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Doral Resources N.L.
(Incorporated in Western Australia)

TUBRIDGI GAS FIELD DEVELOPMENT

CONSULTATIVE ENVIRONMENTAL REVIEW

PREPARED BY

MARCH 1990

WORLEY ENGINEERING AUSTRALIA

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1.0 INTRODUCTION

1.0 INTRODUCTION

1.1 General

The Joint Venture participants in Production Licence L9 propose to develop the natural gas resources from the Tubridgi Gas Field, near Onslow, Western Australia. The Tubridgi Gas Field development will comprise a gas gathering system (flowlines), a plant to dry and compress the gas and a cross-country pipeline from Tubridgi to the existing SECWA Dampier - Bunbury Natural Gas Pipeline.

The Development is being undertaken by Doral Resources NL, as operator of the Tubridgi Joint Venture. The joint venturers propose to sign take-or-pay gas sales contracts with the State Energy Commission of Western Australia (SECWA) and possibly others. The SECWA contract requires that a gas processing and compression facility and a pipeline are in place and fully commissioned no later than July 1991. There is potential for the sale of gas at an earlier date and it is intended that the project be fast-tracked to enable sales to begin as early as possible. SECWA has advised that gas supplied from Tubridgi will be used for power generation purposes, substituting for over 300,000 tonnes of coal per annum which would have otherwise been consumed.

Development of this project is pending approval from the EPA, Department of Mines, Department of Lands Administration and other state instrumentalities. This report has been prepared to outline the economic benefits and environmental effects of the proposed project in order to demonstrate Doral Resources commitment to developing an economically viable and environmentally safe engineering operation and to facilitate government approval of the project.

A study has been conducted by specialist environmental and engineering consultants to optimise the cross-country pipeline route and processing plant site, whilst investigating the effects of the proposed project on the environment, in terms of fauna, flora, archaeological, ethnographic and general environmental impact. An area of 40 square kilometres was surveyed within the Production Licence area L9 within which the wellhead, flowlines and pipeline will be located. This report details the results of the study and provides an overall description of the project.

The overall environmental impact of the project would be minor and is unlikely to have any permanent consequences on the environment in the vicinity. Noise levels are not anticipated to exceed those output from the existing SECWA compressor stations on the Dampier to Bunbury Natural Gas Pipeline. There are currently no species of vertebrate fauna known to be exclusive to the pipeline route, nor any recordings to date of rare or endangered species in the vicinity.

The proposed pipeline and flowline routes will avoid all archaeological and ethnographic sites with an indirect impact buffer zone of no less than 200 m.

At the time of submitting this CER document to the Western Australian State government, the ethnographic survey within the Production Licence area L9 was being carried out. An addendum to this document detailing the results of the survey and any newly recorded ethnographic sites will be forthcoming.

Refer to Figure 1 for pipeline location.

1.2 Report Structure

- a summary of the benefits that the proposed project will provide to the community;
- a description of the project engineering, design, construction and operation of the gas gathering system and pipeline;
- a description of the existing environment through which the pipeline will traverse, highlighting the most significant features;
- assessments of the effects on the environment that are likely to result from construction of the project and subsequent operation;
- an outline of management practices and safeguards that will be implemented in project construction and operation to minimise adverse impacts;
- a composite plan showing the main features of the above, including the proposed gas gathering system and pipeline route.

FIGURE 1 - PIPELINE LOCATION

(F) DENOTES FUTURE COMPRESSOR STATION

FIGURE 1 - PIPELINE LOCATION

2.0 BENEFITS OF THE PROJECT

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With the decline of the State's gas over-supply from the North West shelf, alternative gas sources represent significant benefits to the community in both environmental and economic terms and in providing increased employment opportunities.

Development of the Tubridgi Gas Field and installation of the Tubridgi pipeline will provide an additional source of fuel for power generation in Western Australia. Additional economically producible gas supplies is very desirable to meet Western Australia's future power requirements as predicted by SECWA's long term planning. The Tubridgi Gas Field can make a significant contribution to this supply shortage.

SECWA has advised that gas supplied from Tubridgi will be used instead of coal for power generation. As such it will replace up to 300,000 tonnes per annum of coal usage and thus be an extremely positive step forward environmentally for Western Australia as the emission of sulphur dioxide and carbon dioxide to the atmosphere will be significantly reduced.

The proposed development can be considered in three phases: design, construction and operation. Each phase of the project will effect increased employment opportunities within Australia. The construction phase represents the largest employment opportunity, providing a high level of participation by local and Australian businesses, with approximately 50 people involved in construction-related activities at any one time. In addition, Australian made materials will be purchased wherever proven to be cost competitive and of suitable quality.

During the operating life of the field, the project is expected to provide employment opportunities. Four personnel will be employed for regular operations and maintenance duties, whilst non-routine work would be carried-out on a contract basis further increasing local employment.

The development is also anticipated to enhance the involvement of the local community in providing supporting services such as plant and machinery, light aircraft and other transportation services and engineering supplies.

The project provides economic benefits to the community through provision of direct and indirect employment and long term environmental improvement from substitution of coal by natural gas.

3.0 PROJECT DESCRIPTION

3.0 PROJECT DESCRIPTION

3.1 Introduction

It is anticipated that the Tubridgi Gas Field will produce up to 30 terajoules of gas per day. The gas will be gathered from existing and future wells and be transported via flowlines to a central processing plant.

The processing plant will separate the small quantity of condensate from the gas, dehydrate the gas, compress and cool the gas before transportation via the Tubridgi pipeline to the SECWA Dampier - Bunbury Natural Gas Pipeline.

The pipeline is expected to be 150 mm - 200 mm (6" - 8") nominal diameter of steel construction and buried for its entire length, of approximately 85 km. The pipeline will be constructed within a dedicated easement of width 20 m and will connect into the SECWA Dampier - Bunbury Natural Gas Pipeline at compressor station CS2, where it will be metered. The pipeline rating is expected to be ANSI 900#, with operating pressures in the range of 8.5 - 15 Mpa.

Operating personnel will be located at the processing plant where they will conduct routine operating and maintenance procedures. Pipeline and easement inspections will be conducted on a routine basis by aerial and ground survey patrols.

Specialist engineering consultants have been commissioned to design the gas gathering system and pipeline. Site work is anticipated to commence in July 1990, with proposed completion by July 1991.

3.2 Pipeline Route Determination

3.2.1 Methodology

On December 7 1989, Doral Resources NL made application to the Minister for Mines, Fuel and Energy for access to an area between the Tubridgi Gas Field and the Dampier-Bunbury Natural Gas Pipeline for preliminary surveying and environmental studies. Approval was granted on January 8 1990, and shortly after that date consultants were engaged to begin work on pipeline route selection.

3.2 Pipeline Route Determination

3.2.1 Methodology (cont'd)

It became apparent immediately, however, that the land corridor considered for route selection was to be much reduced in size as a result of the SECWA requirement that the Tubridgi Pipeline be connected to the main line downstream of Compressor Station 2 (CS2). This restricted the route alternatives to a strip of land parallel to the Ashburton River between the gas field and CS2.

A desk study was initiated by the consultants to gather all available information on the route. This included geology, topography, vegetation, fauna, land ownership, mining tenements, archaeology, ethnography, well locations and planning constraints. Based on this information, a preliminary pipeline route was selected.

A helicopter field trip was undertaken to review the preliminary pipeline route, followed by ground surveys to ascertain environmentally sensitive areas. A Survey Zone of width 500 metres was covered, traversing the length of the preliminary pipeline route.

As a result of the field survey, several environmentally sensitive areas were identified that necessitated shifting the proposed pipeline alignment from its original position. The basis of this re-alignment is given in Section 3.2.2. Two sections of the proposed pipeline route were re-aligned outside the Survey Zone and this necessitated a return field trip to identify any environmentally sensitive areas along the new route. The two re-aligned sections were:

i) North west section of pipeline route for 15 km, including a shift 3 km north for the proposed processing plant site;

ii) river crossing shifted 3 km south, including the remaining 5 km of the pipeline route between the river crossing and compressor station CS2.

3.2 Pipeline Route Determination

3.2.1 Methodology (cont'd)

The return field trip included surveying an area of 40 square kilometres within the Production Licence area L9 which included flowline routes between the gas production wells and the Central Processing Plant. The resultant flowline routes would be selected to avoid all those environmentally sensitive areas found to exist within this Survey Zone. An area of 40 square kilometres was selected to allow for the development of future production wells and their associated flowlines within the area of the gas field, as well as the existing ones.

Environmentally sensitive areas identified during both field surveys are indicated on the drawing in Appendix D.

3.2.2 Pipeline Route Selection Criteria

The pipeline is required to connect the Tubridgi Gas Field Central Processing Plant to SECWA's Dampier - Bunbury Natural Gas Pipeline.

The processing plant site has been selected to be close to the gas production wells. The plant site is within 200 m of an access road, which connects Urala Station with the Onslow township. The site is on elevated, vegetated ground in an area relatively free of mud flats and termite mounds and having a calcarenite foundation, thus avoiding the claypan and sand dune regions, which are subject to flooding and shifting respectively.

The pipeline route is largely governed by SECWA's requirement to connect into the Dampier - Bunbury Natural Gas Pipeline downstream of compressor station CS2. The pipeline will, as far as possible, follow a direct line from the processing plant to compressor station CS2 with a few minor deviations. The flowlines may be installed either as individual lines to the processing plant or coupled into a manifold which runs to the processing plant.

3.2 Pipeline Route Determination (cont'd)

3.2.2 Pipeline Route Selection Criteria (cont'd)

In selecting a route for the pipeline and possible routes for the flowlines, a number of engineering and environmental factors were considered, these being:

- length of pipeline
- subsurface excavation conditions
- availability, proximity and condition of access
- the number and nature of river crossings and the extent of areas subject to flooding
- overall capital cost
- minimisation of sand dune intersection
- the occurrence of problem soil likely to lead to erosion, corrosion or scour
- the presence of Aboriginal ceremonial, art, habitation or resource sites on or near the pipeline route
- the presence of Aboriginal artefacts and areas of archaeological significance
- the presence of existing or proposed conservation reserves
- the presence of ecologically sensitive or biologically valuable areas such as heathlands, wetlands and sand dunes

Deviations have been made around those areas of particular environmental sensitivity. These locations have been identified by specialist environmental consultants during field survey work. The final pipeline route with its obvious deviations are shown on drawing no 8351 in Appendix D. Other minor deviations may be determined during the topographical and easement surveys to be conducted at a later date. Such deviations may be accommodated by the natural flexibility of the pipe or by installing pipe bends.

Specifically, the crossing of permanent or semi-permanent water courses has been avoided, in order to minimise the destruction of vegetation and surrounding unstable soils which may lead to erosion. Archaeological and ethnographic sites have also been avoided for their historical value and for their importance to Aboriginal and Australian communities. Areas of more dense vegetation have been avoided wherever possible to minimise the destruction of vegetation and to minimise soil erosion.

3.0 PROJECT DESCRIPTION (cont'd)

3.2 Pipeline Route Determination (cont'd)

3.2.2 Pipeline Route Selection Criteria (cont'd)

The pipeline will cross the Ashburton River at its South-Eastern end. The crossing location is selected to minimise both the engineering and the disturbance to the river area where there is potential for soil erosion.

A general area was surveyed for the flowlines within the gas field. This takes into account the potential for future wells to be constructed with their respective flowlines, and for the option of installing individual flowlines and/or manifolds. The surveyed area is marked on drawing no 8351 in Appendix D showing those areas of environmental sensitivity. All flowlines or manifolds will be constructed to avoid these sites, as is the case with the main pipeline.

3.3 The Pipeline

The pipeline will be designed in accordance with AS 2885 - Pipelines - Gas and Liquid Petroleum. Fully welded and mechanically jointed piping systems are being evaluated with the final selection being subject to approval by the Department of Mines as the Licensing Authority. The design details of the pipeline are based on preliminary studies and is expected to conform to the following description:

Length

Estimated to be 85 km between the Tubridgi Gas Field Processing Plant and SECWA's compressor station CS2 on the Dampier - Bunbury Natural Gas Pipeline.

Diameter

The pipeline diameter will be 150 mm - 200 mm (6" - 8") nominal size. The wall thickness will be in accordance with pipeline code requirements as required by the terms and conditions imposed by the Pipeline Licence Application (as required by the Pipelines Act, 1967).

3.3 The Pipeline (cont'd)

Operating Pressure

The operating pressure will be in the range 8.5 to 15 MPa.

Material

Steel, class API 5L Grade B.

Depth of Cover

The pipeline will be buried for its entire length and will have a minimum ground cover of 750 mm in soil and 450 mm in rock. Road and river crossings will be deeper.

Corrosion protection

The pipeline will have a continuous external coating and a solar powered impressed current cathodic protection system. The coating will be either Fusion Bonded Epoxy or yellow jacket.

River crossing

The pipeline will entail a single crossing of the Ashburton River at its south-eastern end. The river crossing will be open excavated during the dry season.

Road crossing

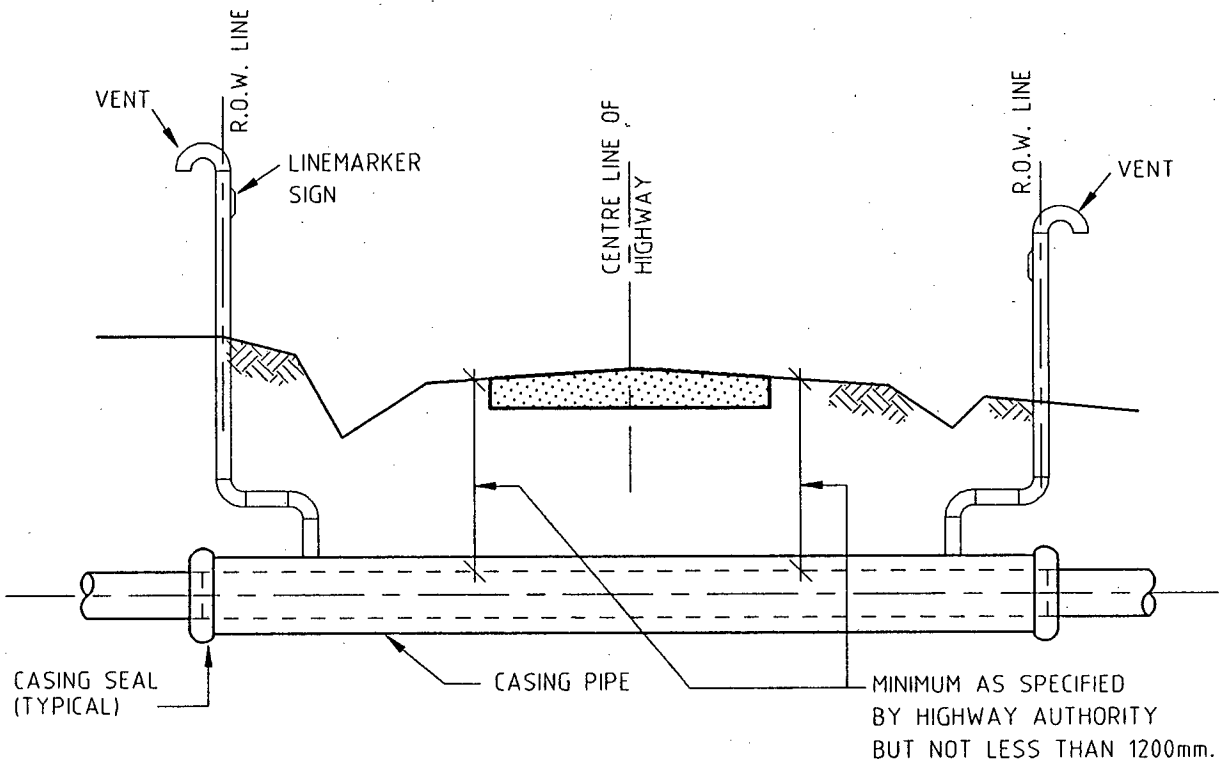
The pipeline will cross the Twitchen Road and other minor roads. The pipeline design may include heavy walled pipe or pipeline casing beneath the roads (reference Figure 3.3.1).

