident frequency	Transport probability	Seasonal Risk	Accident frequency	Transport probability	Seasonal Risk	Interaction distance (km)	Annual risk
Corrosion 5mm hole)	$3.55x10^{-7}$	No Contact		$2.37x10^{-7}$	No Contact		15	
Medium hole (50mm)	$1.7x10^{-6}$	No Contact		$1.1x10^{-6}$	No Contact		15	
Full bore (a) (7000 tonne)	$4.5x10^{-8}$	No Contact		$3x10^{-8}$	No Contact		15	
Full bore (b) (14000 tonne)	$4.5x10^{-8}$	No Contact		$3x10^{-8}$	No Contact		15	

TABLE: 5-17

Receptor: Keast Island

KP10	*Summer*			*Winter*				
	Accident frequency	Transport probability	Seasonal Risk	Accident frequency	Transport probability	Seasonal Risk	Interaction distance (km)	Annual risk
Corrosion 5mm hole)	$3.55x10^{-7}$	0.1	$3.6x10^{-8}$	$2.4x10^{-7}$	No Contact		16	$5.8x10^{-7}$
Medium hole (50mm)	$1.1x10^{-7}$	0.1	$1.1x10^{-8}$	$7.6x10^{-8}$	No Contact		16	$1.8x10^{-7}$
Full bore (a) (7000 tonne)	$6x10^{-9}$	0.2	$1.2x10^{-9}$	$4.0x10^{-9}$	0.1	$4x10^{-10}$	16	$2.6x10^{-8}$

Receptor: Keast Island

KP30	*Summer*			*Winter*				
	Accident frequency	Transport probability	Seasonal Risk	Accident frequency	Transport probability	Seasonal Risk	Interaction distance (km)	Annual risk
Corrosion 5mm hole)	$3.55x10^{-7}$	No Contact		$2.37x10^{-7}$	No Contact		15	
Medium hole (50mm)	$1.7x10^{-6}$	No Contact		$1.1x10^{-6}$	No Contact		15	
Full bore (a) (7000 tonne)	$4.5x10^{-8}$	No Contact		$3x10^{-8}$	No Contact		15	
Full bore (b) (14000 tonne)	$4.5x10^{-8}$	No Contact		$3x10^{-8}$	No Contact		15	

TABLE:5-18

Receptor: Legendre Island

KP10	Summer			Winter				
	Accident frequency	Transport probability	Seasonal Risk	Accident frequency	Transport probability	Seasonal Risk	Interaction distance (km)	Annual risk
Corrosion 5mm hole)	$3.6x10^{-7}$	No Contact		$2.4x10^{-7}$	0.1	$2x10^{-8}$	16	$3.8x10^{-7}$
Medium hole (50mm)	$1.1x10^{-7}$	No Contact		$7.6x10^{-8}$	0.1	$7.6x10^{-9}$	16	$1.2x10^{-7}$
Full bore (a) (7000 tonne)	$6x10^{-9}$	No Contact		$4.0x10^{-9}$	0.1	$4x10^{-10}$	16	$6.4x10^{-9}$

Receptor: Legendre Island

KP30	Summer			Winter				
	Accident frequency	Transport probability	Seasonal Risk	Accident frequency	Transport probability	Seasonal Risk	Interaction distance (km)	Annual risk
Corrosion 5mm hole)	$3.55x10^{-7}$	No Contact		$2.37x10^{-7}$	No Contact		15	
Medium hole (50mm)	$1.7x10^{-6}$	No Contact		$1.1x10^{-6}$	No Contact		15	
Full bore (a) (7000 tonne)	$4.5x10^{-8}$	No Contact		$3x10^{-8}$	No Contact		15	
Full bore (b) (14000 tonne)	$4.5x10^{-8}$	No Contact		$3x10^{-8}$	No Contact		15	

TABLE: 5-19

Receptor: Conzinc Island

KP10	Summer			Winter				
	Accident frequency	Transport probability	Seasonal Risk	Accident frequency	Transport probability	Seasonal Risk	Interaction distance (km)	Annual risk
Corrosion 5mm hole)	$3.6x10^{-7}$	No Contact		$2.4x10^{-7}$	No contact		16	
Medium hole (50mm)	$1.1x10^{-7}$	No Contact		$7.6x10^{-8}$	0.1	$7.6x10^{-9}$	16	$1.2x10^{-7}$
Full bore (a) (7000 tonne)	$6x10^{-9}$	No Contact		$4.0x10^{-9}$	0.1	$4x10^{-10}$	16	$6.4x10^{-9}$

Receptor: Conzinc Island

KP30	Summer			Winter				
	Accident frequency	Transport probability	Seasonal Risk	Accident frequency	Transport probability	Seasonal Risk	Interaction distance (km)	Annual risk
Corrosion 5mm hole)	$3.55x10^{-7}$	No Contact		$2.37x10^{-7}$	No Contact		15	
Medium hole (50mm)	$1.7x10^{-6}$	No Contact		$1.1x10^{-6}$	No Contact		15	
Full bore (a) (7000 tonne)	$4.5x10^{-8}$	No Contact		$3x10^{-8}$	No Contact		15	
Full bore (b) (14000 tonne)	$4.5x10^{-8}$	No Contact		$3x10^{-8}$	No Contact		15	

TABLE: 5-20

Receptor: Western Burrup

	Summer			***Winter***			
	Accident frequency	Transport probability	Seasonal Risk	Accident frequency	Transport probability	Seasonal Risk	Annual risk
Corrosion 5mm hole)	$3.6x10^{-7}$	0-1	$2x10^{-6}$	$2.4x10^{-7}$	0-1	$1x10^{-6}$	$3x10^{-6}$
Medium hole (50mm)	$4.2x10^{-8}$	0-1	$2x10^{-7}$	$2.8x10^{-8}$	0-1	$1.5x10^{-8}$	$3.8x10^{-7}$

5.3.4 Interpretation of Quantitative Risk Assessment for Condensate Diesel Spills

To assist the interpretation of risk estimates for condensate/diesel spills, the following risk comparisons are provided for Woodside activities:

Risk Level	*Comment*
Approx 10^{-4}	Annual risk to offshore worker of involvement in a helicopter accident
Approx 10^{-5}	Annual risk of an earthquake causing loss of offshore production facility
Approx 10^{-6}	Annual risk of fatality at work for an Australian office worker

Condensate spills from Trunkline
The highest risk to an environmental receptor in the Dampier Archipelago is to the Western Burrup ($3x10^{-6}$) and Cohen Island ($1.1x10^{-6}$) from small hole (corrosion type) hole (5mm) events in the second trunkline. The risk from these events is regarded as very low and for which no specific measures are considered necessary to reduce.

All other risks to environmental receptors lie between $9.6x10^{-7}$ and $6.4x10^{-9}$ per year, risk levels which are well below the region considered acceptable for the safety of human beings engaged in workplace activities.

Diesel Spills from Construction Activities
Modelling results indicate that a 1000 litre diesel spill due to a dredge refuelling accident at KP10 has similar probability of coastal impact to the largest condensate spill scenario. This is primarily due to the relatively lower evaporation rate of diesel.

Data for the frequency of spills from dredge refuelling on station is not available, and so annual risk is unable to be quantitatively determined, however the consequences of such a spill indicate a high priority should be given to mitigation measures.

5.3.5 Consequences of a Condensate/Diesel Spill

The effects of a spill will vary considerably. Factors determining the level of effect include,

- the inherent toxicity of the oil;
- the degree of weathering prior to exposure;
- the period of exposure;
- the susceptibility of the impacted community components;
- the ability of the affected communities to recover; and
- the persistence of the oil in the impacted environment.

In general, the greatest impact is likely in sheltered environments close to shore where oil may persist for extended periods of time. In high-energy environments natural weathering and dispersion processes are accelerated, resulting in minimal exposure of marine species.

The overlying water column generally protects subtidal communities. Weathering and physical factors have been included in the assumptions during the modelling stage.

Ecotoxicity of Condensate and Diesel

According to Baker *et al.*, (1990) natural recovery processes will commence as soon as the toxicity or other adverse property of oil has declined to a level tolerated by the most robust colonising organisms.

Woodside has performed studies on the toxicity of whole condensate, dispersed condensate and the Water Soluble Fraction (WSF) of condensate to Tiger Prawns (*Penaeus monodon*) and the Water Flea (*Ceriodaphnia cf dubia).* The Tiger prawn is expected to be a good indicator species that is a relatively sensitive organism and is found in the waters adjacent to the second trunkline development where it is a commercially exploited species in the region.

Studies were also done to determine toxicity of the condensate in combination with a range of third generation chemical dispersants. Chemical dispersion is a common method of combating hydrocarbon spills.

Toxicity studies performed by the Center for Environmental Toxicology (University of Technology, Sydney) resulted in a 96hr LC_{50} of 11%of undiluted WSF in seawater for the Tiger Prawns. This is equivalent to total organic concentration of 1.5mg/l, with most toxicity being attributed to the aromatic fraction.

[NB: 96hrLC_{50} is the concentration of a particular toxicant that will be lethal to 50% of a particular test animals population over a nominated test period and is a common measure of toxicity].

For the Water Flea, the 96hr LC_{50} was 24% of the undiluted WSF or 7mg.l total organics. Results from Tiger Prawns for the condensate and dispersant mixtures (not WSF) established a 96hr LC_{50} of 43 to 135 mg/l mixture, dependent on the dispersant. Finally, the acute toxicity (as 96hr LC_{50} for Tiger Prawns) of whole condensate in seawater was determined as 109mg/l condensate.

Although ecotoxicology work has been undertaken, most mobile organisms should have an opportunity to avoid toxic effects in the case of a spill. Condensate is expected to be acutely toxic to most intertidal fauna and mangrove infauna.

Woodside has reported extensively on the effect of condensate on Mangrove communities following a leak from the Oil Contaminated Sewer System into North East Creek in 1987/88.

The action of condensate on mangroves is suggested to be acutely toxic, rather than the more usual smothering effect attributed to heavier oils. The toxicology is believed to be related to the high aromatic/napthene content of North West Shelf condensate giving it enhanced penetration and solvation properties on the plant cell walls (Chegwidden et al, 1989).

In addition, the presence of fine grained, anoxic muds which comprise typical mangrove habitat in the Pilbara contribute to enhanced absorption of the hydrocarbon and low rates of aerobic degradation.

Resources at Risk from a Condensate/Diesel Spill

Both ecological and socio-economic resources of the Dampier Archipelago have been identified and assigned to one of four categories of environmental sensitivity by the

Woodside Oil Spill Contingency Plan (ERP-09). Resource maps, contained within ERP-09, indicate protective measures and suitable cleanup methods for each component and are presented as Appendix 13.

Possible environmental receptors in the Dampier Archipelago were identified using the ERP-09 resource maps and Figure 12 for the condensate/diesel spill model runs (refer section 5.3.3). The effect of a spill on these receptors is mediated by the toxicity and mass of condensate diesel coming ashore. Model outputs showing the mass of oil stranded on each $600m^2$ grid of the model are contained in Appendix 11 and are summarised in the following Table 5-21.