Anchorage

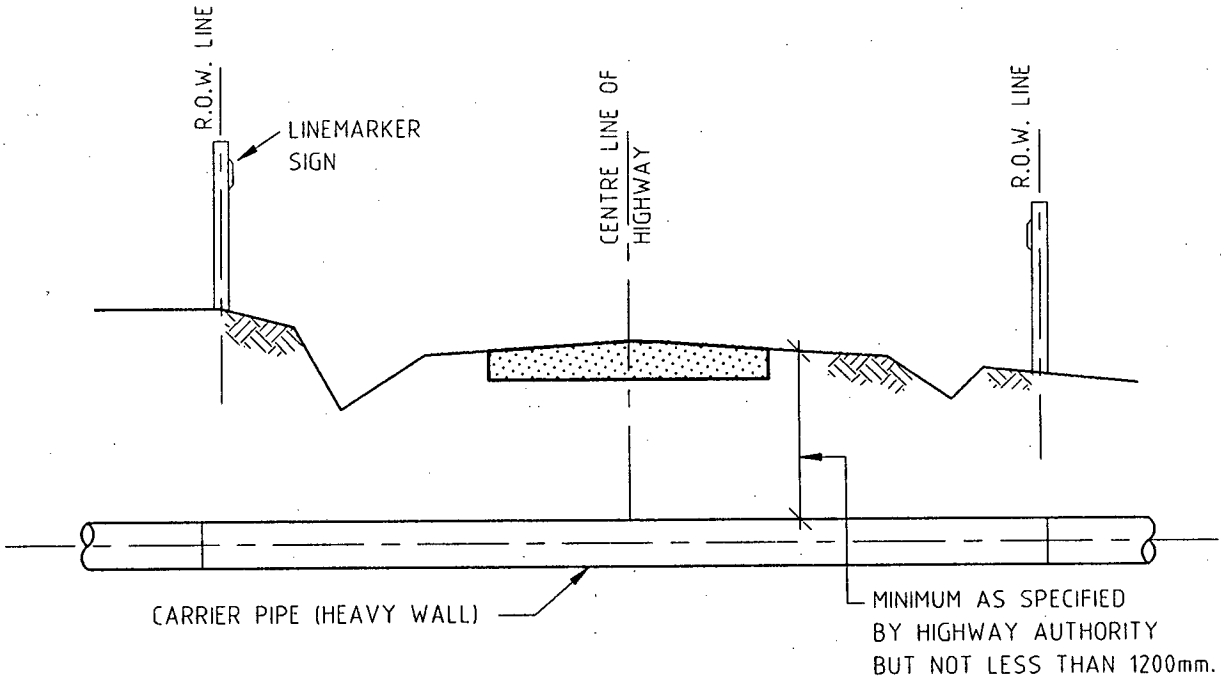
The pipeline will be anchored if necessary to resist buoyancy in those areas where flooding is expected.

SECWA pipeline connection

This will be at an existing valve manifold (MLV 30) downstream of compressor station CS2 on the Dampier - Bunbury Natural Gas Pipeline.



TYPICAL CASED PIPELINE CROSSING HIGHWAY



TYPICAL UNCASED PIPELINE CROSSING HIGHWAYS

FIG : 3.3.1

3.3 The Pipeline (cont'd)

3.3.1 Pipeline Facilities

Permanent pipeline facilities, excluding those of the processing plant, are given below:

Metering

A metering facility will be installed at the downstream end of the Tubridgi pipeline, prior to connection into the SECWA pipeline.

Scraper traps

Permanent traps will be installed at each end of the Tubridgi pipeline: at the processing plant and at the metering facility. Additional scraper traps would be installed at any intermediate sectioning valves.

Mainline valves

These will be located at each end of the Tubridgi pipeline, with the possibility of additional intermediate isolation valves installed between. All valves will be either remotely controlled or fail-safe operation.

Signposts

Identification markers and warning signs will be installed along the entire length of the pipeline, spaced at regular intervals, direction changes, road, river and fence crossings and at all other above-ground permanent facilities. Markers will be visible from the air and the ground.

Fencing

Security fences will be installed at all above-ground permanent facilities.

3.3 The Pipeline (cont'd)

3.3.1 Pipeline Facilities (cont'd)

Access

It is not proposed to maintain a permanent access road along the entire pipeline route. In fact, public access will be discouraged by vegetative restoration of the entire easement and erection of locked gates at all fences which cross the easement. However, growth of vegetation will be controlled so that access is always possible by four-wheeled drive vehicles along a narrow strip adjacent to the pipeline, within the easement, to facilitate regular inspection of the line.

Some sections of permanent track may be maintained within the easement as the most feasible means of access in these areas. In such cases, public access will be discouraged by installation of adequate gates and fences.

3.4 Gas Gathering System

Gas will be collected from approximately six wells three of which exist.

Individual flowlines will be constructed from each of the production wells which will either connect into a manifold which runs to the central processing plant or will connect into a manifold located within the central processing plant where the gas will be gathered and treated accordingly. The flowlines and/or manifolds will be installed below ground for their entire length, until connecting to the above ground facilities within the boundary of the central processing plant.

Flowlines will generally be aligned in a direct route between the wells and the plant, with deviations as required for archaeological sites or sensitive environmental areas. Full definition of flowline alignment will be made when well locations are finalised as part of the reservoir development program.

Each wellhead will be remotely controlled at the central processing plant. Each wellhead will be located above ground and fitted with security fencing.

3.4 Gas Gathering System (cont'd)

3.4.1 Processing Plant

The components of the processing plant will be designed in accordance with the respective Australian or International Standards, namely:

- ANSI/ACME B31.3 Chemical Plant and Petroleum Refinery Piping
- AS 1210 SAA Unfired Pressure Vessels Code
- API RP 520 Guide for Pressure Relief and Depressurising Systems
- API 616 Combustion Gas Turbines for general refinery service
- API 617/8 Compressors for General Refinery Service.

The details of the processing plant are yet to be finalised, but are expected to conform to the following description:

Equipment

This is expected to include:

- Production Separator
- Test Separator
- Dehydration Unit
- Compressor
- Aftercooler
- Power Generator
- Water Treatment Unit
- Fire Protection Facilities.

Site

It is anticipated that the area required to accommodate the plant will be approximately 5000 m^2. The site has been selected to be close to the production wells and to facilitate access. The location is on elevated, vegetated ground thus avoiding the claypan and sand dune regions, which are subject to flooding and shifting respectively.

3.4 Gas Gathering System (cont'd)

3.4.1 Processing Plant (cont'd)

Access

The location of the proposed processing plant is close to an existing access road which connects Urala Station with the Onslow Township. A new road will be constructed between the existing road and the processing plant site, to maintain vehicular access for operating personnel.

Accommodation/Control Room

It is anticipated that initially the processing plant will be manned 24 hours per day. Accommodation will be provided, including office and ablution facilities. A small workshop and store will also be provided. A control room will be constructed to house the control equipment for the processing plant. The equipment will be highly automated with emergency safety shutdown facilities.

Security

Fencing will be erected around the processing plant site with access allowed to authorised personnel only.

Services:

- **Power Generation**

  Power will be generated by gas fuelled generator sets with an emergency alternatively fuelled standby set. All units will be housed in weatherproof acoustic enclosures to minimise noise levels.

- **Fresh Water Supply**

  Fresh water will be provided by means of a reverse osmosis plant operating on water drawn from a bore and stored in a fibreglass tank. Distribution will be by pressure pump.

3.4 Gas Gathering System (cont'd)

3.4.1 Processing Plant (cont'd)

Services (cont'd)

- **Sewage**

  Septic tanks will be installed as part of the office ablution facilities for handling sewage.

- **Brackish Water**

  Reject water from the reverse osmosis plant will be discharged to the evaporation pit.

- **Rubbish**

  Office waste will be collected on site and disposed of at an approved location, as part of the routine maintenance operations of the process facility.

Fire Control Facilities

These will consist of fire detection equipment throughout the plant; use of fire retardant materials within the office and control building, and fire extinguishing facilities on site in accordance with statutory requirements.

Production:

Oily water from the production separator will be fed to a wastewater treatment tank for oil removal. The recovered oil will be collected in drums and disposed of at an approved location.

The treated water will be discharged to an impervious concrete evaporation pit. This pit will be designed to accommodate maximum period rainfall to prevent overflow. As this clean water evaporates, the relatively small quantity of oil will gradually build and collect as a surface film on the evaporation pit. This can be manually skimmed, collected and disposed of to an approved location.

3.4 Gas Gathering System (cont'd)

3.4.1 Processing Plant (cont'd)

Production (cont'd)

The evaporation pit will be designed so that inadvertent accidental oil discharge will not contaminate the environment.

All rainfall runoff from equipment areas and washdown water facilities subject to possible contamination, will be drained to a collection point and transferred to the wastewater treatment plant for the recovery of any oil and the clean up of water before discharge to the evaporation pond.

A vent will be erected at the process plant for gas relief and blowdown purposes.

3.5 Project Engineering

Specialist engineering consultants will be engaged to design, construct and commission the gas gathering system and pipeline.

The project engineering will consist of the activities outlined below.

3.5.1 Easement Acquisition

An easement width of 20 m will be acquired to accommodate the pipeline and its construction, and to allow for future access by inspection personnel. Other areas will be secured for above-ground facilities.

The gas gathering system and pipeline will be located on crown land crossing four pastoral leases:

- Urala
- Minderoo
- Yanrey
- Nanutarra

An easement application is being made to the Department of Land Administration (DOLA). The 20 m width easement will be aligned within the 500 metres Survey Zone and will be finalised after construction.

The easement will allow for construction and maintenance. Once pipeline installation is complete and the surface of the easement restored, the landholder or lease holder resumes full use of the land surface in accordance with the conditions imposed by DOLA. Certain activities are prohibited to ensure the safety of the public and pipeline. These are:

- excavation and drilling within the easement, except under Operator supervision and with prior written approval of the Operator.

- construction of permanent buildings and other obstructions in the area of the easement.

3.5.1 Easement Acquisition (cont'd)

Normal agricultural activities such as cultivation (not below a depth of 300 mm), seeding, fertilisation, grazing and harvesting are permitted.

The terms of the easement allow the Operator to enter at any time for the purpose of monitoring, inspecting or carrying out remedial or repair work along the pipeline route.

According to location, land use and other circumstances, leaseholders are entitled to compensation as a result of:-

- Damage to crop or pasture, in the event that actual foliage is destroyed by construction activities or subsequent maintenance.
- Loss of productivity of the land during construction.
- Inconvenience due to limitations on land use caused by easement establishment.
- Damage outside the easement during construction or subsequent maintenance.

Compensation for the first three categories listed above will be negotiated with leaseholders by the Operator. Any damage outside the easement during construction would be the responsibility of the construction contractor causing the damage who would need to obtain a satisfactory settlement with the leaseholder. Provisions governing the responsibilities of contractors in such circumstances will be included in contract specifications. It is intended to follow normal practice which is for representatives of both the Operator and the construction contractor to conclude equitable arrangements with leaseholders prior to entering properties.

3.5 Project Engineering (cont'd)

3.5.2 Topographical and Easement Survey

A topographical and easement survey will be conducted for clearing, marking and profiling the pipeline route, following receipt of the appropriate authority approvals. A description is given below of the work involved.

- The pipeline route will be cleared by bulldozer (in accordance with Sections 3.6.1.2 and 3.6.1.3) and marked with pegs at all changes in direction, fence lines, roads and on straight section at intervisible points, nominally 200 to 300 m. The clearing will be confined to the pipeline easement.

- Offset survey pegs will be placed at nominal 500 m intervals left and right of the centreline.

- The survey will be related to the State Mapping System at appropriate locations.

- The centreline will be levelled at each centreline peg and significant changes in grade. Levels will be related to the Australian Height Datum.

- A survey to create an easement along the pipeline route will be carried out in accordance with Department of Land Administration requirements.

- The route plan and profile will be plotted on A1 sheets and include all pertinent details such as creek and river crossings, roads, tracks, windmills etc, on or adjacent to the centreline.

- Easement plans will be drafted in accordance with DOLA requirements.

- Detail surveys and plans at major creek crossing etc will be produced as required.

- Plans and field books for the easement will be lodged at DOLA.

- All property fences cut during the course of the surveys will be fitted with gates.

3.5 Project Engineering (cont'd)

3.5.3 Geotechnical Survey

This will comprise detailed fieldwork, laboratory testing, engineering and reporting activities. The geotechnical survey will lag behind the topographical survey to enable access after the easement has been cleared. Work will include:

- Backhoe test pitting along pipeline route (with test pits excavated to the proposed depth of burial for the pipeline), resistivity surveys and groundwater level measurements as appropriate.

- Backhoe test pits will be undertaken at regular intervals along the pipeline route to provide details of excavation conditions and to collect soil and groundwater samples for chemical testing. Ph testing of soils will be undertaken in the field as soils are logged. The frequency of the test pitting will depend on the results of the soil, rock and groundwater conditions encountered during this work. In areas of hard excavation such as rock, the test pit spacing will be closed up to ensure a complete coverage of the rock conditions is obtained. A rock breaker especially adapted for the backhoe will be used should caprock be encountered. In areas where groundwater may be present, particularly saline groundwater (towards the gas field end of the route) test pits will be undertaken more frequently. Up to 120 test pits will be excavated during this phase of the work.

- The resistivity survey will be carried out in conjunction with the test pit work.

- Laboratory testing comprising classification testing of soils, compaction testing of soils (for crossing points), point load strength testing of rock (if encountered) and chemical testing of soil and groundwater will be carried out on selected samples recovered from the fieldwork.

- All laboratory testing will be carried out in NATA (National Association of Testing Authorities) registered laboratories.

3.5 Project Engineering (cont'd)

3.5.3 Geotechnical Survey (cont'd)

Evaluation of the field work and laboratory results will be undertaken and reports prepared. The information will be provided for the engineering design stage of the project.

3.5.4 Engineering Design

Specialist consultant engineers will undertake the detailed engineering design, in accordance with the requirements of Australian and International Standards and Statutes. Environmental consultation will be continued throughout the design stage to ensure that the procedures detailed in this document are incorporated in the design and in the construction specifications.

3.6 Construction

Construction of the gas gathering system and pipeline will be carried out by specialist construction companies. It is anticipated that construction will be carried out as given below.

3.6.1 Pipeline and Flowlines

3.6.1.1 Materials Supply

Coated pipe and other materials will be supplied either from within Australia or from overseas and transported to site by road. Some Australian supplied equipment may be shipped in via Onslow. The trucks will use existing roads as far as possible, but will require to travel along the pipeline easement from the nearest point of intersection with an existing road. The resultant traffic will be the most noticeable indication of the project construction to local people.

3.6.1.2 Clearing and Grading Easement

Clearing the easement will include the removal to ground level of trees, stumps and other obstacles.

3.6 **Construction** (cont'd)

3.6.1 Pipeline and Flowlines (cont'd)

3.6.1.2 Clearing and Grading Easement (cont'd)

Clearing through bushland will be such as to retain the maximum amount of rootstock. Grubbing of stumps will be kept to the trench line only, and those stumps likely to impede the movement of construction vehicles. Grubbed stumps will be spread over the easement after clean-up. Stump voids will be backfilled with imported local material (in accordance with Section 3.6.1.5); topsoil will not be used to backfill voids.

Cleared vegetation will be spread over the easement during clean-up operation.

Grading will ensure that natural drainage is maintained. Material removed during grading will be stockpiled for subsequent replacement.

3.6.1.3 Excavation (reference Figure 3.6.1 & 3.6.2)

Exploratory excavation will be carried out prior to trench excavation to determine ground conditions along the pipeline route. This will be achieved by means of a single pass along the pipeline route by a bulldozer on which is mounted a single tyne ripper.

Backhoe machinery will be used for trench excavation in soft soil conditions. It is not anticipated at this stage that any blasting will be carried out.

Topsoil removed from the trench and material excavated from river or creek beds will be stockpiled separate from other excavated materials, for subsequent replacement to their original environment. All excavated material from the trench will be placed on the spoil side of the trench. Stones, wood, vegetation, clods of earth, debris and water will be removed from the trench.

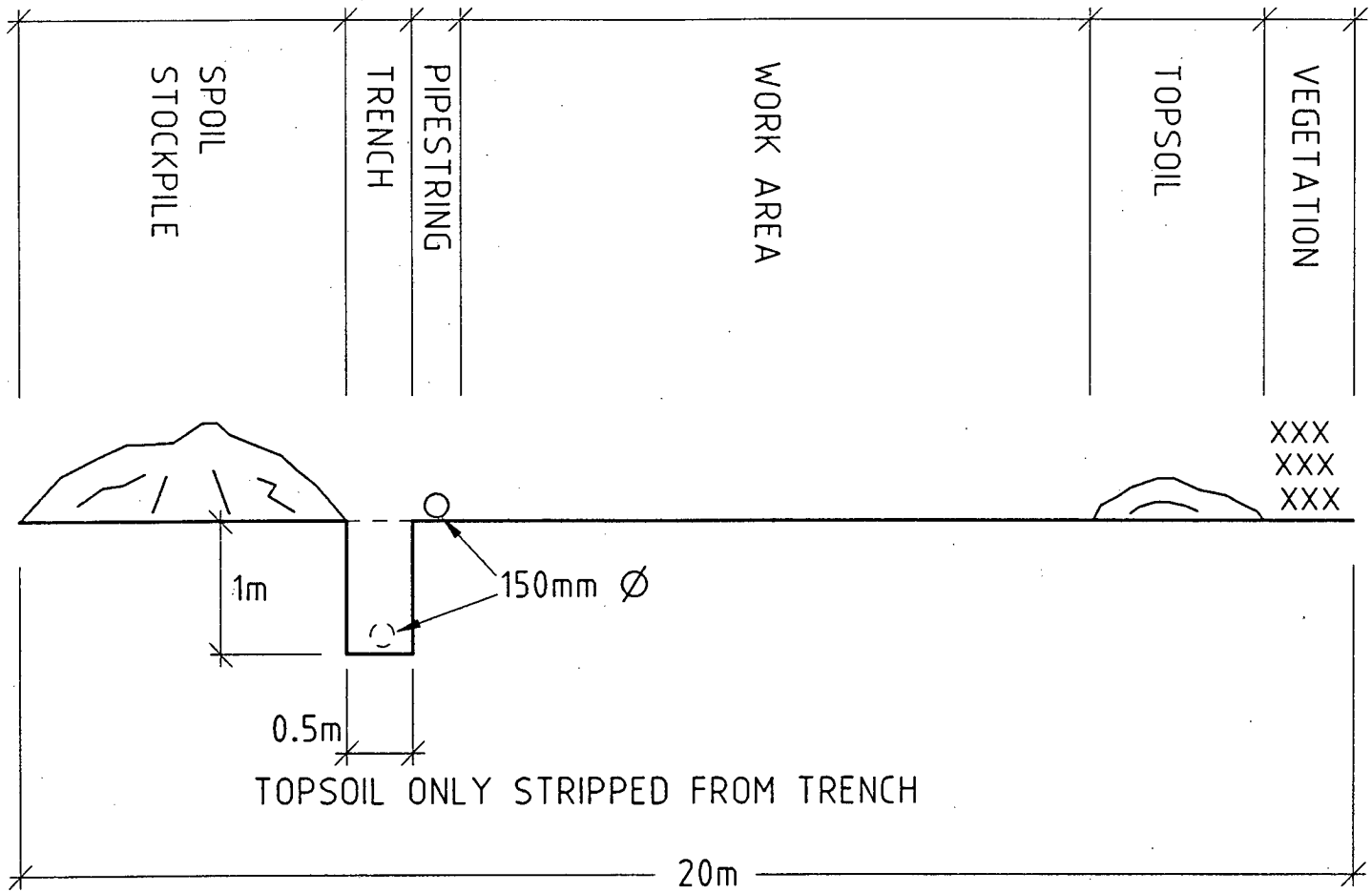


FIG 3.6.1

PIPELINE CONSTRUCTION
REMOVAL & STOCKPILING
OF VEGETATION & TOPSOIL

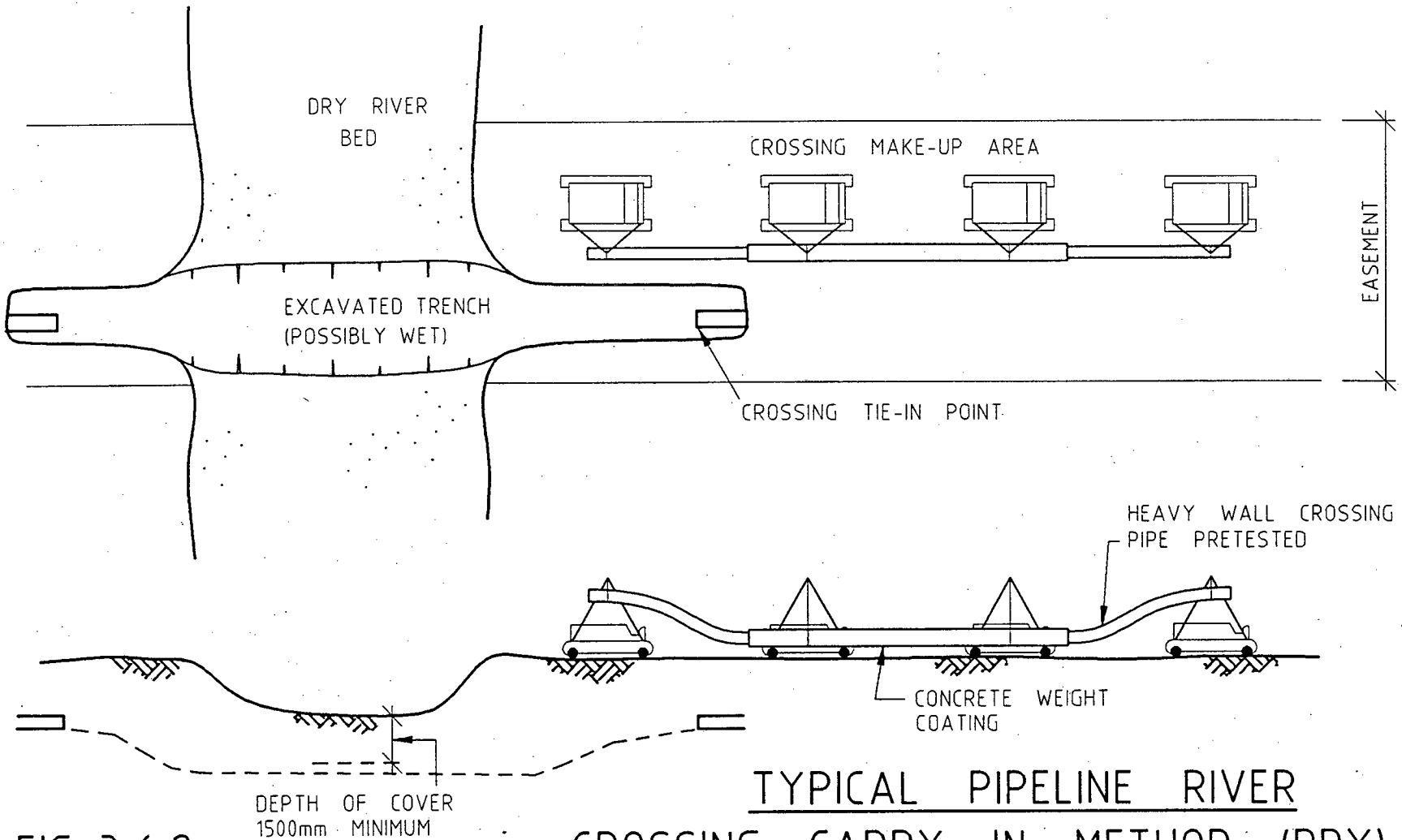


FIG 3.6.2

TYPICAL PIPELINE RIVER CROSSING CARRY IN METHOD (DRY)

3.6 Construction (cont'd)

3.6.1 Pipeline and Flowlines (cont'd)

3.6.1.3 Excavation (reference Figure 3.6.1 & 3.6.2) (cont'd)

The average trench width and depth will be 500 mm and 1,000 mm respectively.

The river crossing will be open-excavated below the river scour level.

3.6.1.4 Pipe Storage, Stringing and Welding

Pipe storage areas will be located along the easement on well drained land with suitable access during all weather conditions. These areas will be selected to minimise local environmental impact and will be cleared, graded and then reinstated as for the pipeline easement.

Where the pipe is to be strung out, normal access along roadways and tracks will be maintained with sufficient openings allowed for fauna and livestock to cross particularly where the easement is located on grazing land. Pipeline installation will be progressive and follow up operations will minimise the duration of inconvenience and environmental interference.

Welding or mechanical jointing of the pipeline will only be carried out under strict safety procedures to minimise the risk of fires, and will not be carried out during periods of total fireban without the appropriate authority approvals. Welding will be shielded during periods of high winds to prevent fire danger.

Pipeline installation equipment required to lift and transport the pipe sections will be progressively moved along the pipeline in accordance with the overall easement and transport restrictions.

3.6 Construction (cont'd)

3.6.1 Pipeline and Flowlines (cont'd)

3.6.1.5 Backfill and Compaction

The pipe will be bedded in sand to a depth of 150 mm, then backfilled with excavated spoil, if suitable. The sand padding may be selected from trench spoil, but not topsoil, seed or rootstock. Topsoil will be re-spread after the trench has been backfilled.

The pipelines and flowlines will be backfilled with suitable material and with trench-breakers to ensure its stability during flood conditions and to prevent the erosion of soil around the circumference of the pipeline.

In the event that suitable padding and backfill material is unavailable, borrow pits will be established from land as agreed with any leaseholder, along with associated haul roads. Borrow pits and haul roads will be restored in accordance with environmental requirements.

Backfill will be compacted mechanically to a density that will ensure no subsidence of the trench occurs.

The pipeline will be backfilled progressively during construction.

3.6.1.6 Restoration

Restoration will be carried out in accordance with the environmental management programme, as given in section 6.0 of this document. The following is a summary of the pipeline restoration procedures.

Public roadways will be reinstated to the satisfaction of the governing authority.

Graded land will be restored to its original contour and condition by replacing and progressively compacting spoil to its original position.

3.6 Construction (cont'd)

3.6.1 Pipeline and Flowlines (cont'd)

3.6.1.6 Restoration (cont'd)

Excess excavated soil, rock and other debris will be removed from site and disposed of at an authorised location, such as borrow pit excavations, erosion gullies, or light and even spreading over the easement prior to topsoil re-spreading.

Erosion control banks will be constructed across the easement at all necessary areas to divert the flow of rainwater run-off into natural drainage channels, as soon as possible after backfill and prior to replacement of the topsoil.

Deep ripping of the easement will be carried out to loosen earth, only where it has become compacted from construction activity.

Vegetation will be spread evenly over the easement, except where permanent clearing is required (ie firebreaks).

Construction materials, debris and rubbish will be removed from the easement, campsites and all other areas of construction activity and will be disposed of in an authorised manner.

Materials imported to construct temporary roads for pipeline stringing and vehicle movement will be removed and disposed of in an appropriate manner.

Control banks will be constructed across the full easement width on the road reserve boundary of unfenced roads, to discourage vehicle access, except in areas used for agricultural purposes.

Fences will be re-erected where removed to allow for the movement of construction vehicles.

3.6 Construction (cont'd)

3.6.1 Pipeline and Flowlines (cont'd)

3.6.1.7 Care of Property

Care of property will be maintained during construction and operation by installing temporary culverts in water courses and drainage systems, protecting and repairing systems (where necessary) bridges, cattle grids, roads, fences, buildings, facilities and services.

3.6.1.8 Pollution

Pollution will be controlled during construction by way of:

- preventing the pollution of any water course, dam or other water supply.
- minimising the spillage of fuel or other contaminants
- Exercise extreme care during re-fuelling and oil changing operations.
- regularly collecting rubbish and litter generated along the easement during construction and disposing of in approved areas.

3.6.1.9 Quality Control

Quality will be assured by engaging construction inspectors to monitor the construction procedures and to supervise the environmental management programme.

Quality control procedures will include non-destructive testing of field welds by radiographic examination and pipeline hydrostatic testing.

3.6.1.10 Hydrostatic Testing, Purging and Commissioning

Hydrostatic testing of the pipeline will be carried out in sections after pipeline construction. Water will be imported, sufficient for one section and re-used in subsequent sections.

3.6 Construction (cont'd)

3.6.1 Pipeline and Flowlines (cont'd)

3.6.1.10 Hydrostatic Testing, Purging and Commissioning (cont'd)

Temporary pig launching and receiving facilities will be constructed with cross-connecting pipework to allow for passing water between sections.

The water will contain a bio-degradable corrosion inhibitor and will be disposed of in an approved manner after satisfactory hydrostatic testing.

The pipeline will be dried internally and purged of air with inert gas before commissioning with production gas.

3.6.1.11 Construction Personnel and Equipment

The men and equipment involved in pipeline construction from clear and grade to backfill and clean up, are collectively known as a construction spread. Pipeline construction from mobilisation to commissioning and demobilisation is anticipated to take up to 3 months depending on the construction method employed. A single shift, 10 hour working day is normal practice during construction activity.

One spread will be mobilised for pipeline construction supported by a temporary camp.

Camp facilities will consist of cooking, eating, sleeping, ablution and recreation facilities. Also included will be construction support facilities, namely fuel supply, stores, etc. The camp will be provided with power generation and telecommunication facilities and water will be imported from local bores. Camps will be installed where soil conditions will allow the use of oblique pit sewage systems without detrimental effect to the environment. Routine supplies of food and fuel will be delivered by road transport; emergency supplies will be delivered by air.

3.6 **Construction** (cont'd)

3.6.1 Pipeline and Flowlines (cont'd)

3.6.1.11 Construction Personnel and Equipment (cont'd)

Other site equipment will include that which is used for pipeline construction, typically bulldozers for clearing the easement, backhoes for excavation, sidebooms for pipe stringing and other such equipment, namely welding machines, generators, storage vehicles, etc. Equipment usage will be restricted to the working side of the trench.

3.6.1.12 Emergency and Medical

First aid officers will be on site with the construction spread. Radio communications will be available for emergencies; use will be made of local airstrips for emergency transportation.

Fire fighting facilities will include a water tanker equipped with pumping equipment and fire extinguishers will be mounted in each vehicle. Contractors will be required to co-operate with the Onslow fire authority and to observe relevant local fire regulations.

3.6.2 Processing Plant

The processing plant will be constructed in modularised form off site. Each module will be skid mounted and transported to site for final assembly. Generally, construction will involve the following stages of work:

- offsite fabrication, coating and testing of plant vessels
- offsite fabrication, coating and testing of pipe spools
- construction of a permanent access road between the processing plant and the existing road

3.6 Construction (cont'd)

3.6.2 Processing Plant (cont'd)

- clearing and grading the site
- earthworks for foundations of vessels and equipment and for site utilities
- transportation to site of materials and skid-mounted equipment
- equipment erection on-site and assembly of pre-fabricated components
- testing and commissioning of piping, instrumentation and equipment

It is anticipated that construction of the processing plant from site mobilisation through to commissioning will take 3 months.