Table 5-21: Areas potentially impacted by condensate spillage – condensate mass (Kg) stranded on land

KP10	***Summer***				***Winter***			
	5mm hole	50mm hole	1000mm hole	Diesel spill	5mm hole	50mm hole	1000mm hole	Diesel spill
Keast Is			1200	1200			1200	50
Cohen Is			1200	1200			40	50
Flying Foam Passage Cp Brugieres Collier Rocks			1200	1200			80	100
Legendre is			200	1200				
Sailfish reef Rosemary is Bear Rocks					10			10
Angel Is Gidley Is			1000	1200				
Conzinc Is				1200				

KP30	***Summer***				***Winter***			
	5mm hole	50mm hole	1000mm hole (7000 tonne)	1000mm hole (14000 tonne)	5mm hole	50mm hole	1000mm hole (7000 tonne)	1000mm hole (14000 tonne)
Keast Is								
Cohen Is								
Flying Foam Passage Cp Brugieres Collier Rocks								
Legendre is								
Sailfish reef Rosemary is Bear Rocks			70	70				
Angel Is Gidley Is								
Conzinc Is								

The above table clearly establishes a maximum of 1200 kg of condensate or diesel coming ashore in any 600m^2 grid. The model indicates only the greatest mass coming ashore for any of the 100 trajectories considered. The results are therefore inherently conservative and need to be evaluated in conjunction with the spill risk (refer Tables 5-13 to 5-20).

The model is also conservative in the sense that it assumes no diversion, dispersion or cleanup actions are taken. Accordingly, it is unlikely the full 1200 kgs would reach land, and in the case it did so, the effects would be localised and the small mass of condensate/diesel would be biophysically weathered within a short time interval.

5.3.6 Sensitivity of Dampier Archipelago habitats

Extreme Sensitivity

Wading birds and their habitats:

Wading birds feed and roost on many intertidal mudflats around the Dampier Archipelago. Both the birds and their habitats would be extremely sensitive to condensate or diesel pollution. They are protected under Japan-Australia and China-Australia Agreement (JAMBA and CAMBA, respectively).

Mangroves:

Mangroves are extremely sensitive to condensate/diesel pollution with effects ranging from leaf burn and defoliation to death at quite low levels of contamination. Hydrocarbons can penetrate mangrove sediments via animal burrows and root channels and persist for many years, particularly in fine anaerobic sediments.

Mangroves are important as a coastal stabiliser and as a provider of food and shelter to birds, fishes and a range of invertebrates. Important mangrove stands in the Archipelago include Withnell Bay, Conzinc Bay, King Bay, Karratha Bay and Searipple Passage.

The recovery of mangroves is generally considered extremely slow, however studies by Woodside at a condensate affected site adjacent to the OTP suggest that some individual *Avicennia marina* trees, previously recorded as dead, have shown evidence of recovery some seven years after the initial condensate contact. Mangrove seedlings which have colonised the impacted area, along with more recent plantings, are successfully becoming established despite residual hydrocarbon contamination.

High Sensitivity

Pearling leases:

Pearl oysters are considered highly sensitive to condensate/diesel pollution, although spill models indicate negligible risk of a spill from the second trunkline reaching existing oyster leases. Pearl oysters are located at three locations within the Archipelago; Flying Foam Passage, between Enderby and West Lewis Islands and between Goodwyn and Enderby Islands, although only the Flying Foam site is close to the second trunkline. Should Pearl Oysters be contacted, mortality would be confined to the animals in contact with the water surface and near surface dissolved hydrocarbon zone. The current method of oyster farming is to grow the oysters in metal cages well under the water surface. It is expected the very thin film of hydrocarbon on the surface at the oyster farm locations would generate only small local soluble hydrocarbon concentrations close to the water surface. For this reason, toxic effects on oysters are not expected, however some coating of

infrastructure in contact with the condensate or diesel is expected and temporary economic loss would occur until affected stock or equipment can be replaced.

Industrial areas:

These are areas of industrial development associated with Woodside, Dampier Salt and Hamersley Iron Operations (Port facilities, saltwater intakes, jetties etc.). Modelling has indicated little risk to these facilities from a condensate or diesel spill.

Marine mammals:

Potential effects of condensate or diesel on marine mammals can be related to direct surface fouling, direct or indirect ingestion (oiled fish, molluscs, plankton and seagrasses) and the inhalation of toxic vapours. Effects may include irritation of sensitive membranes in the eyes, mouth, digestive and respiratory tracts and organ or neurological damage. Dugongs could be affected if their food source (primarily seagrass) is impacted.

Birds other than Waders:

There are many species of seabirds both in the offshore areas and within the waters of the Dampier Archipelago, which could be detrimentally impacted by a condensate/diesel spill. Nesting sites for many sea birds including wedge-tailed shearwaters, pelicans and terns occur within the Dampier Archipelago. The waters and beaches adjoining these nesting areas are seasonally vulnerable to the effects of any condensate or diesel spill. Seabird nesting sites are detailed in Appendix 14 and are included in Woodside's Oil Spill Response Plan (ERP-09).

Offshore, sea birds tend to be patchily distributed and a major condensate or diesel spill is unlikely to have a significant impact. Near to shore or islands, larger aggregations occur. Seabirds most at risk include surface feeders and divers.

Effects include hypothermia from plumage fouling; anaemia, pneumonia, organ damage from oil ingestion; and embryo mortality from transfer of condensate/diesel residues to eggs.

All bird species potentially at threat from a condensate or diesel spill within the Archipelago are widespread and even significant mortality is unlikely to pose a long term threat. Bird populations in the area are severely disturbed on a regular basis with the passage of tropical cyclones and recovery of the population after a condensate/diesel spill is therefore expected to be rapid.

Turtles:

Green, hawksbill and flatback turtles are common in the waters of the Dampier Archipelago. Loggerhead turtles, whilst less common, have also been recorded. Significant nesting beaches occur on Keast, Legendre, Delambre, Rosemary and Enderby Islands. Turtles can be expected to avoid areas of condensate/diesel spillage.

The effects of condensate on marine animals are documented above, however the greatest threat to turtle populations would be from the beaching of condensate or diesel on nesting beaches during the turtle nesting season.

Coral Reefs:

Coral reefs fringe the shores of many of the islands in the Dampier Archipelago. The corals in this area are important and highly diverse. Unless the tide is extremely low, the majority of corals are unlikely to come in to direct contact with floating condensate or diesel. Corals may be impacted if subjected to direct contact during periods of low water,

or through exposure to suspended droplets of dispersed hydrocarbon. Effects include tissue damage, growth and behavioural effects and death. Recovery from an extensive impact is estimated to take 10-20 years.

Moderate Sensitivity

Boats and Moorings:

Boats and moorings are classed as moderately sensitive as cleaning may be both difficult and expensive. Damage is, however, not permanent. The Archipelago is popular for recreational boating and larger boats are often moored in Hampton Harbour.

Sandy Beaches:

These include amenity beaches on the Burrup Peninsula and the islands of the Dampier Archipelago. Pollution of amenity beaches will result in disruption to recreational activities, however, most of these beaches can be cleaned without causing long term damage to their recreational value. Most sandy beaches are of low ecological diversity.

Fishing Activities:

Pelagic fish are not considered to be particularly sensitive to condensate/diesel spills because of their ability to move away from affected areas, however eggs and larvae are believed to be susceptible to the effects of hydrocarbon pollution. Demersal fish are unlikely to be impacted in deeper waters, however, fish in shallow sheltered embayments and rock pools would be at risk. The greatest threat to fish stocks from a condensate or diesel spill is considered to be to inshore nursery areas. Recovery from a major spill event is estimated to take several years.

Sheltered Rocky Shores:

Condensate or diesel beaching on rocky shores in more sheltered locations within the Dampier Archipelago can be expected to accumulate in rocky crevices. Whilst weathering of lighter oils (condensate and diesel) will continue, these shorelines often support mangrove fringes which may be detrimentally impacted (see above).

Algae and Seagrass Beds:

These communities occur in intertidal and subtidal areas within the Dampier Archipelago. Algae are considered to be tolerant to the effects of hydrocarbon pollution, however, intertidal seagrasses and their associated invertebrates, may incur adverse impact. Recovery of seagrasses from oil spills has been observed within 1-2 years.

Low Sensitivity

Pebble and Shingle Mixed Beaches:

These types of beaches are of low sensitivity to condensate or diesel pollution as they are usually found in high wave energy areas which promote weathering and dispersion. The substrates are well aerated and biodegradation of residual hydrocarbon will occur rapidly. Ecological diversity of these habitats is low and recovery rate is moderate.

Exposed Rocky Shores and Cliffs:

Within these areas the natural degradation of condensate/diesel would be rapid due to strong wave action. Beaching of condensate residue may result in the mortality of the animals inhabiting the shores, primarily molluscs and barnacles. Recovery rates are considered moderate to fast.

Open Waters:

Plankton in the upper water column are expected to be susceptible to the effects of condensate or diesel spills, but recovery is expected to be rapid from surrounding waters.

5.3.7 Mitigation of Risk to the Dampier Archipelago from the Second Trunkline

Risk Management and Monitoring

The management of risk relies on adequate barriers to prevent the event and avert the consequences should an incident occur.

The following design practices are in place to minimise the risk of trunkline failure:

- Applications of design codes and material specifications to appropriate Australian and international standards.
- X-ray inspection of welded joints.
- Hydrostatic pressure testing prior to commissioning.
- Provision of external corrosion protection (coatings and anodes).
- Providing on bottom stability and impact protection (eg: weight coating, trenching, rock berm placement, exclusion zones/pilotage requirements).
- Monitoring, measurement and logging of the mechanisms which cause corrosion.
- Monitoring and evaluation of the corrosion protection system.
- Measurement of the corrosion attack to pipelines and risers.
- Use of anti-corrosion chemicals.

Trunkline monitoring

The following methodologies are used to detect damage to the existing trunkline and will be extended to the second trunkline:

- Routine trunkline inspections by side scan sonar, ROV and divers.
- Post cyclone inspections.
- Routine intelligent pigging operations (sending a computerised monitoring device through the trunkline powered by gas pressure).
- An engineering assessment of service history of the pipeline.

Trunkline ruptures could include pinhole leaks, small cracks, large splits and damaged components such as valves, flanges and gaskets.

Ruptures of the trunkline are detected by:

- Platform or plant instrumentation during routine operations.
- Visual observations (plant, platform, vessel or helicopter personnel).
- ROV or diver inspections.

Emergency Response

In the event of a serious trunkline rupture the Woodside Pipelines Emergency Response Plan (ERP-04) and the Woodside Oil Spill Emergency Response Plan (ERP-09) would be

activated. Responses will vary depending on the location and severity of the leak, however, actions that may be undertaken include:

- Stopping the flow of gas and condensate.
- Informing the marine authorities and establishing a marine safety zone.
- Depressurising the trunkline.
- Trunkline inspection and remediation planning.

In the event of severe damage, the Pipelines Emergency Response Plan will take precedence until such time as the Duty Offshore Manager considers the emergency controlled to the extent that oil spill response measures can be initiated. Mobilisation of equipment and personnel in readiness for the execution of response actions in accordance with the Woodside Oil Spill Response Plan (ERP-09) will then proceed. The Table of Contents of ERP-09 is included as Appendix 12.

Woodside maintains a comprehensive oil spill contingency plan for the Dampier Sub-basin (WOP ERP-09). This Plan, approved by the WA Department of Minerals and Energy and updated annually, addresses specific actions in the event of potential spills sourced from:

- vessels
- fuel transfers
- cargo loadings
- production facilities
- drilling operations
- trunkline loss of containment.

The Oil Spill Response Plan is supported by trained personnel and equipment stockpiles on the King Bay Supply Base.

The Oil Spill Response Plan was last updated in November 1996 and is currently undergoing a major revision. While all information presented in this document is current, certain information, such as contact details, may change during this revision. The Table of Contents of the Plan is presented as Appendix 14 to illustrate the breadth of this document.

The decision flow chart adopted for spills is illustrated in Figure 19. In most cases a spill would be first attended by the Woodside's Fast Response Craft permanently moored at King Bay Supply Base. This craft carries a crew of 2-4 persons and a limited amount of oil spill equipment sufficient to deal with small volumes of hydrocarbon such as minor spills from dredges.

The Fast Response Craft would be quickly supplemented by other available vessels such as the large pilot vessel, tugs and available supply vessels. These vessels have the capacity to carry large amounts of booms and dispersant spraying equipment, however response time is greater as equipment needs to be loaded and there may be draught limitations close to shore. The ability to use aircraft based dispersant spraying equipment also exists.