3.7 Operation and Maintenance

The process plant facility will be manned 24 hours per day by on-site personnel.

Operation and maintenance procedure manuals will be prepared, detailing both normal and emergency operations, as well as detailed instructions on preparation for the passage of cyclonic storms to ensure the safety of both personnel and property.

The procedures will be reviewed at regular intervals to ensure their adequacy and suitability in view of developing experience and modifications to plant design.

Prior to commencement of duties all personnel will receive training in safety and operating procedures as well as environmental protection practices.

The pipeline easement will be inspected on a regular basis by aerial patrol and ground patrol. During the course of the ground patrols, routine maintenance and any easement repairs will be undertaken and a pipeline cathodic protection survey will be carried out annually.

3.7 Operation and Maintenance (cont'd)

Operation and maintenance records will be maintained from the start of operation until final abandonment, in accordance with the requirements of AS 2885 - 1987 Pipelines - Gas and Liquid Petroleum, detailing all necessary operational data, information from pipeline patrols and corrosion surveys, leaks, ruptures, damage and other routine inspections.

3.7.1 Pipeline Safety and Encroachment

Natural gas pipelines constructed in accordance with AS 2885 - 1987 Pipelines - Gas and Liquid Petroleum are inherently extremely safe installations. Hydrostatic tests conducted on the pipeline in accordance with SAA Field Pressure Testing of Pipelines AS 1978 - 1987 ensure the integrity of the installed pipe. Stringent corrosion protection procedures will ensure that the integrity of the pipeline is maintained.

Physical damage to a buried gas pipeline, caused by external encroachment, is the major safety hazard which may cause a pipeline rupture. Procedures to advise third parties of the presence of the gas pipeline will be stringent. Marker signs will be installed at regular intervals and will be explicit in their safety instruction.

Another precaution against encroachment to the pipeline will be the proper dissemination of information defining the exact location of the pipeline on all Government, Local Authority and private working and registered drawings and documents, covering the area. Regular checks will be carried out to ensure that this information has been received and understood.

Regular aerial and ground patrols will provide a major safeguard against third party encroachment.

With the sophisticated and highly reliable methods now available for controlling pipeline operations, public hazard and the risk of loss of gas due to third party encroachment and/or pipeline breaks have been substantially reduced. Should a malfunction occur, the use of modern computer technology will provide the capability to detect faults and isolate the pipeline using quick-action fail safe block valves.

3.7 Operation and Maintenance (cont'd)

3.7.1 Pipeline Safety and Encroachment

The risk of accidents can never be completely eliminated and therefore a stringent set of procedures will be formulated for implementation in the event of an emergency. An Emergency Response Manual will be prepared in accordance with the pipeline licence requirements.

3.7.2 Termination and Abandonment

3.7.2.1 Pipeline and Flowlines

Procedures for termination of pipeline operation and final abandonment will be in accordance with the requirements of AS 2885 - 1987 Pipelines - Gas and Liquid Petroleum.

The pipeline will be disconnected from any potential sources of hydrocarbons that may be present in other pipelines or facilities and will be purged of hydrocarbon gas with an inert fluid.

The ends of the pipeline will be cut off below ground surface and sealed on completion of purging, and warning signs along the route will be removed.

3.7.2.2 Gas Wells

Production wells will be sealed with cement to prevent any gas or fluids rising to the surface in the future and then cut off below the ground surface.

3.7.2.3 Processing Plant

The facilities of the processing plant will be removed, including cutting off pipes below the ground surface and sealing, then restoring the site to its original condition.

3.8 Project Timing

The Joint Venturers propose to sign take-or-pay sales contracts with the State Energy Commission of Western Australia (SECWA) and possibly others. These contracts require that a gas gathering system and pipeline are in place and fully commissioned no later than July 1991. There is potential for the sale of gas at an earlier date and it is intended that the project be fast-tracked to enable sales to begin as early as possible.

To meet this time schedule, site work is programmed to commence in July 1990. Specialist engineering consultants have been commissioned to design the gas gathering system and pipeline, in accordance with the timing of this project.

4.0 EXISTING ENVIRONMENT

4.0 EXISTING ENVIRONMENT

4.1 Climate

Along the northern extent of the Ashburton River the pipeline route is in the arid, summer rainfall sub-tropical zone (Department of Science & Technology, 1983). The summers are very hot and the winters moderate. The average January maximum temperature for Onslow, only 30 km from the processing plant location, is 36°C and the average January minimum temperature is 23°C. In July, the average maximum temperature is 25°C and the average minimum temperature 11°C (WA Year Book, 1988). Further inland the maxima become higher, and minima lower, Nyang having average maximum temperatures in both January and February above 40°C and an average minimum temperature which is less than Onslow.

Rainfall is low and variable. In the period 1976-1981, Onslow averaged 248 mm of precipitation, with a standard deviation of 148 mm. This represents 60% of the average. (In comparison, for the period 1976-1981 Perth received an average 750 mm of rain, with a standard deviation of 146 mm. This is only 19% of the average). Rainfall is significantly influenced by the passage of cyclones which predominantly occur from January to March. These can result in extremely heavy falls, the highest 24 hour recording at Onslow being 356 mm. Rainfall generally decreases with increasing distance from the coast, up river, but over the pipeline length the variation is negligible.

Evaporation is high, varying from 130 mm during the month of June to 340 mm during the month of January (Onslow figures). Droughts are, however, less frequent along the pipeline route due to the proximity of the coast (Payne, et. al, 1988).

4.2 Geology

Preliminary studies indicate the proposed pipeline route is generally located in areas containing sediments of the Quaternany Period (Pliocene/Pleistocene to Holocene Epoch) which comprise the geological units as shown on Plate 1, Appendix B, and detailed below.

(i) Sand dunes and residual sand plains (comprising quartz sand);
(ii) Clay pans with sand dunes (comprising clay, silt, sand and gravel);
(iii) Alluvial materials (comprising clay, silt, sand and gravel partly calcreted);
(iv) Colluvium materials (comprising poorly sorted clay, silt, sand and gravel).

At the site of the proposed river crossing some rock, indicated as comprising sandstone/siltstone and granule conglomerate materials of the Nanutarra Formation was observed in the river bed.

4.3 Topography

The pipeline route is contained within the Coastal Plain geomorphic province (Payne et al, 1988) which extends inland from the coast for about 90 km. It is characterised by extensive sandy plains, bare claypans and circular grassy depressions. Relief is subdued with spot levels rarely exceeding 40 m. There is a very gradual downward incline toward the coast with numerous shallow waterways crossing this plain toward the Ashburton River. No tributaries of any consequence flow into the Ashburton, but there is evidence of it having changed its course a number of times.

4.4 Vegetation

The vegetation that occurs along the pipeline route belongs to the Carnarvon Botanical District, one of the naturally occurring subdivisions of the vast biogeographical region referred to as the Eremaean Botanical Province (Beard 1975). The area is semi-arid and the vegetation is eremaean in character and relatively sparse, reflecting the harshness of its environment, . Topography dictates dominant species, and although species diversification is not great for the entire pipeline route, nine significant physiographic vegetation units have been classified by the consultants. These units are listed below and described in full in Appendix A.

1. Samphire Flats
2. Sand Plains
3. Circular Depressions
4. Low Lying Plains and Depressions
5. Alluvial Plains
6. Stony Drainage Area
7. River
8. Grasslands Parallel to the River
9. Inland Dunes.

The salt tolerant *Halosarcia* species dominate Samphire Flats. The dominant grass species for the entire pipeline route area is Soft Spinifex, *Triodia pungens* with an abundance of the introduced fodder species, Buffle Grass, *Cenchrus ciliaris*. *Eriachne* species dominate glazed claypans and the salt tolerant Sea couch, *Sporobolus virginicus* the samphire flats.

4.4 Vegetation (cont'd)

Middle storey species include *Cassia oligophylla, Rhagodia eremaea* with occasional *Enchylaena tomentosa. Acacia translucens* is common on white sand dunes.

The *Acacia* species dominate the middle upper storey with *Acacia victoriae* being the most widespread species in the area, growing with the abundant *A. tetragonaphylla* and *A. farnesiana*. Towards the river, *A. trachycarpa* and *A. coriacea* are more common. Groves of *A. xiphophylla* occur especially on bare areas with stony mantle.

The upper storey consists of scattered Coolibahs, *Eucalyptus coolibah*, found 25 km inland from the coast along the pipeline route. Often dwarfed in claypan areas, they become tall and dense along the river and water courses. The banks of the river also support tall River Red Gum, *Eucalyptus camaldulensis*, and Cajeput, *Melaleuca leucodendra*.

An uncommon species of Acacia, *Acacia pachyacra* occurs rarely in the claypans. This species is more common in southern areas and it is possible that it has arrived there with shifting sands.

Although the vegetation appears harsh and well adapted, it is in fact very fragile and vulnerable to disturbance. Years are needed before plants establish and mature. Lack of vegetation results in erosion and soil loss, therefore it is important that vegetation disturbance is minimised.

4.5 Fauna

A relatively small range of ecosystems occur within the biogeographical region known to zoologists as the Eyrean Zoogeographic Zone (Serventy & Whitell 1976). It is through this zoogeographic zone that the pipeline route will run.

The natural ecosystems along the proposed pipeline route have been somewhat degraded by introduced grazing animals, both domestic and feral. Fauna in the area of the pipeline route is poorly documented and research data is scarce. There are, however, currently no species of vertebrate fauna known to be exclusive to the pipeline route, nor are there any recordings of rare or endangered species in the vicinity.

4.5 Fauna (cont'd)

Fauna in the region tend to be hardy and well adapted to the arid conditions. The larger species are generally nomadic, following food and water sources as necessary, therefore population numbers vary. Other species, especially frogs, reptiles and snails have the ability to aestivate. Pastoral areas along the proposed route provide windmills and bores to support more water-reliant species, as does the close proximity of the Ashburton River. Despite baiting and various other eradication programmes, feral cats, donkeys and foxes all compete with native fauna populations in the area.

Animals native to the pipeline vicinity include the Red Kangaroo, Emu, Common Wallaroo and various species of Antechinus. The Spinifex Hopping Mouse has been observed by station owners and it is likely that rodents are common.

During the first field visit, 21 bird species were identified, but the proximity of permanent water in the Ashburton River ensures the number of species will be much higher.

Reptiles of the area include various species of skink and dragon. Faunal lists are included in Appendix A of this report.

4.6 Archaeology

A review of existing site files and regional consultancy reports indicate that two previously recorded archaeological sites occurred within the Survey Zone. These comprised a quarry focussed on a large outcrop of silicified sediments (P0268) and a large, diffuse artefact scatter on the slope of a rocky rise (P5129). An additional nine archaeological sites were located during the field survey of the pipeline route (Field Sites 1-9). These all comprise artefact scatters of varying size and complexity, usually associated with relict aeolian dune features, presumably formed in the late Pleistocene. One of these sites (Field site 6) has potential stratification and is argued to be highly significant. Full details of the archaeological field survey are contained in Appendix C.

4.7 Ethnography

Three ethnographic sites have been previously recorded in the vicinity of the proposed pipeline route. These are Urama (P1110), Jibia/Jaminn Pool (P4374) and Peepingee Rocks (P1114). These sites are located 4.5 km, 3.5 km and 4.0 km east from the proposed pipeline easement, respectively, and thus are under no threat of impact. Two other ethnographic sites identified during the field survey are Queerbulla Claypan (Ethnographic Site 1) and Warralee Claypan (Ethnographic Site 2). Full details of the ethnographic survey are contained in Appendix C.

4.8 Towns

The Tubridgi gas field is sited approximately 30 km from the Onslow Township in a direct route; access to the processing plant will require a travelling distance of some 60 km. Karratha is the next nearest town, this being located approximately 300 km by road from Onslow.

4.9 Social Environment

4.9.1 History of Human Use

Aboriginal occupation of the Onslow area probably dates from more than 40,000 years before present (White & O'Connell, 1982). In Tindale's survey of the Aboriginal "tribes" of Australia he identifies the people residing throughout the area of the present survey as belonging to a group known as Talandji (1974). The Talandji people no longer live in their traditional territory, but live in the larger settlement areas of Roebourne, Carnarvon and Onslow.

The first pastoral lease in the Ashburton area was granted to Walter Padbury in 1864. He was closely followed by other pastoralists, and in 1885 the town of Onslow was gazetted at the mouth of the Ashburton River. Interest in the area heightened during the 1880's and 1890's with the Ashburton gold rush. Changing river flow patterns forced the township to move from the original site to Beadon Point between 1923 and 1927. A minor pearling industry operated out of Onslow from the early 1900's to just after World War II, eventually giving way to the more competitive industry located in Broome.

4.9 Social Environment (cont'd)

4.9.1 History of Human Use (cont'd)

The opening of the Pilbara iron ore mines during the 1960's significantly increased the number of people living in the region. The facilities available to travellers improved. Whilst Onslow has not benefited directly from the mining development, it has been increasingly used as a launching point for recreational fishermen, shell collectors and tourists.

More recent development of industries located in the North West Shelf region has further increased the number of people living in the Pilbara region, leading to the development of the Karratha and other outlying industrial areas.

4.9.2 Present Human Use

The present population of Onslow is 500 and swells to approximately 800 persons during April to October as a result of tourist influx. Most visitors are attracted by the recreational fishing opportunities offshore. As well as tourism, the other major commercial activities which are based in Onslow are professional fishing and oilfield supply.

5.0 ENVIRONMENTAL IMPACT ASSESSMENT

5.0 ENVIRONMENTAL IMPACT ASSESSMENT

5.1 General

The environmental impacts due to the pipeline and plant can be broadly divided into two phases: construction and operation. During the construction period, disturbance to landform, flora and fauna will occur over the pipeline length. This disturbance is a short-term effect concentrated along the narrow corridor of the pipeline easement. During operation there will be little impact apart from that caused by occasional reconnaissance of the pipeline. The processing plant area will be the main area of longer term environmental effects: light, heat, fume and noise discharges will be more or less continuous, however, these discharges are of limited extent. The overall impact of the project is of a minor nature and is unlikely to have any permanent consequences on the environment in the vicinity.

5.1.1 Construction

Principal impacts due to the construction phase of the project can be grouped into clearing, excavation and discharge effects. Clearing is required at the plant site, along the easement, at laydown areas, borrow pits, campsites and wherever access tracks are required. Excavation is necessary at stream crossings, along the pipeline route, at borrow pits and the plant site. Discharges will include dust, noise, vehicle fumes, light, vibration, hydrotest water, sewage and heat. These are all of a minor and transient nature.

5.1.2 Operation

During operation, there will be discharge effects; principally dust (due to vehicular access), fumes (from the vent stack), light, sewage, noise and heat. Rubbish will be collected and disposed of by transport to Onslow. The effect of people living in a previously uninhabited area is difficult to gauge and some impact on vegetation is possible. Generally the presence of humans in a remote environment is to increase the population of at least some animal species. The provision of water associated with farming usually increases vegetation and as a consequence, animal habitat. A reliable water source also allows many animals to remain in the vicinity and it is common for certain bird, mammal and reptile species to increase as a result of a permanent manned facility.

5.2 Traffic and Clearing Effects

Along the length of the pipeline, an easement of 20 m width will be cleared of vegetation. Clearing will be also required at the plant site, at borrow pits, laydown areas and their associated access tracks. It is, however, a short-term effect as regeneration will be promoted. Clearing and traffic are most likely to have greatest impact over the sand dunes and claypans at the pipeline's northern end.