The Woodside Oil Spill Response Plan carries specific plans for Withnell and King Bay, but these can be generalised for most spills within Mermaid Sound according to the wind direction:

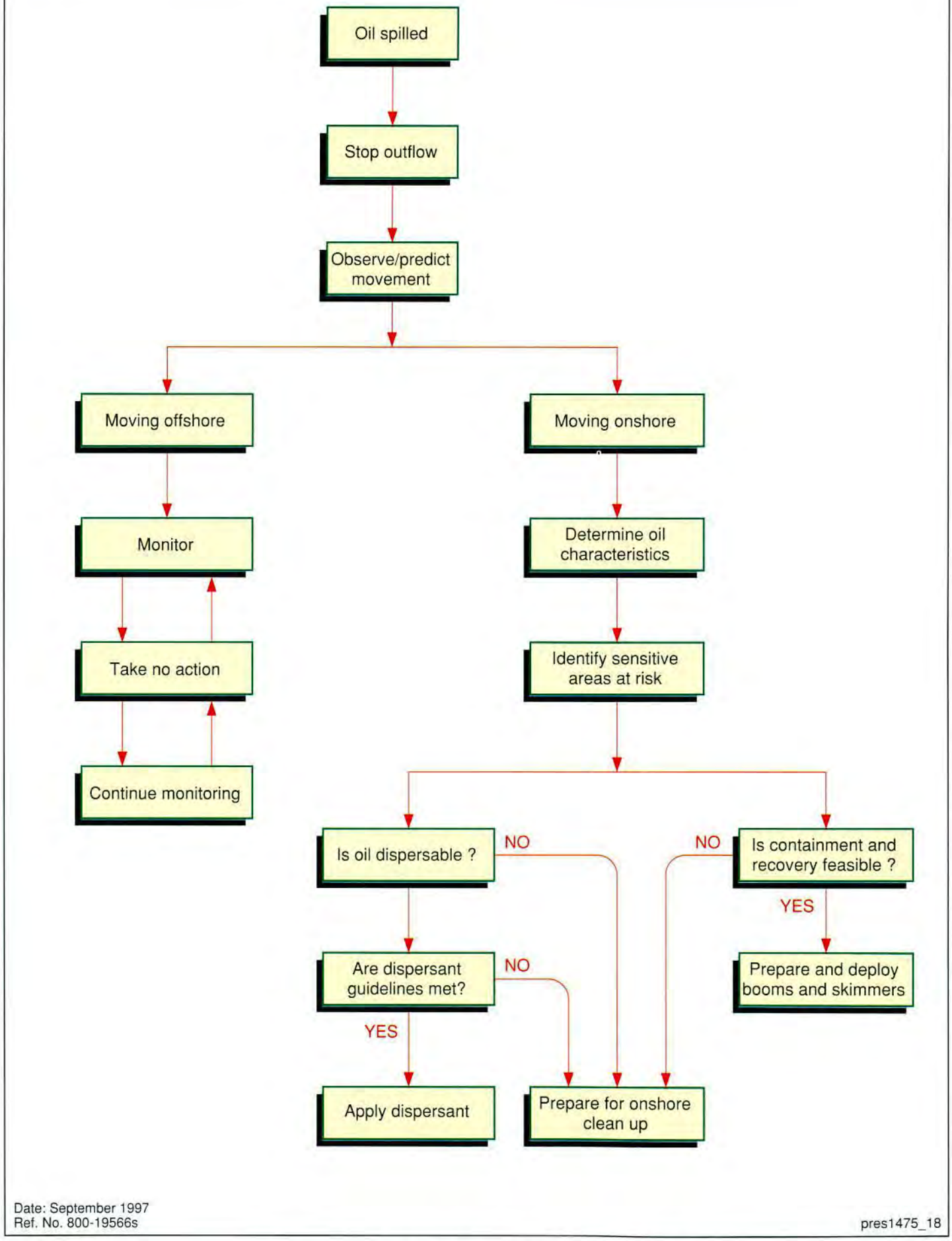


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Figure 19 - Second Trunkline Project PER

OIL SPILL RESPONSE STRATEGIES

Offshore Winds

- Observe/monitor. Commence Oil Spill Trajectory modelling and observe visually during daylight hours
- When safe to approach spill, commence mechanical agitation to assist dispersion. Deploy absorbent mats where practicable.
- Prepare booms and containment equipment for deployment in the event of wind shifts.
- If the slick persists and threatens sensitive areas, then deploy booms to corral or deflect spill to designated collection beaches.

Onshore Winds

- Initiate the immediate mobilisation of sorbent booms.
- Commence oil spill trajectory modelling to ascertain probable spill landfalls.
- Protect designated sensitive resources by deflecting oil to designated collection beaches.
- When safe to approach spill, commence mechanical agitation to assist dispersion.
- Deploy a secondary barrier of sorbent booms within threatened mangrove areas to protect from un-deflected oil.
- Where the oil has been brought ashore onto a collection beach, monitor and contain. Commence cleanup operations.
- Allow natural dispersion and commence clean-up where possible.

Woodside maintains a large store of oil spill combat equipment at the King Bay Supply Base and has access to the equipment maintained by other petroleum operators and the Dampier Port Authority.

The highly volatile nature of condensate precludes a close approach to a spill by any craft until all the light hydrocarbons have evaporated and dispersed. This "safety stand-off time" depends on spill size, but a minimum of 30 minutes post spill is necessary. For ongoing spills or where gas escape is occurring, the safety stand-off time may have to be extended, however it should be possible for spill containment and shore protection operations to commence in safe areas.

Response time

Response time within the Archipelago is dependent on the distance from King Bay Supply Base and whether the spill is ongoing, forcing response vessels to stand off the spill.

If the cause of a spill is a trunkline rupture, response time will also be affected by the size of the rupture and associated period until the rupture is noticed.

The modelling gives some idea of the time of travel of the various spill scenarios to selected areas of the Archipelago. These are detailed in Table 5-22 below.

For the diesel spill and the 1000mm rupture at KP10, notification would be almost immediate. Although time to the closest landfall (South end Angel Is, west coast Gidley,

Conzinc Is) is <3 to <4 hrs in the summer scenario, this would be adequate time to mount an effective response. For the condensate spill, it can be expected that over 80% of the volume would have evaporated, although the hazardous area may be unsafe for vessels to enter for a period of 6 hours due to ongoing gas and/or condensate releases. It is expected that spill containment and shore protection activities would be initiated almost immediately in safe areas.

Holes in the trunkline (5 to 50mm) at KP10 have the potential to take longer to notice, although proportionately less condensate will be spilled. For releases in the area KP0-KP8, it is possible that impact with shorelines could occur, before a response could be mounted.

Most receptors in the Dampier Archipelago take from 9 to 24 hours to be affected in all scenarios modelled. This time is important as it gives the condensate or diesel time to evaporate and/or weather. In addition, it allows response teams to implement measures to protect sensitive areas identified in the Oil Spill Response Plan.

Woodside also maintains a real time 3D oil spill modelling capability through the services of the Bureau of Meteorology. The model can be used to track condensate spills both offshore and within the waters of the Dampier Archipelago.

Please refer to Table 5-22 overleaf for times of travel to various environmental receptors within the Dampier Archipelago.

Tiered Response Mechanism

In the event of a condensate spill beyond the response capability of Woodside, a request will be made for the Oil Industry Marine Oil Spill Action Plan (MOSAP) to be activated. The Regional Incident Controller of this plan (a Woodside employee) is able to co-ordinate and receive rapid assistance from other petroleum operating companies on the North West Shelf. Additional support for oil spill management is also available within 24 hours of notification from the industry sponsored Australian Marine Oil Spill Centre (AMOSC) based in Geelong, Victoria.

Shipboard Oil Response Plan and Reporting of Spills

Support vessels involved with the trunkline installation are required under international maritime law to have a Ship-Board Oil Spill Response Plan (SOSRP). These plans will be required to interface with Woodside's ERP-09. Vessel Masters will be required to immediately report to Woodside any spills over 20 litres, so that any necessary remedial action can be undertaken. Vessels will also be required to have an 'on deck' capability for containment and recovery of minor oil spills.

Diesel Spill Mitigation

On-station refuelling of vessels, such as dredges, poses a risk of spillage. Modelling has shown that the spillage of a modest amount of diesel (1000 litres), has an equivalent potential to affect environmental receptors in the Archipelago than a larger spill of condensate. This is primarily due to the different physical properties of diesel affecting weathering rates

Most dredges (trailer hoppers and clamshell) will not have to refuel at all and if this is necessary, refuelling will be done in port, where spill risk factors are more easily controlled.

Cutter-suction dredges will have to refuel on station. It is anticipated approximately 6 on-station refuellings will occur. The following measures are proposed to mitigate the risk of a diesel spill:

- Refuelling only in daylight hours
- Refuelling only in calm sea states (<15 knots wind speed)
- Use of dry break couplings on refuelling hoses
- Refuelling to be supervised by an observer in contact with operators by radio
- On-board availability of absorbant booms for quick response to minor spills.
- Quick availability of back-up equipment from King Bay Supply Base via the Fast Response Craft and the "Burrup Pilot"
- Ensuring integrity of fuel transfer equipment by regular maintenance and inspection.

5.4 Risk from Second TOT

A PRA has been formulated for the proposed second Trunkline Onshore Terminal (TOT) to determine the associated risks and whether these risks meet the Department of Environmental Protection and Department of Minerals and Energy risk criteria.

Both societal and individual risk criteria were determined for the second TOT by a process involving hazard identification, hazard screening, and calculation of frequency, evaluation of consequence and finally, the calculation of risk. Analysis was performed on both the existing and the second TOT together and the second TOT in isolation.

Table 5-22: Locations potentially impacted by condensate spills – Time of Travel to Land (Hours)

KP10	Summer				Winter			
	5mm hole	50mm hole	1000mm hole	Diesel spill	5mm hole	50mm hole	1000mm hole	Diesel spill
Keast Is	12-24	24	12-24	12-24	24		24	24
Cohen Is	9-12	9-12	9-12	9-12	24		24	24
Flying Foam Passage Cp Brugieres Collier Rocks	12-24	12-24	9-12	12-24	12-24	24	12-24	12-24
Legendre is	12-24	24	12-24	12-24				
Sailfish reef Rosemary is Bare Rocks								
Angel Is Gidley Is	<3 <4	<3 <4	<3 <4	<3 <4	<3 24	<3	<3 24	<3 24
Conzinc Is		<4	<4	<3				
East Lewis is				24				

KP30	Summer				Winter			
	5mm hole	50mm hole	1000mm hole (7000 tonne)	1000mm hole (14000 tonne)	5mm hole	50mm hole	1000mm hole (7000 tonne)	1000mm hole (14000 tonne)
Keast Is								
Cohen Is								
Flying Foam Passage Cp Brugieres Collier Rocks								
Legendre is								
Sailfish reef Rosemary is Bare Rocks		9-12	12-24					
Angel Is Gidley Is								
Conzinc Is								

When the risks from the second TOT are taken in isolation from the existing facility, risk contours decline from 10^{-4} per year around the processing equipment itself to 10^{-6} per annum at the plant boundary. The 10^{-6} per annum boundary contours extend approximately 100m into Mermaid Sound on the west, but is approximately in line with the Withnell Bay shoreline to the east of the OTP.

5.4.1 Hazard Identification

Hazards evaluated were;

- Equipment failure
- Plane crash
- Traffic impact
- Dropped objects
- Severe weather
- Earthquake
- Missiles

The major identified accidents were releases of gaseous flammable materials as high pressure momentum jets and flammable liquids as either pool, liquid jet or dispersing low momentum plumes.

5.4.2 Frequency Analysis

The frequency analysis was performed in a standard manner utilising generic equipment failure databases such as E & P Forum.

A parts count was then performed on the proposed TOT and a failure frequency assessment performed. This equipment failure assessment was combined with a standard distribution of possible hole sizes to produce the overall frequency of small, medium and large releases.

Using relevant process data applied to the particular equipment item an assessment of which holes would produce what flow rate could be determined. The frequency of that failure could then be assigned to a particular flow rate

Event trees were then used to assign a frequency to each release consequence (ie whether it resulted in a jet fire, dispersed plume or explosion) for each process section and flow rate.

5.4.3 Consequence Assessment

The consequence assessment derives the effects of releases. The consequences assessed were:

- Methane jet fires (5-6400 kg/s)
- Flammable methane jet (5-6400 kg/s)
- N-Hexane bund-pool fire
- N-Hexane jet fire
- N-Hexane continuous low momentum release (7-75 kg/s)
- N-Hexane instantaneous low momentum release of 22000 kg/s

Hexane is taken to be representative of a condensate release. The result of the consequence assessment was distances for each of the consequence cases at which fatal thermal doses, threshold thermal doses for various burn degrees or the Lower Flammable Limit (LFL) would be exceeded. Escalation to other nearby facilities was also considered.

5.4.4 Risk Analysis Results

The risk assessment modelled the previous data on a matrix of points around the OTP.

In isolation, the second TOT was found to have a very low boundary fence contour of 10^{-6} or lower. The 10^{-6} contour extended into Mermaid Sound a short distance, but was coincident with the Withnell Bay Shoreline. The 10^{-5} contour was short of the administration areas and laboratories on-site and the risk to these areas acceptable.

The cumulative risk is that due to the proposed and existing facilities. In this case the contours from the second TOT are similar to the existing OTP.

A result of these studies indicates negligible additional risk from the proposed facilities to the public or local environment.

Adoption of good engineering practice and accepted standards will ensure the additional risk from the second TOT will be tolerable when assessed against Woodside, industry and regulatory criteria.

Due consideration will be given to escalation risks from new and existing facilities during the detailed design phase. Assessment of escalation risks is an inherent part of the design process to maintain existing plant integrity.

Primarily design considerations and operational practice will manage risk from the second TOT. A risk management strategy for the entire second trunkline and TOT/Domgas projects is provided below.

5.5 Risk from Domgas and Fractionation facilities

The definition of the Domestic Gas Debottlenecked facilities is not yet sufficient to enable preparation of a meaningful PRA.

However a PRA has been prepared for the *Liquids Expansion Project* (LEP) which assumes an identical fractionation plant to the one proposed in this Project. It also includes extra liquids handling and power generation facilities and in this respect represents a higher risk scenario.

Methodology was similar to the above risk assessments with an equipment parts count done on isolatable sections of the facilities. From this a set of release cases was developed with associated release frequencies.

The model for the Onshore Treatment Plant was then run using the above data and modified risk contours produced.

The results show movement outwards of the 10^{-6} per annum contour at the Southern end of the Plant by about 90m. In all other respects, the contours are indistinguishable from the current ones and remain well within the Plant Boundary.

As the LEP facilities, for which the fractionation unit proposed for this Project is a major part, meet the DEP criteria, there is good evidence to suggest compliance by the

additional components of the domgas debottlenecking project (sales gas and fuel booster compressors).

When project definition is sufficient, a PRA will be performed on the additional domgas facilities to ensure compliance with DEP criteria and enable update of the OTP Safety Case.

5.6 Risk Management Strategy

To ensure that there is a consistent approach to risk management, including the definition of acceptance criteria, a Project Risk Management Strategy has been defined which demonstrates the processes to be applied to meet safety and risk reduction goals.

The objectives of the Risk Management Strategy include;

- To state Project policy with respect to risk management
- To define the Project requirements for risk based engineering and external risk/safety submissions, in each physical area.
- To define the risk analysis methods to be applied in each physical Project area.
- To define the plan for performing risk and safety analysis, including scope and timing of the work.
- To define the documentation to be prepared in the course of risk analysis work.
- To define the physical interfaces to be used within the risk analysis, for each Project element and define data transfer requirements.
- Devise means of minimising risk to the Project.

5.7 Project Safety and Risk Management Policy

In order to achieve the desired best risk management outcome for the Project it is imperative that all relevant aspects of health, safety and environment (HSE) are properly considered and quantified for inclusion in the key decision making processes.

The costs associated with reducing risk to personnel, the environment the asset and to production will be taken into account in the assessment of life cycle costs.

5.7.1 Hazard Management & Development/Update of Safety Cases

Studies will be performed to identify and assess all significant hazards associated with the design, construction and operation of the Project Facilities. The result of this work will be utilised to ensure the design of the facilities minimises the risk to personnel, the asset and the environment.

A formal Safety Assessment Schedule is being developed which will ensure the early identification of studies and their effective coordination and planning. The first steps of this are complete with the development of the PRAs detailed above.

During the latter stages of the detailed Engineering Phase, risk reduction options will be identified and a Quantitative Risk Assessment (QRA) will be carried out to demonstrate the risks from the trunkline are ALARP (As Low As Reasonably Practicable).

Since the proposed facilities have the potential to increase the hazard, the existing offshore and onshore Safety Cases will be revised. It is planned to submit the revised Safety Cases to the Explosives and Dangerous Goods Division and the Petroleum

Operations Division of the Department of Minerals and Energy for onshore and offshore facilities respectively. This will be done prior to start-up.

The risk assessment required for Safety Case revision will follow the methodology and consequence models that were used in preparing the original Formal Safety Assessment. Woodside will assess any risk to human life, the environment and business risk associated with the new facilities. For the Onshore Treatment Plant risks both to onsite personnel and the public outside of the plant boundary will be assessed.

5.8 Project Risk Management

5.8.1 Project safety

Project Safety shall encompass the requirements of the *WA Occupational Safety and Health Regulations, 1996*.

Hazard identification processes to be used during the design and execution of the Project will include:

HAZard & OPerability Studies (HAZOP)

Major and minor HAZOPs will be performed during the Detailed Engineering Phase of the Project. An independent Chairperson will be provided for the duration of the HAZOP workshops.

Design Reviews

Safety design review workshops will be held to review selected design operability and construction aspects.

Hazards Register

A Hazards Register will be established via a HAZard IDentification (HAZID) workshop and will be continually updated on the basis of hazards recognised during design reviews and changes.

6 SOCIAL EFFECTS

6.1 Recreational Boating - Mermaid Sound

Trenching, pipe-laying, rock dumping and spoil disposal operations are likely to cause some temporary disruption to boat based recreational use in the waters of Mermaid Sound. The majority of the Dampier Archipelago will, however, remain unaffected.

Vessels will be required to remain outside the working area during trunkline installation activities. During blasting operations support vessels will be deployed and radio procedures instigated to ensure all recreational and commercial vessels are outside the hazardous area before charge detonation. Blasting operations are expected to occur over a period of up to 4 months and will primarily be restricted to two areas - adjacent to the onshore treatment plant and at the entrance to Mermaid Sound (refer to Figure 6b). Pamphlets will be distributed through local outlets to advise recreational boaters of the hazardous periods and areas.

Some localised reduction in water quality is possible in the vicinity of Withnell and Conzinc Bay (south), Conzinc, Angel and Gidley Islands and Hammersley Shoal during trenching, pipe-lay and rock dumping operations. This may result in temporarily reduced water clarity for recreational divers.

6.2 Land Based Recreation

The beaches at Holden Point are accessible by 4WD and are utilised for recreational activities. A temporary exclusion zone will need to be enforced at the Holden Point beaches to protect the public from fly rock hazards sourced from quarry blasting. Quarrying operations are expected to last for up to 22 months.

6.3 Visual Amenity

The quarry will not be visible from the main access road on the Burrup Peninsula and whilst every effort will be made to avoid impacting visual amenity, it may not be possible to completely screen the quarry from Mermaid Sound and the beaches adjoining Holden Point.

6.4 Workforce

The workforce for the offshore trunkline laying operations is expected to operate on a fly in, fly out basis and is therefore not expected to impact on community resources in Karratha or Dampier. Manpower requirements for the construction of the TOT are anticipated to peak at 200. Approximately 60 persons are expected to be required both for quarrying and haulage activities. The size is not considered likely to impact on local community resources.

6.5 Aboriginal Heritage

The trunkline route crossing onto the OTP will avoid disturbance to Aboriginal sites. The proposed quarry site(s), haul road extension and additional land requirement to the south of the King Bay Supply Base are likely, however, to impinge on Aboriginal sites. Archaeological and ethnographical surveys are planned in these areas during 1997/98. Woodside will consult with the appropriate Aboriginal communities and comply with the provisions of the Aboriginal Heritage Act, should site disturbance be required.