5.2.1 Erosion

Erosion can be caused by traffic on bare soils, by wind or by winter rains. Erosion is a particular problem along cleared banks of water-ways and on soft, sandy soils. It can also be a problem across the many claypans and salt flats on the pipeline route, particularly if the soil is damp. Measures to minimise these effects are set out in Section 6, and include placement of gravel, construction of furrows or ridges, placing of rocks as well as revegetation. Nevertheless, some erosion of surface soils is inevitable, particularly if summer rains are heavy. The management programme therefore includes regular inspection of the construction work to ensure that no problem is allowed to remain unattended.

5.2.2 Compaction

Compaction of the soil is likely along cleared areas used for access ways. When this occurs a programme of ripping will be instigated to promote revegetation. The seaward portion of the pipeline is largely positioned on sandy soils however and compaction in these areas will not be a problem.

5.2.3 Water Sources

Water may be obtained from surface water sources if these are available and the water can be safely and sensitively removed. Approval of the pastoralist and advice from environmental consultants will be sought.

5.3 Excavation Effects

The entire pipeline will be buried, and excavated to a depth of one metre and a width of 500 mm will occur along the easement. Borrow pits may also be required and stream crossings will require some excavation. Backfill will generally be with excavated soil. Padding material for the pipeline will be either selected trench spoil or sand from borrow pits.

Excavation has the possibility of causing erosion. Erosion can occur through the redirection of surface runoff by a linear mound (caused by excess backfill) or surface depression (caused by backfill settlement) along the pipe route. It may also occur below the surface, in the porous trench backfill material. If the pipeline has adequate slope, a permeable drain occurs within the backfill, which may eventually erode. This is particularly the case in excavated river crossings which are likely to have steep pipeline gradients on either side.

The management plan addresses those matters by regular pipeline route inspection and repairs as necessary. The design will ensure that river crossings are deep enough to avoid scour and that pipeline gradients are minimised. If necessary, sheet piling or gabions will be used to stabilise banks. Excavation erosion is not likely to be a problem on this project, however, due to the very low pipeline gradient and the sandy nature of the soils. Borrow pits, if necessary, will be re-contoured and natural drainage patterns re-established.

5.4 Discharges

5.4.1 Gaseous

Gaseous emissions which will occur are generally vehicle fumes, power generation and miscellaneous equipment exhausts, and vented product gas. The process does not produce noxious fumes. Vehicle emissions are small, short term and transient and are not a significant pollutant. Similarly, construction equipment will be utilised for a short time, which is generally diesel driven and relatively non-polluting. The plant site will have permanent power generation and consequent exhaust emissions. There is also a gas vent, but this is likely to be used in emergency situations only. Vented gas volumes will generally be small and in consideration of the generally consistent coastal breezes, is not regarded as dangerous nor environmentally significant.

5.4 Discharges (cont'd)

5.4.1 Gaseous (cont'd)

The only other atmospheric discharge is likely to be dust. Although this will peak during pipeline trench excavation, construction will be restricted to a period of three months, and to the length of the spread. Dust spread will be dependent on wind speed and direction and will not have any permanent affect on the local environment.

5.4.2 Liquid

Liquid discharges include hydrotest water, sewage, brackish water and drainage sediment.

Hydrotest water will be disposed of in dry, sandy depressions so that it will not enter the surface drainage system.

Sewage will be treated in a septic tank and the outlet monitored for biological pollution and erosion.

Brackish water will be produced from the process and from the reverse osmosis water purifiers. It will be disposed of in a concrete pit at the plant site. No seepage into the ground water supply will occur.

Drainage sediment will be minimised through erosion protection and revegetation. Nevertheless, some will occur. This is not regarded as a significant problem, however, as the construction period will occur during the dry, winter season.

5.4.3 Noise and Vibration

Noise and vibration will occur during construction work due to the use of heavy machinery and access vehicles. The transient nature of the work and the remoteness of the site make this a minor effect.

There will be three main noise sources within the processing plant:

5.4 Discharges (cont'd)

5.4.3 Noise and Vibration (cont'd)

i) Gas turbine compressor
ii) Diesel generator and instrument air compressor
iii) Fin-fan aftercooler.

The first two items will be housed within acoustic enclosures with attenuated ducts for inlet and exhaust air. Minimal continuous noise is anticipated from the production separator, aboveground piping and gas wells, and intermittent noise can be expected from the blow-down vent (commissioning, de-commissioning and emergency purposes only). Noise from any component within the process plant is not expected to exceed 85 dB(A) at 1 metre distance or 70 dB(A) at 100 m of the site boundary during normal operating conditions.

Noise levels are not anticipated to exceed those output from the SECWA compressor stations, located on the Dampier - Bunbury Natural Gas Pipeline. Assessments of the noise impact on local residences indicates that the processing plant will have zero impact on the nearest homestead of Urala Station, offering no more than the background noise of 30 dB(A).

5.4.4 Light and Heat

Light and heat will occur due to the presence of plant and vehicles. As there are no photo-sensitive animal species in the area, this is not expected to be a problem.

5.4.5 Wastes

Wastes may be classified into domestic or industrial varieties. Domestic wastes include food scraps, paper, cans and packaging. Industrial waste includes oils, chemicals, scrap steel and any other rubbish utilised for construction or operational purposes.

5.4 Discharges (cont'd)

5.4.5 Wastes (cont'd)

Putrescible wastes, paper and domestic waste will be taken to the Onslow tip. This includes both construction camp and operations personal rubbish.

Oils, chemicals and other liquid industrial wastes will be sealed and removed from the site, to be deposited in a manner consistent with Ashburton Shire policy. Scrap steel and concrete left over from construction will be removed from site and disposed of in a similar manner.

5.5 Vegetation

Impact on the vegetation of the area will occur, but be of a limited and temporary nature. Although an area of some 170 ha along the pipeline route will be cleared, only a small portion of this less than 10 ha will have topsoil removed. The intent of the management plan is to remove vegetation to ground level only to allow regeneration from root stock.

Areas to be cleared of vegetation include the pipe route, laydown areas, camp areas, borrow pits and the plant itself. Vegetation cover in the area is sparse to moderate; the only dense areas being in areas of permanent or semi-permanent water. These latter areas will be avoided.

Major plant species along the pipeline route which will be affected include various species of Acacia, notably *Acacia victoriae*, *A. xiphophylla*, *A. tetragonaphylla*, and *A. trachycarpa*. Some *Eucalyptus coolabah* and *Grevillea sp.* will be removed, however, dense stands will be avoided. The dominant grass species along the route, *Tricodia pungens* and *Cenchrus ciliaris* will be disturbed. The latter species, being an exotic, will re-establish itself rapidly. The vulnerable and slow growing Soft Spinifex, *Triodia pungens*, may take some years to re-colonise in disturbed areas.

5.5 Vegetation (cont'd)

In the coastal area, some re-contouring of the ground will be necessary as the pipe route crosses claypans and their encompassing sand hills. Removal of some vegetation in such areas will be required, but all efforts will be made to limit this as much as possible as it is recognised that such areas are vulnerable to erosion when vegetation cover is removed. Where possible the pipeline will be installed around sand dune contours to minimise erosion. Species affected in these areas include the samphires, *Halosarcia* spp in the saltpans, grass species *Eragrostis* spp and *Eriachne* spp in the claypans with *Cenchrus ciliaris*, *Triodia pungens* and the shrub *Acacia translucens* on the sandhills.

As the pipe route crosses no areas which include rare species, the long term impact on the vegetation is considered to be minimal.

5.6 Fauna

Two classes of faunal impact will occur: that due to habitat destruction and that due to the presence of a workforce in the area. The former is regarded as a minor effect only. Although an area of habitat will be destroyed, the mobility of most animals means that mortality will be less than that indicated by vegetation loss. Small animals, particularly lizards, scorpions, centipedes and insects will be most affected but except for these, no species is expected to be subjected to any significant disruption.

The presence of a workforce in the area has potentially more impact than the physical disruption of native habitat. Leisure-time activities in particular can have an effect on fauna through fishing, hunting and the use of river pools for recreation. To reduce this impact, a workforce education programme will be instigated. Fire arms and pets will be banned from construction camps and the operational facilities.

5.7 Archaeology and Anthropology

The significant archaeological and ethnographic sites located within the Survey Zone of the proposed pipeline and flowline routes will be avoided. The pipeline and flowlines will deviate around the sites using pipe bends or using the natural flexibility of the pipe. The processing plant, pipeline and flowlines will be located at a minimum distance of 200 m from any significant site.

5.7 Archaeology and Anthropology (cont'd)

If the proposed deviations are implemented, then there are no archaeological reasons nor ethnographic grounds under the Western Australian Aboriginal Heritage Act 1972 - 80 for the pipeline not to proceed.

5.8 Pastoral Activities

Impacts on the activities of pastoralists have been addressed in section 3.5.1 of this report.

5.8.1 Access Limitations

The pipeline will be backfilled progressively during construction, therefore, inconvenience to pastoralists will be minimised.

5.8.2 Loss of Natural Feed

The arid nature of the land and the size of the stations means that temporary loss of natural feed due to vegetation clearing is a minor restriction. The greatest inconvenience will occur at Minderoo, which is crossed by 74 km of pipeline. This will involve a temporary loss of 150 ha or 0.01% of the pastoral land available. In addition, the vegetation loss is temporary and as far as pastoral activities are concerned, should regenerate in two to three years.

5.9 Social Environment

Onslow is a township of approximately 500 people and was established in mid 1860. The primary industries are fishing, tourism and oil field supply and support to Barrow Island and the Saladin Field.

Impact on the township of Onslow is likely to be determined in part by cultural considerations; that is, by the presence of established traditions and community cohesion, shared values and attitudes, and relatively strict codes of conduct. To minimise social impact on local residents, both construction work and construction worker social activity shall be closely regulated and controlled by the procedures described in this document and further detailed in all work contracts. Sections 6.3 and 7.0 set out some of these commitments. The development itself is likely to be welcomed by the town in providing an extension to the existing oil field supply industry and having minimal direct effect on the local people once construction is complete.

5.9 Social Environment (cont'd)

In order to minimise problems of isolation and loneliness, the camp facilities will include the most modern communications and amenity facilities practicable.

Good relationships with the local community will depend on:

- the establishment of good relations and understanding between pipeline contractors and townspeople
- the use of local labour and facilities
- effective control over the behaviour of construction workers in the town.

Control of the workforce will depend upon careful selection of personnel, adequate and attractive camp conditions and benefits, and the siting of construction camps at a sufficient distance from town to discourage regular or large scale visiting.

Section 6.3 describes the management procedures which will be employed.

5.9.2 Homesteads

The nearby pastoral homesteads are located in areas remote to the proposed development; Urala homestead being the closest, approximately 5 km to the central processing plant. For the most part, the occupants of these homesteads should experience little disruption during construction. Urala homestead may experience some intrusion of noise, dust and general activity during construction of the flowline between Tubridgi 4 and the central processing plant; Tubridgi 4 being located some 1.5 km from Urala homestead.

Good public relations will be maintained between the operator and the pastoralists during construction and operation, to ensure that the presence of an active workforce is not resented. The involvement of the pastoralists will be encouraged wherever possible and practicable to ensure that they do not feel isolated nor alienated by the development.

5.10 Accidents

5.10.1 Bushfires

Although construction will occur during the cooler winter season, there remains a risk that either construction or operational activities will result in a fire.

Liaison with the local fire authority will be maintained throughout construction. Some activities may be partly or wholly curtailed during periods of severe fire risk, in accordance with the directives of the local authorities.

A fire control and prevention programme will be established for both the construction and the operational phase of the gas gathering system and pipeline.

Precautionary measures will include:

- a ban on naked flames during the fire risk season;
- use of guards around welding operations;
- provision of fire-fighting equipment, including extinguishers in all vehicles;
- spark arresters;
- sensors and alarms on buildings and selected equipment.

5.10.2 External Damage to Pipeline

Rupture of the Pipeline During Operation

All reasonable action will be taken to prevent the encroachment of the pipeline by external means. Section 3.7 outlines the extent of preventative measures to be taken including:

- full code compliance including pipeline testing.
- development and implementation of strict operation and maintenance procedures.
- thorough personnel training.
- cathodic corrosion protection.
- regular easement inspection.
- full time process monitoring.

5.10 Accidents (cont'd)

5.10.2 External Damage to Pipeline (cont'd)

Rupture of the Pipeline During Operation (cont'd)

- approved QA / QC procedures during construction.
- provision of detailed accurate pipeline location data to all relevant authorities.

However the possibility still exists that an accident, such as rupture of the pipe by earth moving equipment, could occur.

Failures in pipelines can also result from corrosion of various types, generally resulting from improper construction procedures. Compliance with procedures as outlined will minimise the risk of such an event.

Whether a natural gas pipeline is broached by accident or improper procedures the ensuing events are similar.

When the pipe wall of a high pressure pipeline is fractured, a quantity of gas is released. Ignition may be initiated by the discharge of static electricity generated by the high flow rate of gas. Any serious damage will be limited as there is minimal property or life in the vicinity and the vegetation will recover over time.

The engineering design, manufacture, operation and maintenance procedures currently in use on natural gas pipeline systems have been advanced and developed to the extent that failures due to corrosion can be virtually eliminated. With proper enforcement of the practices and procedures as laid down by the relevant codes and standards, risk of other types of pipeline failures can be minimised.

The same general approach applies to rupture of pipelines by encroachment. Safety standards must incorporate effective means of ensuring that there is public awareness of the presence of the pipeline, not only adequate marking of the route but also by communicating to all authorities who could be engaged in excavation, grading or similar work in the easement. It is important to ensure that all these bodies notify the Operator of intended works in the vicinity of the pipeline system.

5.10 Accidents (cont'd)

5.10.2 External Damage to Pipeline (cont'd)

Rupture of the Pipeline During Operation (cont'd)

Pipeline patrols will be conducted as part of a routine maintenance programme to check for gas leaks and unauthorised earthworks within the pipeline easement.

In summary, adequate preventative measures will be implemented in the design, construction, operation and maintenance of the gas pipeline system to prevent such occurrences. Essential components of such a system include stringent corrosion protection, inspection and monitoring procedures and a highly reliable communications and control system, all of which will be implemented for installation and operation of this pipeline.

An Emergency Response Plan will be prepared as part of the pipeline licence to ensure adequate response procedures are in place in the unlikely event of an accident of this nature.

5.10.3 Accident Within the Processing Plant

The processing plant will be designed and operated in accordance with Australian and International Standards and Statutes. Regular monitoring of equipment and piping will ensure that risks to worker safety and the environment are minimised.

Potential spills within the processing plant will be contained within bunded and graded areas, then recycled through the processing plant. Gas leaks to atmosphere may potentially occur at pipe and equipment fittings and flanges. These will be of a minor nature and will be located and repaired as part of the routine maintenance procedures.

5.10 Accidents (cont'd)

5.10.4 Safety

The possibility of a major gas leak or accidental fire is minimal. Such events will be ameliorated by automatic shutdown of the processing plant which would be activated by low pipeline pressure detection. Isolation of major piping and equipment and blowing-down of the processing plant through the vent stack would be subsequently initiated. Gas fires will be immediately extinguished by fuel starvation. The occurrence of a fire within any other part of the processing plant will be controlled by the use of fire retardant materials and the fire extinguishing facilities.

The facilities will be designed, installed and operated with strict regard to the safety of personnel and the public. Safety systems and shut-down devices will be installed to ensure fail-safe operation.

Occupational health and safety procedures will be developed and an induction and training programme will be implemented for all operational personnel. The programme will provide for the prevention of accidents, hygiene control, hot work control, electrical safety and routine maintenance checks. Personnel will be trained in first aid procedures and first aid facilities will be available on-site.

Operating personnel will be trained in all aspects of equipment operation in emergency situations.

6.0 ENVIRONMENTAL MANAGEMENT

6.0 ENVIRONMENTAL MANAGEMENT

6.1 Introduction

The proposed pipelines cross a variety of terrain, including saline mudflats between the wells and plant, sand ridges, alluvial soils, river gravel and rocky areas. The major environmental problem anticipated is erosion at sand dunes and mud flats. Other areas of concern are drainage, borrow pits, camp sites, river crossings and discharge pollution. The objective of this Environmental Management Plan is to minimise all impacts to flora, fauna and landforms.