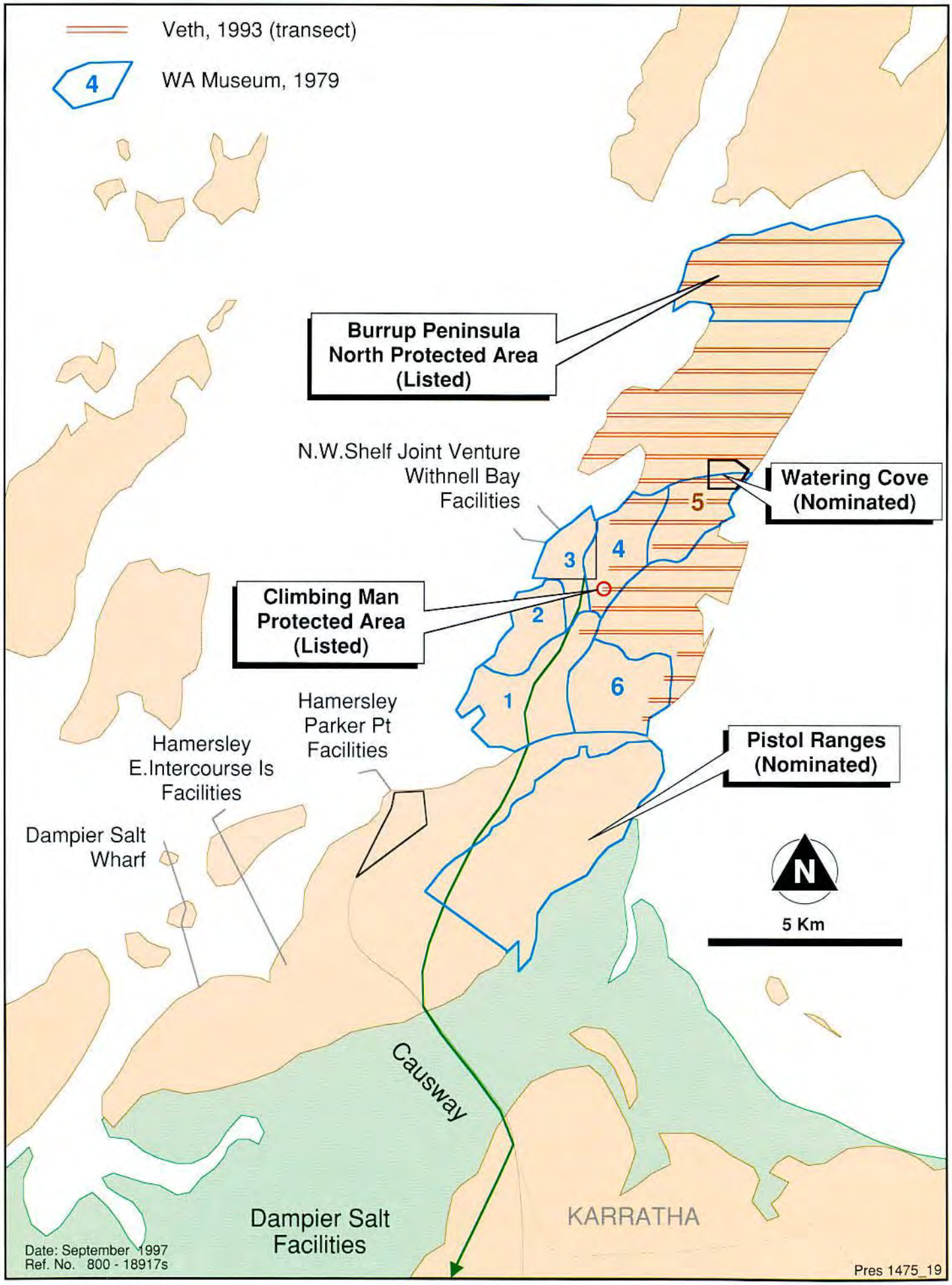

Figure 20 - Second Trunkline Project PER

ABORIGINAL SITE SURVEY COVERAGE AND BURRUP PENINSULA PROTECTED AREAS

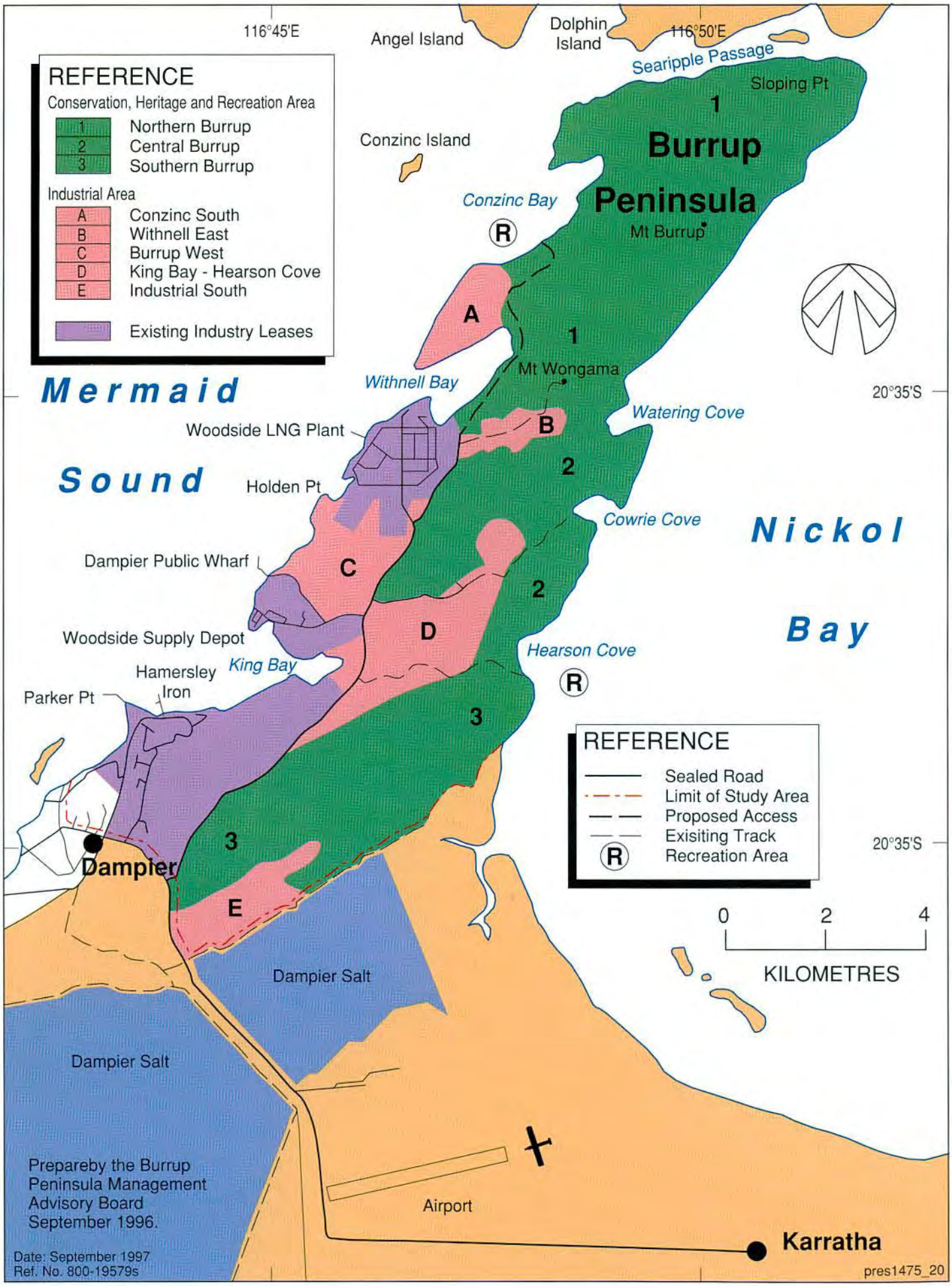

Figure 21 - Second Trunkline Project PER

BURRUP PENINSULA LAND USE PLAN

6.6 Commercial Fishing Operations

The proposed trunkline route avoids interference or disruption to commercial fishing and aquaculture operations in the eastern and western parts of the Dampier Archipelago.

The proposed route, however, passes through Zone 2 of the Pilbara Fish Trawl Fishery. Approximately nine boats operate within this fishery. The establishment of a nominal 500m wide trunkline exclusion zone will alienate a portion of the seabed available for fishing operations. The final route option is being selected to avoid or minimise the passage through areas where surface outcrops of calcarenite are known to occur and where fishing is believed to be favoured. As the area alienated by the trunkline, in comparison to the total available fishing area is minimal, no significant impacts on fishery catches are expected. The trunkline will create a refuge for fish species and may provide an overall benefit to the fishery in a similar way as fish sanctuary zones.

6.7 Community Consultation

The community groups that have been consulted in the community consultation process include:

Aboriginal Interest Groups

- Nanga-Nguna Muru-Juga Land Council (non-extant)
- Ngaluma Injibandi Native Title claimants
- Yaburara Mardudhunera Native Title claimants

Recreational & Conservation Interest groups:

- Pilbara Recreational Fishing Advisory Committee
- Dampier Archipelago Recreational Dwellers Association
- Friends of the Burrup
- Nickol Bay Naturalists Club
- Dampier Archipelago Preservation Association
- King Bay Game Fishing Club
- Dampier Skin Diving Club
- Dampier Dive Club
- Nickol Bay Sports Fishing Club

Media Representatives:

- ABC Radio
- North West Telegraph
- West Australian

Business and Government Groups:

- The Roebourne Shire Council
- Pilbara Tourism Association
- Karratha Chamber of Commerce
- Pilbara Development Commission
- Dampier Port Authority

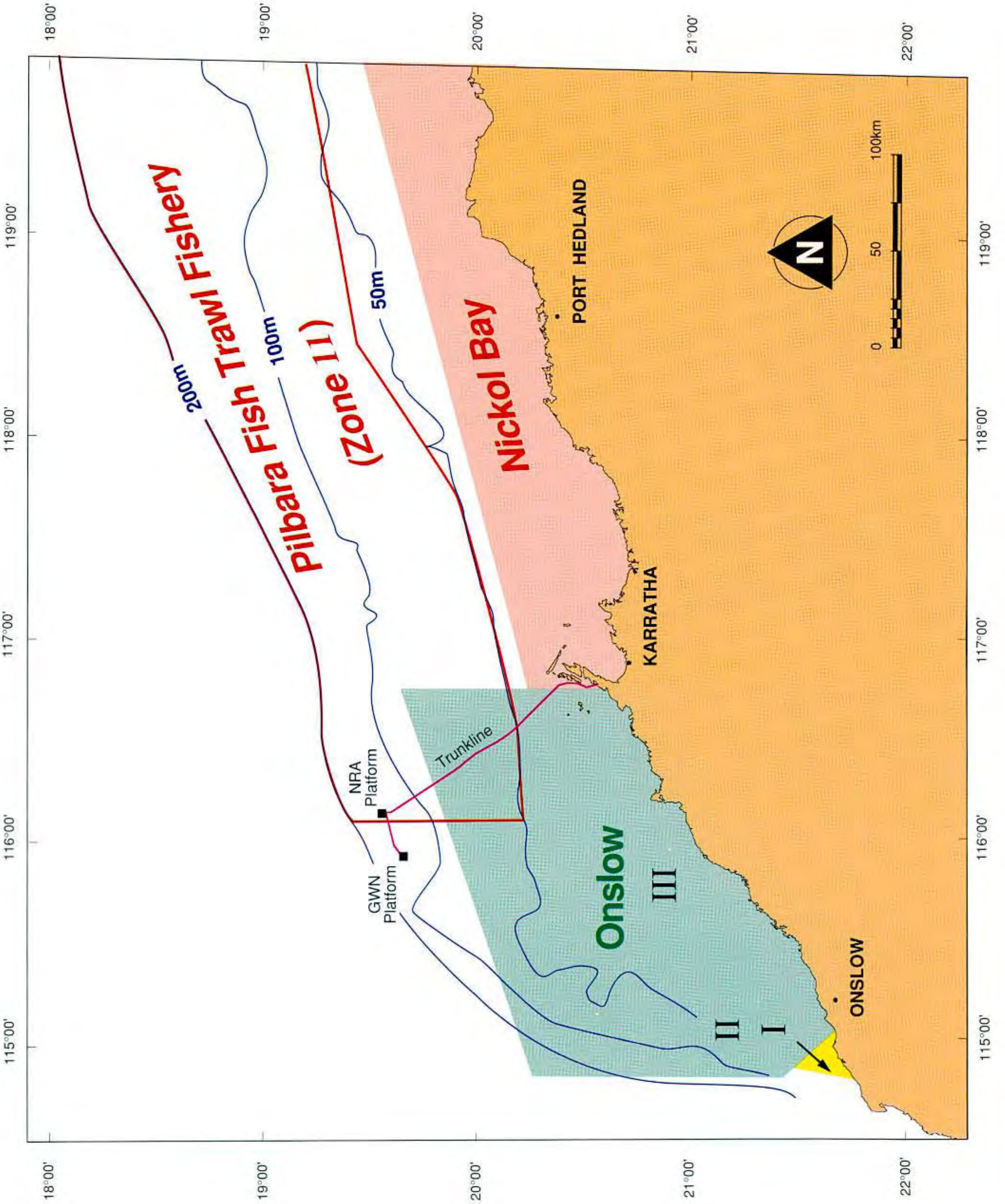

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Figure 22 - Second Trunkline Project PER

ONSLOW - NICKOL BAY LIMITED ENTRY PRAWN AND FISH TRAWL FISHERIES

PEARL FARM LEASE INCLUDES:
ALL THAT PORTION OF TERRITORIAL WATER WITHIN THE BOUNDARY DESCRIBED AND COLOURED RED ON THE PLAN BELOW AND COMPRISING A WATER AREA OF 1.94 SQUARE NAUTICAL MILES.

BOUNDARY CORNER COORDINATES

POINT	LATITUDE SOUTH	LONGITUDE EAST
A	20° 24' 48" 8	116° 51' 21" 35
B	20° 24' 48" 8	116° 53' 48" 8
C	20° 25' 30" 5	116° 53' 48" 8
D	20° 25' 30" 5	116° 52' 48" 8
E	20° 26' 30" 5	116° 52' 00"
F	20° 25' 57" 95	116° 51' 57" 95

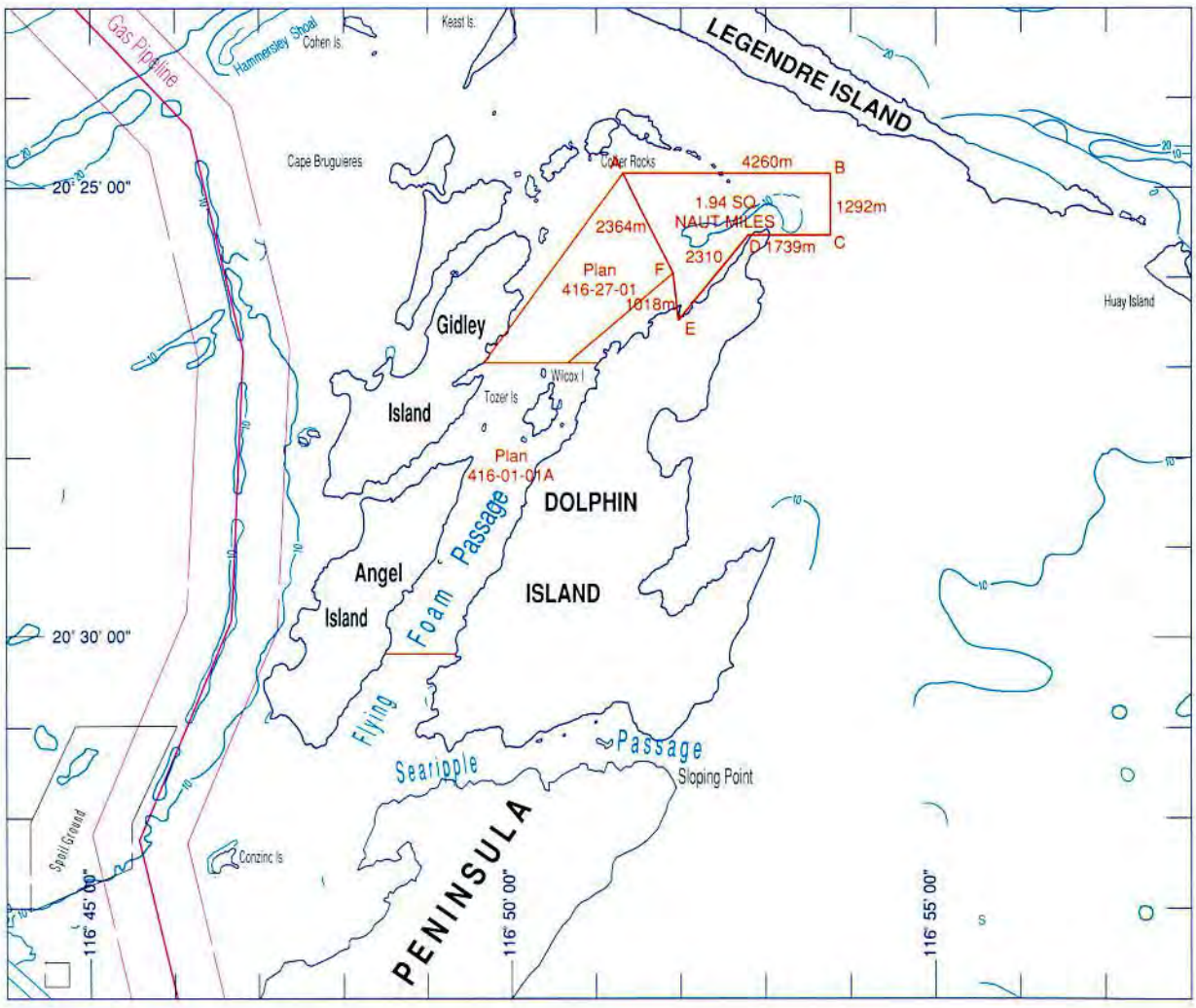

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Figure 23 - Second Trunkline Project PER

FLYING FOAM PASSAGE AND COSSACK PEARLS PTY. LTD. FARM LEASE UNDER PEARLING ACT 1990

- Woodside's Karratha based employees
- West Australian Fishing Industry Council (WAFIC)
- Nickol Bay Professional Fishermens Association
- Commonwealth Environment Protection Group
- Commonwealth Department of Primary Industries and Energy
- WA Department of Resources and Development
- WA Department of Minerals and Energy
- WA Department of Environmental Protection
- WA Department of Conservation and Land Management
- WA Department of Fisheries
- Australian Institute of Marine Science

In early June 1997, Woodside arranged a series of community briefings in Karratha and Roebourne to explain the Project, its environmental and social implications and to seek community comment. Meetings were open to interested members of the general community.

Issues Identified During Consultations

The issues raised and responses provided during the recent consultations in Karratha and Roebourne are summarised below.

What is the expected size of the construction workforce?

The workforce for new TOT construction is expected to be in the order of 200. Quarrying and haulage is expected to employ about 60 persons as are the Domgas debottlenecking activities. The Dredging and pipelay workforce will be in the order of 300, however, these will operate on a fly-in fly-out basis and be based primarily on the respective marine facilities.

How will boat access to the beaches of Holden Point be managed to ensure public safety from fly rock risks during quarry blasting operations?

Regulation of boat access has yet to be finalised, however, information pamphlets and beach signage are likely to be used, in combination with pre-blast beach inspections.

Will salt or freshwater be used for dust control in quarry and rock stockpile areas?

It is probable that freshwater will be used in preference to salt water to avoid impacting native vegetation and to prevent soil salt loading which could hamper subsequent revegetation.

Will the quarry site be rehabilitated?

As the quarry is expected to be used for sequential industrial development, it is not intended to conduct extensive rehabilitation operations.

Will quarry blasting affect Dampier residents?

It is not expected that vibrations from blasting operations will be felt in Dampier.

What will be the impact from road construction?

Rock haulage will be along the existing haul road for the majority of the route. The short extension required to avoid traffic interactions will be a maximum of 1 km in length.

Will heritage surveys be conducted over areas to be disturbed?

Aboriginal site surveys have been planned and will be conducted during 1997 to compliment those done for earlier developments. Woodside will comply with all aspects of the Aboriginal Heritage Act.

Will Woodside provide access to the beaches at Holden Point at the completion of quarrying?

Woodside does not control the land in the vicinity of Holden Point and is therefore not in a position to provide upgraded road access.

Will any new effluents will be discharged into Mermaid Sound?

No new types of effluents will arise from this project. Like the existing trunkline, the second trunkline will carry gas and condensate and minor quantities of water which are condensed out in transit. Small quantities of chemicals used offshore to dehydrate the gas and to prevent corrosion will be carried over and eventually discharged into Mermaid Sound at the end of the LNG jetty via the existing effluent diffuser. Environmental monitoring by Woodside has indicated no deleterious effects on the marine ecology in Mermaid Sound from the current OTP effluent discharge stream.

Will Dredging Activities impact on coral spawning?

It is anticipated that the bulk of the dredging activities will be completed before the coral-spawning period, nominally March/April. The trailer hopper dredge will remain on site through March and April to remove any sediment deposited into the cut trenches from cyclone activity prior to pipe lay. Woodside has committed to avoiding dredging activities within 1km of coral areas for a 10-day period spanning the coral spawning period.

Will boating access be restricted during trunkline installation operations?

As per normal marine protocols, ships and boats will be requested to remain away from dredges and pipelay vessels during installation operations. Exclusions will be necessary during blasting operations to ensure public safety.

Are pearling operations in Flying Foam Passage at risk from dredging operations?

The bulk of the sediment liberated into the water column from dredging operations is expected to fall out of suspension within 500m of operations. Visible plumes of finer materials may occur for 1500m or more (especially where rock flour is liberated), however, these plumes are unlikely to affect pearling operations which are more than 12 km away from the nearest planned dredging activity.

Is sediment deposited at the spoil ground stable?

Very fine materials deposited on the spoil ground could be mobilised by tidal currents. The spoil ground has been carefully selected, however, to ensure no sensitive communities will be affected by mobilised sediments. Coarser materials deposited on the spoil ground will be as stable as naturally deposited sediments adjacent to the spoil ground.

What will be the height of the spoil ground following spoil disposal?

Woodside is required to ensure that the minimum water depth over the spoil ground is 10m with respect to lowest astronomical tide.

Will sediments from the spoil ground be mobilised into the Hamersley shipping channel?

The Woodside shipping channel lies between the Hamersley channel and the spoil ground and to date has not been affected by spoil mobilisation. The Hamersley spoil ground near Boiler Rock lies substantially closer to the Hamersley shipping channel than does Woodside's spoil ground.

Will there be a risk of introducing the Pacific Seastar?

The Pacific Seastar, a native of temperate Japanese waters, has been introduced into Tasmanian and SE Australian temperate waters, with significant ecological consequences. The species would be unable to survive in the tropical waters of the Dampier Archipelago. There are, however, other potential quarantine issues associated with the arrival of overseas and interstate dredges and pipelay vessels that will be managed by Woodside. These include inspection of all vessels for exotic propagules and wildlife.

What will be the impacts from hydrotest water discharge?

Slight effects on marine plankton may occur up to approximately 100m from the point of discharge of hydrotest water.

What is the capacity of Mermaid Sound to absorb contamination by industry?

Whilst it is probable that there is a limit to how much contaminant Mermaid Sound can assimilate, detailed ecological monitoring by Woodside, over many years, demonstrates that the NWS Gas Project has not had any detrimental impacts on the marine ecology of Mermaid Sound.

Will the anchoring exclusion zone be enforced for small vessels?

Woodside, to date, has not sought enforcement of the anchoring exclusion for small recreational vessels. In Mermaid Sound, the rock berm overlaying the trunkline will provide ample protection from recreational vessel anchors, as has the berm on the existing trunkline.

Will a commercial trawling exclusion zone be established offshore?

An exclusion zone would be established for the protection of the trunkline from large vessel anchors and for the protection of fishing vessels. The trunkline itself is not at risk from fishing trawl board impacts. The extent and nature of any exclusion will be determined in consultation with commercial fishermen and their representatives.

Can the trunkline be moved closer to the existing trunkline?

The prime driver in the selection process for the 2nd trunkline route is the presence of seabed conditions that will enhance trunkline stability and integrity. The alignment of the original trunkline was moved substantially by cyclone "Orson" in 1989. Optimal seabed conditions for the stabilisation of the second trunkline have been identified approximately 15km east of the existing trunkline.

Within Mermaid Sound can the 2nd trunkline be positioned to the west of the existing line?

The 2nd trunkline is afforded protection from ship groundings or from large vessel anchors by being positioned east of the existing and heavily armoured trunkline.

Will compensation be paid for the loss of any trawl grounds?

Woodside considers that the loss of trawlable ground attributable to the 2nd trunkline in relation to the total trawling area in the Pilbara Fish Trawl Fishery, is not significant. Any exclusion resulting from the 2nd trunkline may provide a refuge for fish species, potentially enhancing the viability of the existing fishery.

7 ENVIRONMENTAL MANAGEMENT and SAFEGUARDS

The following section outlines the key management controls and safeguards which will, or have been, initiated by Woodside to manage the projects key environmental issues. A summary table of commitments on all major environmental issues is also provided in Section 9.0.

7.1 Environmental Management Strategy

Woodside has in place a Health Safety and Environmental Management System (HSE-MS) which is the basis upon which environmental aspects of the project will be managed. 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. This Policy is included in this document as Appendix 1.

The Woodside HSE-MS is currently being refined and implemented. It is based on the AS/NZS/ISO 14000 series, but has been slightly modified to be auditable against the HSE-MS of the NWSGP Technical Adviser, Shell. The modification involves the addition of an element "Hazard & Effects Management Processes" or HEMP. The high level structure of the system is contained in Appendix 8.

The NWSGP environmental management performance is audited externally every three years. The system also contains a two tiered system of inspections and internal audits on specific activities or facilities. These internal checks are held at least 4 times per annum.

Environmental management will be integrated with all aspects of the proposal. Environmental issues were identified at an early stage in Project planning as an internal *Register of Environmental Effects* enabling Project management could 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.