6.2 Acts, Codes and Standards

The pipeline and plant will be designed and tested in accordance with all relevant Australian and International Statutes and Standards.

Relevant Government Acts will be adhered to including the Wildlife Conservation Act, 1976; the Environmental Protection Act, 1986; the Aboriginal Heritage Act, 1972 - 1980 and the Construction Safety Act, 1972.

It is the intent of this plan that destruction of flora, fauna and landform be minimised by ensuring the processing plant size and easement width do not exceed their required dimensions.

6.3 Management Methods

6.3.1 Rules and Procedures

Upon approval of the project and appointment of a contractor, a set of environmental rules and procedures pertinent to design and construction activities will be produced. Based upon the premises and commitments of this document, these rules will lay out the procedures which must be followed. The intent of such a document is to make the many commitments made in a report such as the current one, readily available and simply understood.

6.3 Management Methods (cont'd)

6.3.2 Monitoring

Construction and operation will be monitored by the Operator to ensure compliance with the environmental commitments made in this document.

6.3.3 Education

All personnel will be given an environmental indoctrination upon joining the project. A pamphlet for distribution to all employees will be produced and talks given to construction staff.

6.3.4 Penalties

Penalties for breaking environmental regulations will be included in contract documents.

6.3.5 Aboriginal Relics

Aboriginal sites have been avoided in the pipeline routing. Any Aboriginal relics discovered during the work will be treated in accordance with the Aboriginal Heritage Act.

6.3.6 Noxious Weeds

Any noxious weeds found growing within the easement after construction will be controlled by the Operator in a manner prescribed by the Department of Agriculture.

6.3.7 Pastoral Activities

It is the intent of this plan that all construction and operational activities relevant to the use of the land as a pastoral lease will be discussed with the lease-holder in an effort to ensure that the aesthetic and agricultural values of the area are not compromised. Advice of pastoralists is regarded as an important input into the successful management of the project.

6.3 Management Methods (cont'd)

6.3.8 Pets

No pets will be allowed by operational employees to impact on the surrounding environment.

6.4 Particular Requirements

6.4.1 Sand Dune Crossings

To maintain a smooth vertical alignment, excavations of up to 5 metres depth may be required in some areas. Where the pipeline crosses claypans, a low dune is almost always encountered, and again considerable excavation may be required. In these areas, the top 200 mm of vegetated soil will be removed off and stockpiled as near as possible to the easement. Excavated sand will be placed in a separate stockpile.

Should rutting and bogging of vehicles be a problem, the easement will be covered by gravel obtained from an appropriate site.

Restoration will proceed by replacing plain sand to approximate the original line of the dune. The topsoil will then be placed over the dune and traffic over the area prohibited.

6.4.2 Mudflats and Claypans

No removal of material other than that for the trench excavation itself will be made.

If rutting and bogging becomes a problem, rocks or gravel will be imported from an approved borrow pit to provide a stable surface. Reinstatement will involve grading of the easement to its original contour.

6.4 Particular Requirements (cont'd)

6.4.3 Clearing and Restoration of Easement

Clearing of the easement will include removal to ground level of trees, stumps and other obstacles, excluding those identified for preservation. Clearing will be such as to retain the maximum amount of root stock. Grubbing of stumps will be kept to the trench line only and those stumps likely to impede the movement of construction vehicles. Grubbed stumps will be spread over the easement after clean-up.

Cleared vegetation will be stockpiled on the access side of the easement and respread after completion of construction. Large items of vegetation, such as logs and branches will be returned to the easement to act as a refuge for fauna.

Grading will ensure that natural drainage is maintained. Access tracks are likely to be compacted due to construction traffic. These will be ripped at work completion to loosen the soil underneath and promote re-growth.

6.4.4 Excavation and Backfill

Topsoil removed from the trench and material excavated from river or creek beds will be stockpiled separate from other excavated materials, for subsequent replacement to their original position. All excavated material from the trench will be placed on the spoil side of the trench. Stones, wood, vegetation, clods of earth, debris and water will be removed from the trench.

6.4.5 Stream and River Crossings

Stream and river crossings will either be bored using direction drilling equipment, or excavated to a depth sufficient to avoid flood scour. Banks will be reinstated to their original contour, but if erosion proves to be a problem, rock gabions, sheet piling or mesh mattresses will be used. Vegetation damage at all waterway crossings will be minimised and tree removal avoided as far as is practicable.

6.4 Particular Requirements (cont'd)

6.4.6 Borrow Pits

Borrow pits may be required to obtain suitable sand padding, suitable backfill or erosion protection for the easement over sandy areas. Should access to the river be difficult, however, sand may be removed from sites as agreed with the pastoralist. Backfill and gravel borrow pits similarly will be established in areas which are not likely to erode further and at a location agreed to by the pastoralist. Before creation of the pit, all topsoil will be removed to a depth of 200 mm and stockpiled nearby. At the end of construction, excess trench spoil may be placed in the pit, but in any case, the excavation will be re-contoured to minimise erosion and unsightly depressions or levee banks. Revegetation will proceed by spreading the removed topsoil over the re-contoured excavation.

6.4.7 Camp Sites and Laydown Areas

Campsites and laydown areas will be located along the easement on well drained land, with suitable access during all weather conditions. Campsite placement will be subject to the approval of the environmental consultants. Vegetation will be rolled in or cut to ground level and reinstated at the end of construction in a manner similar to the easement.

Sewage will be treated in a septic tank with an outfall designed to prevent overflow entering the natural drainage system. Camps will not be sited within 500 m of water holes; no trees will be removed and access to the water limited to one pathway. Water holes will be checked for litter after use.

Camp site wastes will be treated as outlined in section 5.4.5.

6.4.8 Hydrostatic Test Water

Hydrostatic test water will only be obtained from surface water sources that are easily accessible and large enough not to be seriously depleted by its removal. Water will be re-used for various sections of the pipeline and will be inhibited with a bio-degradable corrosion inhibitor.

6.4 Particular Requirements (cont'd)

6.4.8 Hydrostatic Test Water (cont'd)

Disposal of the water will be to an open area (as detailed in section 5.4.2) not connected with the local surface drainage system.

6.4.9 Erosion Protection

Erosion of cleared tracks will be minimised by restricting vehicle speeds, spreading gravel and placing rocks. Wind erosion will be inhibited by watering down. Water used for dust suppression will be obtained from appropriate sources as approved by the pastoralist. Access to the water source will be such as to minimise erosion and vegetation destruction and in any case, access tracks will be reinstated.

Consideration will be given to minimising rain shadow, where surface runoff is re-directed from areas over which it previously flowed.

6.4.10 Easement Inspection

Routine inspections of the pipeline easement will be made to monitor environmental conditions and repairs will be effected where necessary. Photos at fixed locations will be taken to assist with recognition of environmental damage. Inspections will be carried out annually and after periods of heavy rain.

6.5 Abandonment

Abandonment of the pipeline, plant and facilities will be as outlined in section 3.7.2.

7.0 COMMITMENT SUMMARY

7.0 COMMITMENT SUMMARY

The following is a summary of the commitments made by the Joint Venturers to be undertaken during the project design, construction and operation:

- The pipeline, flowlines and processing plant site will not be constructed through significant archaeological and environmentally sensitive sites. A minimum buffer of 200 m will be provided at these sites.
- Power will be generated using production gas, other than in emergencies when diesel will be used.
- Noise attenuation will be provided to limit noise levels under normal operating conditions to 70 Db(A) at 100 m from the plant boundary.
- Treated and brackish water will be discharged to an impervious evaporation pond.
- Sewage will be treated in septic tanks.
- Domestic wastes will be deposited at the Onslow tip.
- Industrial wastes will be deposited in a manner consistent with Ashburton Shire policy.
- Pets and firearms will be banned from site during construction and operation.
- Camps will not be sited within 500 m of water holes.
- Excavations and damaged land will be restored to acceptable ground conditions.
- Backfilled excavations will be graded to ensure natural drainage is maintained.
- Topsoil will be reserved and re-spread over backfilled excavations.
- Cleared vegetation will be re-spread over the pipeline easement.
- Imported materials for construction activity will be removed from the site and disposed of according for Ashburton Shire policy after construction is complete.
- Approval of the pastoralists and advice from environmental consultants will be sought for obtaining water from surface water sources.
- Hydrotest water will contain a bio-degradable inhibitor and will be disposed of in dry, sandy depressions, so that it will not enter the surface drainage system.
- Fire fighting facilities will be available during construction and operation on access roads and tracks within the plant boundary.
- Regular inspections of the pipeline easement will be carried out and also after periods of heavy rain to monitor environmental conditions and to effect repairs where necessary.
- Abandonment of the gas gathering system will include purging and sealing of pipelines, and removal of equipment at the processing plant followed by ground restoration.
- Construction and operation will be monitored by the Operator to ensure compliance with environmental obligations.
- All personnel employed on the project will be trained in the environmental management methods made in this document.
- Penalties for breaking environmental regulations will be included in contracts.
- Any Aboriginal relics discovered during the work will be treated in accordance with the Aboriginal Heritage Act.

CONTRIBUTORS

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The following individuals were instrumental in the production of this report:

Geoffrey Higham	(Associated Surveys International) - Mapping and Data Collection.
Chris Lane	(Soil and Rock Engineering Pty Ltd) - Geology and Pipe Route Selection.
Peter Long	(Astron Engineering) - Environmental Management, Pipe Route Selection and Restoration.
Vicki Long	(Astron Engineering) - Flora and Fauna.
Phillip Moore	(University of Western Australia) - Ethnography.
Lisa Popa	(Worley Engineering) - Pipeline Engineering and Pipe Route Selection.
Wayne Stewart	(Associated Surveys International) - Pipe Route Selection.
Lynda Strawbridge	(University of Western Australia) - Archaeology.
Dr Peter Veth	(University of Western Australia) - Archaeology and Ethnography.

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Conservation and Land Management Department

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Department of Agriculture

Environmental Protection Authority

Geological Survey of Western Australia

Main Roads Department

Marine and Harbours Department

Shire of Ashburton

State Energy Commission of WA

Steedman Science and Engineering

Water Authority of Western Australia

Western Australian Museum

APPENDIX A

FLORA AND FAUNA

AN ASSESSMENT OF FLORA AND FAUNA

ALONG THE PROPOSED TUBRIDGI PIPELINE

Prepared for
Worley Engineering

By PJ & VL Long
ASTRON ENGINEERING

March 1990

1.0 INTRODUCTION

This survey was performed as part of an overall environmental assessment of the Northern Ashburton region being done for the proposed Tubridgi Gas Field Development. This project involves the installation of a gas pipeline from the Tubridgi Gas Field to the Dampier to Perth (SECWA) Pipeline plus plant facilities and flowlines at the field itself. A good indication of the flora and fauna has been obtained but it is intended that identification work will proceed throughout the life of the project to increase the currently limited knowledge of this area.

2.0 VEGETATION

2.1 Introduction

The pipeline route traverses the biogeographical region referred to by botanists as the Eremaean Botanical Province (Beard 1975). This vast Province has been subdivided into naturally occurring districts; the Carnarvon Botanical District being the district relevant to this study. According to the descriptions given by Beard (1975) and Beard and Webb (1974) there are four major vegetation units to be found along the pipeline route, these being, Samphire Mud Flats, Shrub Steppe, Tree Steppe, and Shrub Steppe and Wattle Scrub. The consultants however have described 9 vegetation units, as described below. The area is semi-arid and vegetation is sparse to moderately dense with low ground cover. There are areas totally denuded of vegetation. The north end of the pipeline route is characterised by tidal mudflats behind which are claypans amid sandy ridges. At about 25 km inland the claypans and sand ridges are replaced by a flat sand plain dotted with Coolibah and Wattle scrub. The southern end of the pipe route displays outcrops of rock, and alluvial river deposits. Fringing the Ashburton River are moderately dense stands of Coolibah, River Red Gum and Cajeput.

2.2 Survey Method

The survey was undertaken by helicopter in association with the pipe route determination. The helicopter was landed where appropriate, to collect specimens and identify species. The consultants were, as a result, able to classify 9 significant physiographic vegetation units which are more detailed than the abovementioned Beard units. A later survey was undertaken on land using a four wheel drive vehicle which enabled more data to be collected. This report describes the vegetation units identified, lists the species found and makes recommendations as to the preferred pipeline alignment.

2.3 Vegetation Units

The major units of vegetation along the pipeline route are as listed below.

2.3.1 Samphire Flats

These flat saline plains between sandplains are found at the coastal end of the pipeline route and are common in the vicinity of the proposed Plant Site area.

The reddish brown clay soil is dominated by the *Halosarcia* species, namely *Halosarcia halocnemoides*, *H. auriculata*, *H. indica*, and Sea Couch, *Sporobolus virginicus*. Dunes bordering the Samphire Flats of whitish to pale pink sands support hummock grassland of *Triodia pungens*, (Soft Spinifex), along with the perennial introduced species, Buffel Grass, *Cenchrus ciliaris*. *Solanum lasiophyllum* is frequent with *Pityrodia paniculata* and an overstorey of the low shrub, *Acacia translucens*.

2.3.2 Sand Plains

Red sands support hummock grassland of Soft Spinifex *Triodia pungens*, with an overstorey of *Acacia tetragonaphylla*, *Acacia victoriae*, *Acacia farnesiana*, *Acacia schlerosperma* and *Eucalyptus coolabah*, with lower shrubs *Rhagodia eremaea* and *Cassia oligophylla*.

2.3.3 Circular Depressions

Reddish brown soil with tussock grassland, predominantly *Eriachne Benthamii*, *Eragrostis setifolia* and *Sporobolus virginicus.* The margins of these depressions are fringed with *Eucalyptus coolabah*,, usually extremely stunted.

2.3.4 Low Lying Plains and Depressions

Found in the area of permanent/semi-permanent water courses, dark red soils support tall shrubland of *Acacia tetragonaphylla*, *Acacia victoriae*, *Eucalyptus sp.*, *Eucalyptus coolabah* with *Scaevola spinescens* and an understorey of tussock grasses *Chrysopogon fallax* and *Eragrostis xerophila*.

2.3.5 Alluvial Plains

Red soil supports *Acacia xiphophylla*, *Acacia victoriae*, *A. tetragonaphylla*, *Grevillea sp.*, with scattered *Eucalyptus coolabah* and occasional low shrubs *Rhagodia eremaea* and *Enchylaena tomentosa*. Ground storey includes dense *Cenchrus ciliaris*, Soft Spinifex and *Eragrostis serophila* along with other ephemeral grasses.

2.0 VEGETATION (cont'd)

2.3 Vegetation Units

2.3.6 Stony Drainage Area

Red soil with pebble overlay supports groves of Snakewood, *Acacia xiphophylla* with occasional *Grevillea sclerosperma* and *Acacia victoriae*.

2.3.7 River

The edges of the Ashburton River are fringed with dense tall trees, *Eucalyptus camaldulensis*, *Eucalyptus coolabah*, *Melaleuca leucodendra* and *Melaleuca glomerata*. The poorly developed levees also support *Acacia coriacea*, *Acacia trachycarpa*, *Acacia victoriae* and the grasses *Cenchrus ciliaris* and *Paspalidium jubiflorum*. The annual creeper *Operculina brownii* along with exotic species, *Malvastrum americanum* form the dominant ground cover.

2.3.8 Grassland Parallel to the River

Sandy areas of hummock grassland of Soft Spinifex, *Triodia pungens*, Hard Spinifex, *Trioda wiseana* tussock grass *Eriachne Gardneri* with an overstorey of occasional *Acacia trachycarpa*, *Acacia victoriae*, *Acacia farnesiana*, and *Acacia sclerosperma*.