Construction and installation 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. The Tenderer is required to submit details on its Environmental Management Policy and Environmental Management System and provide a preliminary Environmental Management Plan (EMP). This EMP will be further developed if the Tenderer is successful.

For activities identified as potentially harmful to the environment, detailed Environmental Management Plans will be prepared to Woodside's and where appropriate, regulatory agency requirements. Activities requiring this comprehensive planning include dredging, blasting and quarrying.

In line with the Company's HSE-MS, environmental inductions will be provided to all employees involved in the installation and construction phases of the Project. This induction will usually involve input from professional environmental staff.

In addition, the internal audits and reviews will be used as tools to ensure compliance with Woodside requirements.

The Management of specific environmental issues within the Second Trunkline & Domgas Debottlenecking Project is contained in Section 9 of this document.

8 ENVIRONMENTAL MONITORING & STUDIES

8.1 Air Quality

As a precursor to future OTP expansions, Woodside is currently defining a limited atmospheric study programme, to better characterise the dispersion of pollutants in the prevailing meteorological regimes existing on the Burrup Peninsula. Concurrently the Department of Environmental Protection (DEP) is planning an air quality meteorology study over the West Pilbara Industrial area with the objective of establishing an Atmospheric Environmental Protection Policy and an Atmospheric Management Plan. It has been proposed that Woodside and the DEP work cooperatively in the data acquisition stage.

The operating licence for the OTP, issued by the DEP currently requires emission monitoring of a range of contaminants including NO_x and SO_x, H_2S and dark smoke. Programmed hydrocarbon gas emissions are approved by the DEP by way of an agreed annual schedule. Any accidental or emergency hydrocarbon discharges of greater than 10 tonnes are reported to the DEP in accordance with licence condition A1(a).

The Onshore Treatment Plant Environmental Licence is included as Appendix 15 to this document.

8.2 Water Quality

The operating licence for the OTP also requires effluent monitoring of a range of twenty contaminants, for quarterly reporting. Limits are set for the discharge of total oil in water (30 mg/L) and sulphinol (40 mg/L). The volume of waste water discharged from the OTP is monitored and total contaminant loads to Mermaid Sound are estimated annually.

A ground water monitoring programme is also in place on the OTP. Samples from existing bores are taken quarterly, analysed for total oil and reported to the DEP.

8.3 Biological Effect

8.3.1 Trunkline Installation

An environmental monitoring programme may be prepared if necessary, to assess the effects of trunkline installation on nearby marine communities. It should be noted that an extensive study undertaken for the installation of the original trunkline (T.D Meagher & Associates, 1984), concluded that there were no significant impacts on the marine environment of Mermaid Sound (both water quality and benthic ecology) attributable to the original trunkline construction.

As data sets are available indicating that successful re-colonisation of the Spoil Ground A/B occurs following spoil deposition; and that nearby coral communities have not been affected by this deposition (LeProvost,Semenuik & Chalmer, 1989, 1990; LeProvost Dames & Moore, 1995). Woodside does not intend to conduct additional monitoring for spoil disposal operations in Mermaid Sound.

8.3.2 Shipping Activity

Any effects on coral communities from shipping induced sedimentation in the vicinity of the product loading jetties will be monitored through the existing marine monitoring

program (ChEMMS). Similarly any increases in tri-butyl tin (TBT) sediment and biota loads will be monitored through ChEMMS. A study aimed at documenting the occurrence and extent of the effects of TBT near Woodside shipping operations in Mermaid Sound has recently commenced.

8.3.3 Rehabilitation

The progress of rehabilitation of any land temporarily disturbed during installation and construction activities will be incorporated into Woodside's existing vegetation monitoring program.

9 SUMMARY OF MANAGEMENT STRATEGIES AND COMMITMENTS ON MAJOR ENVIRONMENTAL ISSUES

Topic	Proposal Characteristics	Environmental Issue / Comment	Environmental Management / Controls
		PIPELINE ROUTE SELECTION	
	The proposed 2nd trunkline route will take as direct a route as practicable from platform to the entrance of Mermaid Sound and then parallel the existing inshore trunkline route.	Coral reefs occur within the Dampier Archipelago. Pipe-laying operations and shoreline crossings could potentially affect corals.	Selected route minimises disturbance to significant coral reef areas. Route is as direct as possible within engineering and technical constraints.
		The trunkline will pass through the grounds of the Pilbara Fish Trawl Fishery.	The Project will consult with Fishery Industry Representatives on practicable means to reduce disruption to the fishery, if necessary.
		Currently unidentified historical ship wrecks could be in the vicinity of the proposed trunkline.	Woodside will liaise with the WA Maritime Museum to ensure the trunkline does not impinge upon any identified shipwrecks.
	Shore crossing point of the second trunkline.	The trunkline route from the shore crossing to the OTP has the potential to cause disturbance to the terrestrial environment.	The route enters the OTP lease directly from Mermaid Sound, avoiding potential disturbance to vegetation, landscape and Aboriginal heritage sites.
		PIPELINE INSTALLATION	
	Inshore sections of the trunkline will be buried or covered for stabilisation and protection. Dredging, trenching, ploughing and rock dumping will be required in some areas.	Increased turbidity from dredging and trenching operations may potentially affect nearby corals.	• Dredging and trenching will only be undertaken where ploughing is not feasible or cost effective. • A substantial buffer between pipe-laying operations and significant coral areas will be maintained wherever practicable.
Dredging	Dredging of trunkline trench and project facilities.	Spoil dumped in-situ may affect sensitive benthic communities.	• Spoil not used for backfill will be removed from environmentally sensitive areas to a dedicated spoil ground. • Clamshell dredging may be used in the KBSB wharf extension to utilise some dredged material for wharf backfill without excess turbidity.

Topic	Proposal Characteristics	Environmental Issue / Comment	Environmental Management / Controls
		Dredging program must address waste management, and oil spill prevention and response.	A Dredging Environmental Management Plan will be prepared for the WA DEP, covering Dredging operations, spoil disposal, and monitoring programmes.
		Corals are assumed to have heightened sensitivity to elevated sediment loads during the coral spawning period.	Dredging operations within 1000m of corals will be avoided for a 10 day period during the coral spawning period (nominally March/April).
		Pipeline laying operations could disrupt shipping and fishing operations on the North West Shelf.	Close liaison will be maintained with AMSA , Professional Fishermen's Associations and with the WA Fishing Industry Council to notify commercial shipping and fishing operations during pipelaying operations.
Spoil disposal	Up to 5 x 10^5 m^3 of spoil from trenching and dredging operations may need to be disposed of at a dedicated spoil ground.	Extensive modelling and monitoring has been undertaken at spoil ground A/B in Mermaid Sound. Studies conclude that the area has been colonised by benthic biota comparable to that occurring in neighbouring areas of Mermaid Sound and that there has been no effects on nearby sensitive coral communities.	• Woodside will seek a Sea Dumping Permit from Environment Australia to utilise spoil grounds A & B for dredge spoil disposal. • Woodside will abide by the conditions in the permit and the Dredging EMP.
Blasting	Blasting will be required in inshore areas where calcarenite outcrops occur or where igneous rock or pavement occurs close to shore.	Blasting will result in mortality of aquatic fauna close to the detonation point.	• Routes requiring blasting will be kept to a minimum. • Procedure(s) will be developed to ensure a watch is maintained for marine mammals and turtles. • Safe distances will be ascribed after consultation with regulatory agencies (provisionally 500m). • Fish and invertebrate populations can be expected to recover rapidly.
	Charge delay coatings may enter the marine environment.	• Previous blasting operations at Star Rock in 1987 resulted in the release of buoyant and persistent plastic material. • Persistent plastic blast casings may pose a pollution concern and risk to seabirds.	• Alternatives to buoyant or persistent plastic coating on explosive charges are under investigation. • Woodside will develop a strategy to minimise the release of plastic coatings after each charge.
		Dead fish on ocean surface may attract birds to blast areas.	Collection of dead fish after each blast will be organised if required.

Topic	Proposal Characteristics	Environmental Issue / Comment	Environmental Management / Controls
		Instantaneous charges will result in overpressure effects on marine life close to the detonation point.	The optimal charge structure will be used for each blast to reduce possible effects on adjacent marine life.
Trunkline hydrotesting	A hydrostatic pressure test of the trunkline is required by regulation	Biocides and corrosion inhibitors may be required in the hydrotest water.	Chemicals will be used in the minimum quantities required and will be screened for environmental properties. Woodside will target < 10% LC_{50} concentration values of the contaminant at point of discharge.
Hydrotest discharge		Discharge may be required from both the inshore and offshore sections.	• Discharge designed for maximum dilution and aeration at discharge. Appropriate modelling will be undertaken to ensure any inshore discharge will not impact on sensitive marine communities. • Any discharge onshore will be to evaporation ponds
Line-pipe coating and pipe storage	Individual sections of the trunkline will need to be stored on land. A corrosion protective coating and a concrete weight coating may be applied on shore.	Additional land may be required to support pipe storage and coating.	• A previously disturbed area will preferentially be used for line-pipe coating and pipe storage. • A rehabilitation plan will be developed prior to disturbance to ensure rapid rehabilitation of any disturbed ground. • Consideration will be given to the use of native species in rehabilitation.

Topic	Proposal Characteristics	Environmental Issue / Comment	Environmental Management / Controls
	Chemicals and rinses will be used in the onshore weight coating process. Asphalt wrap coating requires a ice-cold water rinse	Procedures to avoid chemical and rinsewater pollution from the coating area may be required	• Chemical residues will be disposed using existing Chemical Hazard Management System (CHMS) procedures • The coating and storage site will be bunded and drained to ensure proper collection and disposal of contaminated wastewater. Recycling of wrap coating water is under investigation.
VESSEL OPERATIONS			
Pipe-laying vessels, support vessels and dredges will be operating within the waters of the Dampier Archipelago for 6 to 9 months.			
Waste management aboard vessels	Wastes will be generated aboard vessels and dredges.	The disposal of untreated sewage, grey water and solid wastes can result in pollution and localised environmental impact.	The disposal of grey water, sewage and solid wastes will not be permitted within the waters of the Dampier Archipelago or offshore unless treated in accordance with the requirements of MARPOL Annex IV. All other wastes will be brought ashore and managed through Woodside's Waste Management System.
Vessel quarantine	A number of specialised vessels will be mobilised to site to undertake pipe-laying and dredging operations.	Vessels, and in particular dredges, arriving from overseas ports pose a number of potential quarantine risks.	Woodside will ensure a quarantine inspection and report is prepared prior to any dredge arriving in Pilbara waters. The report will ensure that the vessels have a current De-ratting Exemption Certificate (issued every 6 months), are free of exotic propagules and that there is minimal residual sediment contamination from previous dredging operations.