2.3.9 Inland Dunes

These dunes run parallel to the Ashburton River and are often curved. Their red sandy soils support *Triodia pungens*, *Cenchrus ciliaris* with occasional *Plectrachne schinzii* and *Pityrodia paniculata* and an overstorey of sparse *Acacia sclerosperma*, *A. translucens* and *Grevillea ? gordonia*.

Only dominant and frequent species in each of the above units have been named.

2.4 Species List

In total, 120 plant species were identified, representing 27 families. (Confirmation is still pending on some of these). A full list is included in Table 1, following.

2.0 VEGETATION (cont'd)

2.5 Recommendations

It was strongly recommended that the pipeline route avoid areas of dense vegetation, including stands of larger trees, wattle scrub and areas of samphire species. Saline flats are equally vulnerable to erosion and degradation; the low *Halosarcia* bushes both stabilise the soil and, importantly, add nutrients essential for keeping the area fertile. The *Halosarcia* species are an important fodder for stock, and also, presumably, for native species.

Tall trees, such as those found along the banks of the Ashburton River, are relatively scarce in the region and therefore it was recommended that destruction of these be minimised. The river crossing has been located where these trees are sparse to this particular vegetation unit and fauna habitat will not be greatly affected.

Of significant concern are the sandhills. It has been recommended that these be avoided wherever possible as they are extremely fragile. Vehicle tracks, removal of vegetation and altering of contours will inevitably cause erosion, and loss of soil to the elements. Because the sand on these dunes is prone to shift, vegetation takes many years to establish, and there can be no guarantee that a revegetation programme will be effective.

3.0 FAUNA

3.1 Introduction

A relatively small range of ecosystems occur within the biogeographical region known to zoologists as the Eyrean Zoogeographic Zone (Serventy & Whitell 1976). It is through this zoogeographic zone that the pipeline route will run.

The natural ecosystems along the proposed pipeline route have been somewhat degraded by introduced grazing animals, both domestic and feral. Fauna in the area of the pipeline route is poorly documented and research data is scarce. There are, however, currently no species of vertebrate fauna known to be exclusive to the pipeline route, nor are there any recordings to date of rare or endangered species in the vicinity.

Fauna in the region tend to be hardy and well adapted to the arid conditions. The larger species are generally nomadic, following food and water sources as necessary, therefore population numbers vary. Other species, especially frogs, reptiles and snails have the ability to aestivate. Pastoral areas along the proposed route provide windmills and bores to support more water-reliant species, as does the close proximity of the Ashburton River. Despite baiting and various other eradication programmes, feral cats, donkeys and foxes all compete with the native fauna populations in the area.

3.0 FAUNA (cont'd)

3.2 Methods of identifying fauna

Stock and larger animals were identified visually from the helicopter or during land excursions by vehicle.

In order to try to obtain knowledge of smaller mammals, reptiles, insects and other animals in the area, two common trapping methods were used, namely, pit traps and Elliot traps. Three lines of pit traps were laid, being 25 meters long, with 5 open pits. Differing areas and habitats were chosen in order to gain a representative sample. Pit trap 1 was laid in close proximity to a sand dune bordering a mudflat on the northern end of the proposed route in the vicinity of the Plant site. The pinkish sand in which the pits were laid supported hummocks of *Triodia pungens*, with an overstorey of *Acacia victoriae* and *Acacia tetragonaphylla* and occasional *Acacia translucens*. Five Elliot traps were also opened in this same area. The second lot of traps, were laid in red loamy sand 200 m east of the Ashburton River at the original proposed crossing site. This area was dominated by *Triodia pungens*. Five Elliot traps were again opened in this area, being spaced beneath clumps of Soft Spinifex, and occasional shrubs, *Acacia tetragonaphylla*, and *Rhagodia eremaea*. The third line was laid 50 m east of a permanent watercourse off the Ashburton River. *Eragrostis xerophila* was dominant with frequent *Chrysopogon fallax*, with an overstorey of Coolabah. Again, 5 Elliot traps were placed beneath various types of vegetation.

3.3 Discussion of Collection

Extensive rains, predominantly due to the passage of Cyclone Tina, occurred shortly before the survey and resulted in natural food and water sources being abundant and widespread. Trapping of animals for the purposes of identification was therefore difficult. Although in all cases the traps were laid in close proximity to permanent water, the abundance of random surface water meant that fauna populations had no need to aggregate in areas associated with dense vegetation or close to water holes or the river course. Nothing was caught in the Elliot traps, but two species of spider, three species of beetle, one scorpion, three centipedes and ants were caught in the pit traps along with frog and lizard species. The skink *Morethia ruficauda* was sited in the area of Line 1. All collected species have been confirmed or identified by the WA Museum and are listed in Table 2.

3.4 Birds

The widespread water over the survey area in February allowed birds to move away from permanent water sources. Consequently fewer were visible around the Ashburton than may otherwise be expected. By late March, this water had largely disappeared, however, and birds once again congregated at water courses. A total of 47 birds were identified during the field trip and these are listed in Table 3. It is expected that this list will increase as future visits are made.

3.0 FAUNA (cont'd)

3.5 Other Observations and Notes

Recent rains have brought large flocks of Emu, *Dromaius novaehollandiae*, into the area, as well as Red Kangaroo, *Macropus rufus*. The populations of both these species vary during the year according to the rains. Water and food supplies guarantee large numbers in the area, however during the dry months, both the Red Kangaroo and the Emu migrate south, following the rains. Small populations of the Common Wallaroo or Euro, *Macropus robustus*, are to be found within a 8 km radius of Minderoo homestead, where they are protected from any shooting.

A small number of feral donkeys, *Equus asinus*, were seen near the southern end of the pipeline route, despite a recent eradication programme on Minderoo Station by the Agricultural Protection Board. Feral cats are numerous, as are foxes and the station carries out a baiting programme once or twice yearly. Populations of the fox have decreased significantly due to the baiting programme and a noticeable increase in the Emu, reptile and other native bird species has since been observed. (David Forest, pers. comm.) Mr. Forest also commented that the Dingo, *Canis familiaris dingo*, was not known to be resident on his property but small populations do migrate toward the river from the hills during the summer months. These animals do not cause a problem unless they breed, usually during the months of May and June.

There are approximately 20 species of mammals thought to inhabit the northern Ashburton area (Strahan 1983). These include three species of mouse, several rats, two antechinus, two dunnarts and three wallabies. The Spinifex Hopping Mouse, *Notomys alexis*, has occasionally been observed in the area The rarer Mound Mouse is generally found further inland from the coast and no local sightings were indicated.

4.0 PIPELINE ROUTING AND PLANT LOCATION

4.1 Main Pipeline

The proposed pipeline route runs close to the Ashburton River and several areas of permanent or semi-permanent water. In addition there are several wells in the vicinity used for stock watering. Because of this, flora and fauna is relatively abundant along those parts of the route which are close to these water sources.

Both aerial and land surveys, plus a review of aerial photographs were used to avoid crossing any areas of semi-permanent water (except for the Ashburton River). There are at least two significant drain lines which cross the route, but the crossing is made where these lines are normally dry. Individual trees must be avoided wherever possible. This will need to be addressed during the final survey phase.

4.0 PIPELINE ROUTING AND PLANT LOCATION (cont'd)

4.1 Main Pipeline (cont'd)

The northern section of the pipeline crosses many clay pans. The line has been routed to avoid these as far as possible, as they are surrounded by sensitive sand dunes. There are also areas of soil which can become extremely boggy in this area. These have never been mapped and their avoidance must necessarily occur during the survey.

The river crossing has been chosen to occur in an area where there are as few fringing trees as possible, where adjacent land is high and well drained and where river banks are of sufficiently shallow gradient to avoid erosion. These requirements will minimise vegetation and fauna habitat destruction.

4.2 Flowlines

Flowline routing has not yet been decided but the area was surveyed to establish sensitive areas. Straight-line routes were checked and vegetation patterns established.

The gas field is located under an area of coastal mud flats interspersed with lightly vegetated sandy areas, rarely more than 2 m higher than the mud flats. The sandy areas are covered in Tussock grasses (*Cenchrus ciliaris*, *Eragrostis spp.*, *Erachne spp.*) with occasional stands of *Acacia tetragonaphylla*, *Acacia victoriae*. A line of dunes approximately 10 m higher than the coastal flats extends along their south-eastern boundary. Some rock outcrops here and the plant is to be located in one such area.

Direct line routing from each well to the plant site is acceptable for all except Wyloo 1 well. The route for the latter should run to the north of the sandhills and vegetated valleys. Other well lines cross the flat sandy areas of the coastal mud flats themselves and except for the occasional stand of Acacia scrub, these will not cause difficulties.

If a circular manifold or other gathering system is used, the high sand hills and vegetated depressions will need to be avoided. Sand hills are extremely fragile and vulnerable to erosion and soil loss.

4.3 Plant Site

The plant site located during the desk-top study was amid a dense area of claypans and resulted in the pipeline crossing the heavily vegetated depression of a large waterway. This original plant site was also over 2 km from the road, which would have necessitated construction of a new access way. It was on sandy ground that was relatively low.

The plant site was relocated after the environmental survey to an area that was comparatively high (approximately 14 m), close to the existing access track (about 200 m) and on firm ground. A vegetated waterway must be crossed by the pipeline, but the occasionally used pipeline right-of-way was regarded as of less impact than a well used access road. The current site is more central to the field wells and will result in fewer crossing of sensitive dunes. It will not be susceptible to inundation and is in an area free of termite mounds and dense vegetation.

5.0 CONCLUSIONS

None of the flora or fauna identified in the current survey, or previously listed in the area, are known to be rare or endangered. There are, however, significant numbers of introduced and feral species which have reduced native populations.

The pipeline, plant and flow lines have been positioned to avoid impact to the environment as far as possible. Fauna mortality will be negligible but some 100 ha will have surface vegetation removed.

The authors recommend that strict revegetation measures be enforced as soon as construction is complete in order to avoid soil erosion and degradation. Monitoring of this programme should be undertaken over a period of several years to ensure that original ground cover is replicated.

TABLE 1

TUBRIDGI PIPELINE - VEGETATION LIST

FAMILY	NO	GENUS SPECIES	AUTHOR	COMMON NAME
Poaceae	31	Aristida holathera	Domin	Erect Kerosene Grass
		Aristida contorta	F Muell	Bunched Kerosene Grass
		* Cenchrus ciliaris	L	Buffle Grass
		* Cenchrus setigerus	M Vahl	Birdwood Grass
		Chrysopogon fallax	S T Blake	Ribbon Grass
		Chloris pectinata	Benth	Comb Chloris
		Cynodon dactylon	(L) Pers.	Couch
		Dactyloctenium radulans	(R Br) P Beauv	Button Grass
		Enneapogon caerulescens	(Gaudich) N Burb	Limestone Grass
		Eragrostis setifolia	Nees	Plain Grass
		Eragrostis xerophila	Domin.	Roebourne Plains Grass
		Eriachne aristidea	F Muell	Three-awned Wanderrie
		Eriachne Benthamii	(Domin) Hartley	Swamp Wanderrie
		Eriachne Gardneri	Hartley	
		Eulalia fulva	(R Br) Kuntze	Silkey Browntop
		Panicum decompositum	R Br	Native Millet
		Paspalidium jubiflorum	(Trin) Hughes	Warrego Grass
		Plectrachne schinzii	Henrard	Oat-eared Spinifex
		Sorghum plumosum	P Beauv ex. Roemer	Plume Sorghum
		Sporobolus virginicus	(L) Kunth	Sea Couch
		Triodia pungens	R Br	Soft Spinifex
		Triodia wiseana	C Gardner	Hard Spinifex

TABLE 1 (cont'd)

TUBRIDGI PIPELINE - VEGETATION LIST

FAMILY	NO	GENUS SPECIES	AUTHOR	COMMON NAME
Cyperaceae	32	Cyperus vaginatus	R Br	Sedge
		Cyperus cunninghamii	(CB Clarke) C Gardner	
Proteaceae	90	Grevillea eriostachya	lindley	Kalinkalinpa
		Grevillea ? gordonia		
		Hakea suberea	S Moore	Corkwood
Loaranthaceae	97	Amyema sp.		Mistletoe
Chenopodiaceae	105	Atriplex bunburyana	F Muell	Silver Salt Brush
		Atriplex semilunaris	Aellen	Annual Salt Bush
		Enchylaena tomentosa	R Br	Rub Salt Bush
		Halosarcia auriculata	P G Wilson	
		Halosarcia halocnemoides	(Nees) P G Wilson	
		Halosarcia indica	P G Wilson	
		Maireana ? scleroptera	(J Black) P G Wilson	
		Rhagodia eremaea	P G Wilson	Tall Salt Bush
		Salsola kali	L	Roly Poly

TABLE 1 (cont'd)

TUBRIDGI PIPELINE - VEGETATION LIST

FAMILY	NO	GENUS SPECIES	AUTHOR	COMMON NAME
Amaranthaceae	106	* Aerva javanica	(Burm F) Juss ex. Schultes	Kapok
		Ptilotus gomphrenoides	F Meull ex Benth	
		Gomphrena cunninghamii	(Moq) Druce	
		Ptilotus aervoides	(F Muell) F Muell	
		Ptilotus axillaris	(F Muell ex Benth) F Muell	Mat Mulla Mulla
		Ptilotus exaltatus	Nees	Tall Mulla Mulla
Nyctaginaceae	107	Boerhavia repleta	H J Hewson	
		Boerhavia sp. 2		
Portulacaceae	111	Portulaca conspicua	Domin	March Buttercup
		Portulaca oleraceae	L	Purslane
Lauraceae	131	Cassytha aurea	J Z Webber	
		Cassytha filiformis	L	Dodder
Surianaceae	160	Stylobasium spathulatus	Desf	Pebble Bush

TABLE 1 (cont'd)

TUBRIDGI PIPELINE - VEGETATION LIST

FAMILY	NO	GENUS SPECIES	AUTHOR	COMMON NAME
Mimiosaceae	163	Acacia bivenosa	DC	Two Nerved Wattle
		Acacia coriacea	DC	Leather Leave Wattle
		Acacia farnesiana	(L) Wild	Sweet Mimosa
		Acacia gregorii	F Muell	Gregory's Wattle
		Acacia inaequilatera	Domin	Camel Bush
		Acacia pahcycarpa	F Muell ex Benth	
		Acacia schlerosperma	F Meull	Limestone Wattle
		Acacia tetragonaphylla	F Muell	Kurara
		Acacia trachycarpa	E Pritzel	Sweet Scented Minni-Ritchi
		Acacia translucens	Cunn ex Hook	Poverty Bush
		Acacia victoriae (i)	Benth	Prickly Acacia
		Acacia victoriae (ii)	Benth	Prickly Acacia
		Acacia wanyu	Tind	Wanyu
		Acacia xiphophylla	E Pritzel	Snakewood
		Acacia sp.1		
		Dichrostachys spicata	(F Muell) Gardner	Pied Piper Bush
		Neptunia dimorphantha	Domin	

TABLE 1 (cont'd)

TUBRIDGI PIPELINE - VEGETATION LIST

FAMILY	NO	GENUS SPECIES	AUTHOR	COMMON NAME
Caesalpinaceae	164	Cassia glutinosa	DC	Sticky Cassia
		Cassia oligophylla var. sericea	F Muell Symon	Limestone Cassia
		Cassia pruinosa	F Muell	
		Cassia sp. (? desolata)		
		Cassia venusta	F Muell	
Papillionacea	165	Crotalaria medicaginea	Lam	
		Crotalaria cunninghamii	R Br	Green Birdflower
		Indigofera trita	L f	
		Rhynchosia minima	(L) DC	Clover-leafed Yellow Pea
		Sesbania cannabina	(Retz) Poiret	
		Vigna lanceolata	Benth	Yam
Zygophyllaceae	173	Tribulus occidentalis	R Br	Caltrop
Euphorbiaceae	185	Adriana tomentosa	Gaudich	
		Euphorbia coghlanii	Bailey	
		Euphorbia drummondii	Boiss	
		Euphorbia tannensis	Sprengel	
		Flueggea virosa	(Roxb ex Wild) Voigt	
Tilaceae	220	Corchorus walcotti	F Muell	Northern Buttercup