Topic	Proposal Characteristics	Environmental Issue / Comment	Environmental Management / Controls
		Foreign Entrained Organisms may be present in ballast water.	Subject to transit safety risks, pipe-laying vessels and dredges arriving in Australia from overseas ports will be required to comply with AQIS Notice 92/2 *Controls on the Discharges of Ballast Water and Sediment from Ships Entering Australia from Overseas.*
Oil spill	Oil spills from vessels.		Appropriate cyclone procedures will apply for pipelaying and dredging operations.
		Relatively small spills (up to 200 litres) from sources such as hydraulic hose rupture, puncture of oil storage drums etc. may occur.	• Vessels will be required to carry oil spill equipment on board, appropriate for minor spill cleanup. • Ship Board Oil Spill Response Plans (SOSRP), as required by MARPOL will be required to interface with the Woodside Oil Spill Contingency Plan.
	Vessels will carry drums of oils and fuel.	Possibility of small, accidental spills.	Vessel Masters will be required to report all oil spills > 20L and corrective actions taken to Woodside.
	Vessels will need refuelling on station.	Oil spills during refuelling.	Re-fuelling procedures will be prepared for all vessels involved in pipe-laying operations.
QUARRYING & ASSOCIATED ACTIVITIES			
	Up to 3 million cubic metres of rock may be required for trunkline stabilisation and protection.	To obtain suitable grade rock, 1.5 times this mass may need to be quarried. A new quarry site(s) will need to be established to provide the required volume.	• Two potential quarry sites have been identified to the south of the OTP plant within the area designated for industrial development by the State Cabinet-endorsed Burrup Land Use Management Plan. • The existing quarry will be used preferentially.
		Aboriginal sites are known from the Burrup Peninsula.	Aboriginal site clearance will be undertaken in accordance with the Aboriginal Heritage Act. Where site disturbance is unavoidable Woodside will comply with section 18 of the Aboriginal Heritage Act (1972).
		Three species of Priority Flora are known from the Burrup Peninsula.	Vegetation surveys will be undertaken over prospective quarry sites. Woodside will liaise with CALM prior to the destruction of any Priority Flora.
		Landscape values may be damaged by quarrying activities.	Quarrying activity will be designed to reduce the impact on landscape amenities.

Topic	Proposal Characteristics	Environmental Issue / Comment	Environmental Management / Controls
		Quarrying operations may cause noise, drainage and flyrock problems.	A Quarrying activity EMP will be developed prior to commencement of operations.
		Flyrock may be generated during blasting in the quarry.	The Project will impose the required exclusion zone under the *Mines Act* during the blasting phases of quarrying activities.
Crushing and grading	A rock crushing and grading plant will be required to provide appropriately graded rock.	A significant area of land will be required to accommodate the crushing plant. The crushing plant may generate significant amounts of dust.	Crushing and grading facilities will be located within the confines of the quarry site. Dust control measures will be implemented, if required, for environmental and hygiene purposes.
			A comprehensive Environmental Management Plan will be prepared in consultation with the WA DME prior to the commencement of grading and crushing activities.
Haul road	Due to the large rock volumes, a dedicated haul road, suitable for large dump trunks, will be required between the quarry(s) and load out area.	A haul road connects the existing Woodside quarry to the Dampier Port Authority access road. This road will need to be extended to the KBSB through undisturbed terrain to prevent hazards to Port Authority and King Bay traffic. A Haul road is also required to Holden Pt rock storage facility should this option be developed. Aboriginal sites, priority flora and drainage systems may be impacted by the haul road extension.	• Aboriginal site clearance will be undertaken in accordance with the Aboriginal Heritage Act. • Where site disturbance is unavoidable Woodside will comply with section 18 of the Aboriginal Heritage Act (1972).
		Priority flora may be impacted by Haul roads.	A vegetation survey has been conducted along the proposed route extension. Disturbance to Priority flora will be minimised.
	Two public roads will require crossing.	Public Safety issues will need to be addressed in the crossing of public roads.	• Crossings of the Public Wharf and King Bay roads will be conducted in a safe manner with the approval of the appropriate authorities. • The dedicated haul road will ensure, as far as possible, separation of haulage and general traffic.
		Traffic hazards will need to be managed on the haul road.	• Total exclusion from the haul road of non-essential traffic. • Radio control of haul road traffic movements • Visibility devices mounted on all vehicles using the roads.

Topic	Proposal Characteristics	Environmental Issue / Comment	Environmental Management / Controls
Storage and loadout	An area of up to 150,000 m^2 may be required for temporary rock storage prior to loadout.	Storage and rock loadout previously took place on disturbed ground adjacent to the KBSB.	Maximum use will be made of previously disturbed ground adjacent to the KBSB for rock storage and loadout.
	Conveyor loadout facility to be constructed on Holden Point.	Rock storage area to be constructed on Holden Point sandplain.	• Topsoil will be removed and stockpiled for later use in rehabilitation if required. • Area will be rehabilitated consistent with subsequent land use and/or adjacent land conditions. • Appropriate weed control practices will be instituted.
		Trestle Jetty may be constructed from Holden Point.	Trestle jetty will not disrupt inshore processes.
Decommission-ing		Quarry may be used for future expansion so no extensive rehabilitation planned. There is a requirement to make quarry safe.	• Work area cleared and loose material barred off. • Access to quarry will be sealed with large boulders. • Access limitation berm constructed on top of quarry in consultation with WA DME.
		Trestle Jetty proposed for Holden Point to be decommissioned after operations cease.	• Trestle piles sheared at seabed. • Topside infrastructure removed from site.
PLANT EXPANSION			
Infrastructure layout	New infrastructure includes a slugcatcher, pig receiver, gas and liquid outlet lines, export compressor & pipelines and ancillary facilities.	Sufficient un-utilised land is contained within the existing plant boundary to accommodate the proposed expansion.	All new infrastructures will be contained within the existing plant boundary.
	Some Aboriginal Sites are contained within the existing plant boundary.	The plant has previously been comprehensively surveyed for Aboriginal Sites by the WA Museum.	• Where required, Aboriginal Site surveys will be undertaken to assess whether proposed infrastructure may impact upon any sites of Aboriginal significance. • Any removal will be in accordance with Section 18 of the Aboriginal heritage Act.
CONSTRUCTION ISSUES			
Laydown areas	Laydown space for construction materials will be required.	Laydown areas are maintained on the plant's southern leases.	Existing plant laydown areas will be used to support plant expansion.

Topic	Proposal Characteristics	Environmental Issue / Comment	Environmental Management / Controls
Waste disposal	Domestic, industrial and hazardous wastes will be generated during the construction phase.	Poor waste management practices can result in pollution incidents and lost opportunities for recycling. A comprehensive waste management system is in place for Woodside operations.	• Wastes will be disposed of in accordance with Woodside's existing Waste Management Procedure (Procedure DE-04). • No waste will be disposed on the Burrup Peninsula. • Wastes will be disposed according to Shire of Roebourne directions.
	Sewage wastes.	Potential overload of the existing OTP sewage treatment plant during construction.	The capacity of the existing OTP sewage system will be assessed to service the construction workforce. Portable sanitation units will be provided if required.
Workforce	The size of the required construction workforce is currently 2-300 persons onshore.	It is anticipated that the workforce will be accommodated in existing facilities. Only a limited increase in the operational workforce is anticipated.	Woodside has accomodation requirements of a construction workforce currently under investigation.
Pickle liquor	Pickle liquor will be required to treat small diameter pipe-work.	Pickle liquors are known to be toxic in the marine environment.	Pickle liquors will be recycled, or disposed of in an approved manner.
OPERATIONAL ISSUES			
Atmospheric emissions	Overall plant emissions of CO_2 are expected to increase by approximately 5%.	Increased atmospheric emissions will result primarily from increased power generation needs. Further quantification of emissions will occur during the detailed design phase.	• Waste Heat recovery will be installed in the new power generation units to increase energy efficiency. • Atmospheric emissions will be quantified and reported to the DEP as per the existing OTP licence requirements.
	NOx emissions are expected to increase by 4-5%.	NOx emissions contribute to global warming and the production of photochemical smog.	Woodside will specify best practicable low emission burner technology in gas turbines during the detailed design phase.
	Fugitive emissions.	Fugitive emissions could result from seals on the new Domgas compressors.	Woodside will specify seal systems with the lowest practicable hydrocarbon emission characteristics to minimise fugitive emissions.
	Frequent operational pigging may be required, depending on pipeline capacity.	Hydrocarbon gases will be associated with pig receiver de-pressuring.	Gas from de-pressuring of the pig receiver will be re-directed to the process or sent to flare
		Atmospheric processes over the Burrup Peninsula are not well characterised.	Woodside will participate in the joint DEP/industry atmospheric study to better characterise air quality meteorology on the Burrup Peninsula.

Topic	Proposal Characteristics	Environmental Issue / Comment	Environmental Management / Controls
Effluents	No new liquid wastes are expected to be produced as a result of the proposed plant expansion.	The existing plant operating licence requires monitoring and reporting of effluent contaminant concentrations and annual loads to Mermaid Sound.	• Contaminant concentrations and loads will be reported as per the existing plant operating licence requirements. • ChEMMS programme monitoring has shown no measurable effect of the existing plant .
Contaminated drainage	New hydrocarbon liquid handling facilities will be designed and operated.	Hydrocarbon spills could potentially occur from new infrastructure.	• Bunding will be emplaced around new infrastructure where hydrocarbon spills could potentially occur. • Potentially contaminated drainage will be directed to the existing oily contaminated water (OCW) systems. The oil in water discharged from the system is limited under the DEP Licence to 30 mg/l.
Risk	Trunkline operates in areas of high cyclone frequency	Storm generated waves may be capable of moving trunkline and causing rupture	Woodside will investigate risks from storms over the trunkline length (particularly in the approx. KP22-KP50 region) and design stabilisation methods to ALARP principles
Risk	Proposed facilities are for flammable hydrocarbon gas and liquid transport and processing.	Proposed facilities have the potential to pose significant hazards to workforce and general public.	Preliminary hazard assessments have been undertaken in accordance with EPA bulletin 611 to assess the risk posed by the proposed plant expansion facilities to human life. This assessment will be expanded during the updating of facility Safety Cases and Management Systems. The Project has developed a Risk Management Strategy which will be implemented.
		Plant design will ensure risk levels for the workforce and community are acceptable	Hazard identification activities will proceed throughout detailed design to ensure acceptable risk levels from process facilities.

Topic	Proposal Characteristics	Environmental Issue / Comment	Environmental Management / Controls
Oil spill contingency	The addition of a 2nd trunkline will increase the risk of a condensate spill.	• Condensate releases may occur from the trunkline due to mechanical (anchor drag, dropped objects) or corrosion events. • Size of the rupture will determine the eventual spill quantity.	• An assessment will be undertaken of the additional risk posed by the 2nd trunkline. Woodside's existing Oil Spill Contingency Plan will be reviewed and updated, to ensure an adequate response capability is maintained. • Trunkline design integrity will be paramount during the detailed design phase. • Release of the full inventory of the trunkline is unlikely due to blowdown facilities at either end
Increased shipping frequency	Increased condensate and LPG production is expected to result in a moderate increase in the number of shipping movements.	The ChEMMS programme has, to date, not indicated any detrimental effect on corals in the vicinity of the product loading jetties due to shipping induced turbidity.	The existing ChEMMS monitoring programme will continue to monitor for effects on corals in the vicinity of the product load-out jetties.
		TBT loads in sediments and biota are monitored as part of the ChEMMS programme.	TBT sediment & biota loads will continue to be monitored in Mermaid Sound as part of the ChEMMS programme.
		Elevated TBT concentrations may cause marine mollusc imposex leading to reproductive failure	An investigation into the occurrence and frequency of imposex, in a suitable marine gastropod, has commenced.
		A small increase in the risk of exotic organism introductions to Mermaid Sound will accompany increased shipping movements.	Annual auditing will be undertaken of cargo offtake vessel compliance against AQIS notice 92/2 *Controls on the Discharges of Ballast Water and Sediment from Ships Entering Australia from Overseas.*
Decommission-ing and Abandonment	Decommissioning of Plant and equipment may cause adverse environmental impact.	Trunkline decommissioning has the potential to result in hydrocarbon pollution.	• Trunkline will be cleared of residual hydrocarbons • If further use is intended it will be pressurised with inert gas. • If no further use then it will be flooded with seawater and left in-situ. Removal may cause further environmental disruption.

Topic	Proposal Characteristics	Environmental Issue / Comment	Environmental Management / Controls
		Decommissioning of all facilities must be managed for best environmental and cost outcomes	• Facilities will be decommissioned in same manner as existing plant. • Long term nature of facilities (30+ years) means decommissioning options must continue to be open. • Decommissioning plans will be developed prior to plant closure.

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