TABLE 1 (cont'd)

TUBRIDGI PIPELINE - VEGETATION LIST

FAMILY	NO	GENUS SPECIES	AUTHOR	COMMON NAME
Malvaceae	221	Abutilon sp.		
		* Malvastrum americanum	(L) Torrey	
		Sida sp. (1)		
		Sida rohlenae		
Sterculiacea	223	Melhania oblongoifolia	F Muell	
Frankeniaceae	236	Frankenia ambita	Ostenf.	
Violaceae	243	Hybanthus aurantiacus	(F Meull ex Benth) F Meull	Flag Violet
Myrtaceae	273	Eucalyptus aspera	F Muell	
		Eucalyptus camaldulensis	Denh	River Red Gum
		Eucalyptus coolabah	Blakey & Jacobs	Coolabah
		Eucalyptus dichromphoia	F Muell	Bloodwoods
		Eucalyptus sp.		
		Melaleuca glomerata	F Meull	
		Melaleuca leucadendra	(L) L	Cajeput

TABLE 1 (cont'd)

TUBRIDGI PIPELINE - VEGETATION LIST

FAMILY	NO	GENUS SPECIES	AUTHOR	COMMON NAME
Convulvaceae	307	Evolvulus alsinoides	(L) L	
		Ipomoea muelleri	Benth	Poison Morning Glory
		Operculina brownii	Ooststr	Bush Potato
		Polymeria ambigua	R Br	Tangled Morning Glory
Boraginaceae	310	Heliotropium ovalifolium	Forsstal	
		Heliotropium crispatum	F Muell ex Benth	
		Trichodesma zeylanicum	(Burn f) R Br	Rough Bluebell
Chloanthaceae	311A	Pityrodia paniculata	(F Meull) Benth	
Solanaceae	315	Solanum diversiflorum	F Muell	
		Solanum lasiophyllum	Dunal ex Poiret	Flannel Bush
		Solanum sturtianum	F Muell	
Scrophulariaceae	316	Stemodia grossa	Benth	
		Stmeodia sp.		
Cucurbitaceae	337	Mukia maderaspatana	(L) M Roemer	

TABLE 1 (cont'd)

TUBRIDGI PIPELINE - VEGETATION LIST

FAMILY	NO	GENUS SPECIES	AUTHOR	COMMON NAME
Goodeniacaea	341	Goodenia microptera	F Muell	
		Goodenia ? heterochila	F Muell	
		Scaevola spinescens	R Br	Currant Bush
Asteraceae	345	Minuria Cunnighamii	(DC) Benth	
		Olearia sp.* (Eurybia dampieri DC)		
		Pterocaulon sphaeranthoides	(DC) F Muell	

TABLE 2

TUBRIDGI PIPELINE PIT-TRAP CONTENTS

February 1990

VERTEBRATES

Varanidae

Varanus brevicauda

Scinicidae

Ctenotus hanloni
Morethia ruficauda

Amphibians

Neobatrachus sp.
Cyclorana maini

INVERTEBRATES

Arachnids (Spiders)

Araneae: Araneomorphae: Lyosidae, *Lycosa*
Araneae: Araneomorphae: Ctenidae

Insects

Ants

Hymenoptera: Mutillidae, *Ephutomorpha sp.*
Hymenoptera: Formicidae, *Melophorus sp.*
Mymenoptera: Myriapoda: Chilopoda

Beetles

Coleoptera: Carabidae, *Gigadema sp.*
Coleoptera: Tenebrionidae, *Helaeus sp.*
Coleoptera: Tenebrionidae, *Celibe sp.*

Thrips

Thysanura: Lepismatidae, Silverfish

Scorpions

Scorpionida: Buthidae, *Lychas alexandrinus*

Centipedes

Scolopendromorpha: Scolopendridae: *Scolopendra laeta*

TABLE 3

BIRD SPECIES RECORDED ALONG TUBRIDGI PIPELINE ROUTE CONTENTS

February 1990

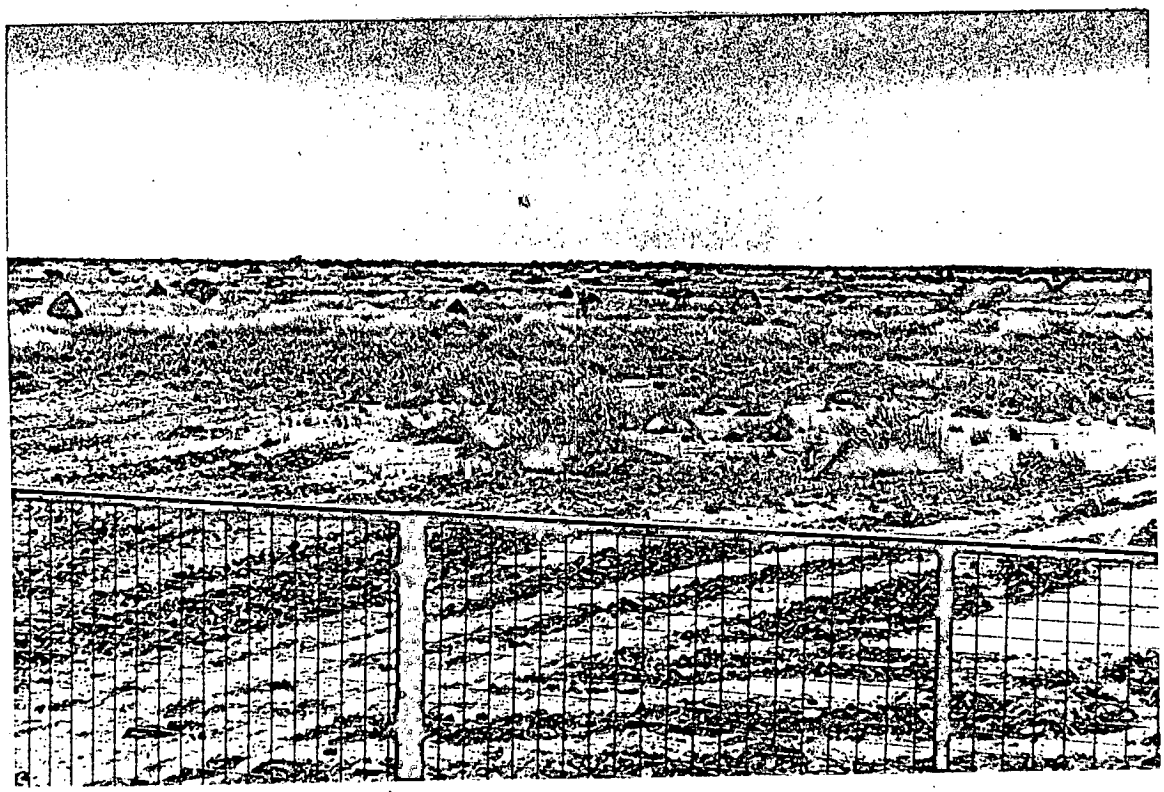
Emu	*Dromaius noveahollandia*
Australian Pelican	*Pelecanus conspicillatus*
Eastern Reef Heron (Grey)	*Egretta sacra*
Pacific Heron	*Ardea pacifica*
Straw-necked Ibis	*Threskiornis spinicollis*
Black Swan	*Cygnus atratus*
Spotted Harrier	*Circus assimilis*
Whistling Kite	*Haliastur sphenurus*
Wedge-tailed Eagle	*Aquila audax*
Black-shouldered Kite	*Elanus notatus*
Brown Falcon	*Falco berigora*
Australian Kestrel	*Falcon cenchroides*
Australian Bustard	*Ardeotis australis*
Brown Quail	*Coturnix australis*
Common Sandpiper	*Tringa hypoleucos*
Wood Sandpiper	*Tringa glareola*
Tern	*Sterna sp.*
Spinifex Pigeon	*Petrophassa plumifera*
Diamond Dove	*Geopelia cuneata*
Peaceful Dove	*Geopelia striata*
Crested Pigeon	*Ocyphaps lophotes*
Galah	*Cacatua roseicapilla*
Little Corella	*Cacatua sanguinea*
Cockatiel	*Nymphicus hollandicus*
Ringnecked Parrot	*Platycerus zonarius*
Budgerigar	
Blue-winged Kookaburra	

TABLE 3 (cont'd)

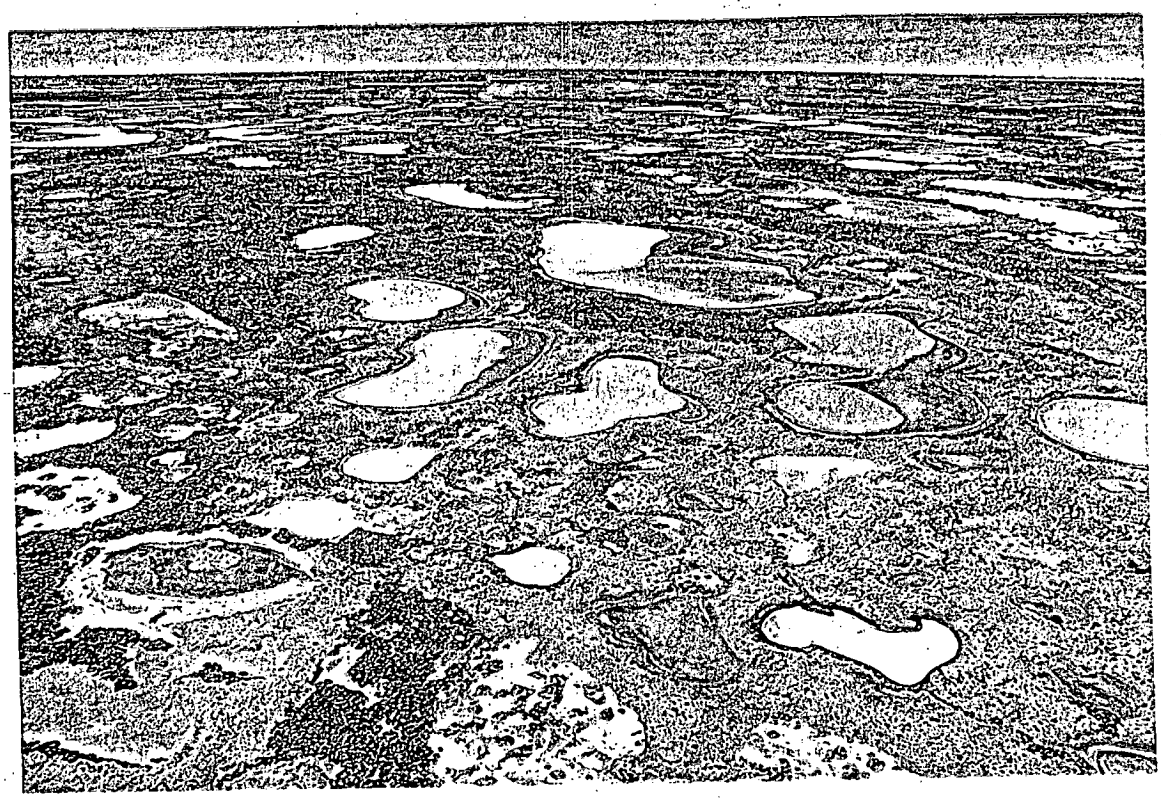
BIRD SPECIES RECORDED ALONG TUBRIDGI PIPELINE ROUTE CONTENTS

February 1990

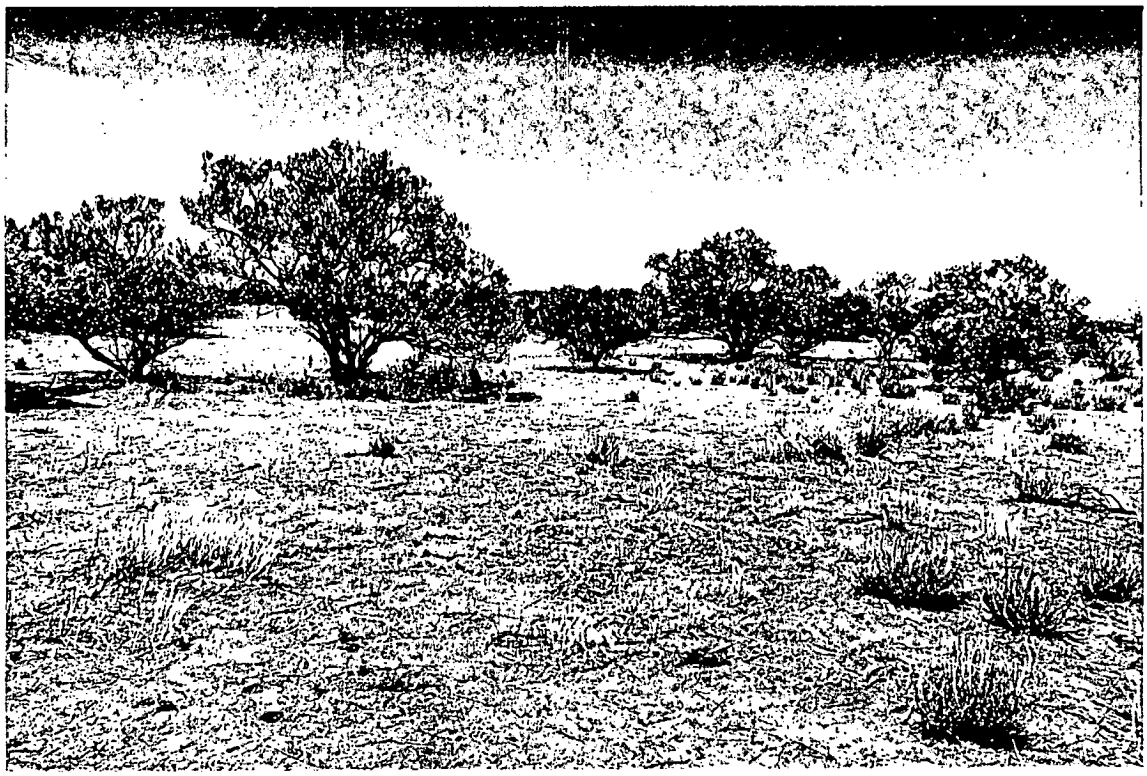
Sacred Kingfisher	*Halcyon sancta*
Welcome Swallow	*Hirundo neoxena*
Tree Martin	*Cecropis nigricans*
Richard's Pipit	*Anthus novaeseelandiae*
Brown Songlark	*Cinclorhamphus cruralis*
Black-faced Cuckoo-Shrike	*Coracina novaehollandiae*
Spinifex Bird	*Eremiornis carteri*
Yellow-throated Miner	*Manorina flarigula*
Grey-headed Honeyeater	*Lichenostomus keartlandi*
White-plumed Honeyeater	*Lichenostomuspenicillatus*
Painted Firetail Finch	*Emblema pictum*
Zebra Finch	*Poephil guttata*
Little Woodswallow	*Artamus minor*
Masked Woodswallow	*Artamus personatus*
White-breasted Woodswallow	*Artamus leucorhynchus*
Magpie Lark	*Grallina cyanoleuca*
Pied Butcherbird	*Cracticus nigrogularis*
Australian Black-backed Magpie	*Gymnorhina tibicen*
Torresian Crow	*Corvus orru*
Little Crow	*Corvus bennetti*



1. Hummock grassland with Termite mounds
North end of pipeline.
View to plant from Tubridgi 1 wellhead

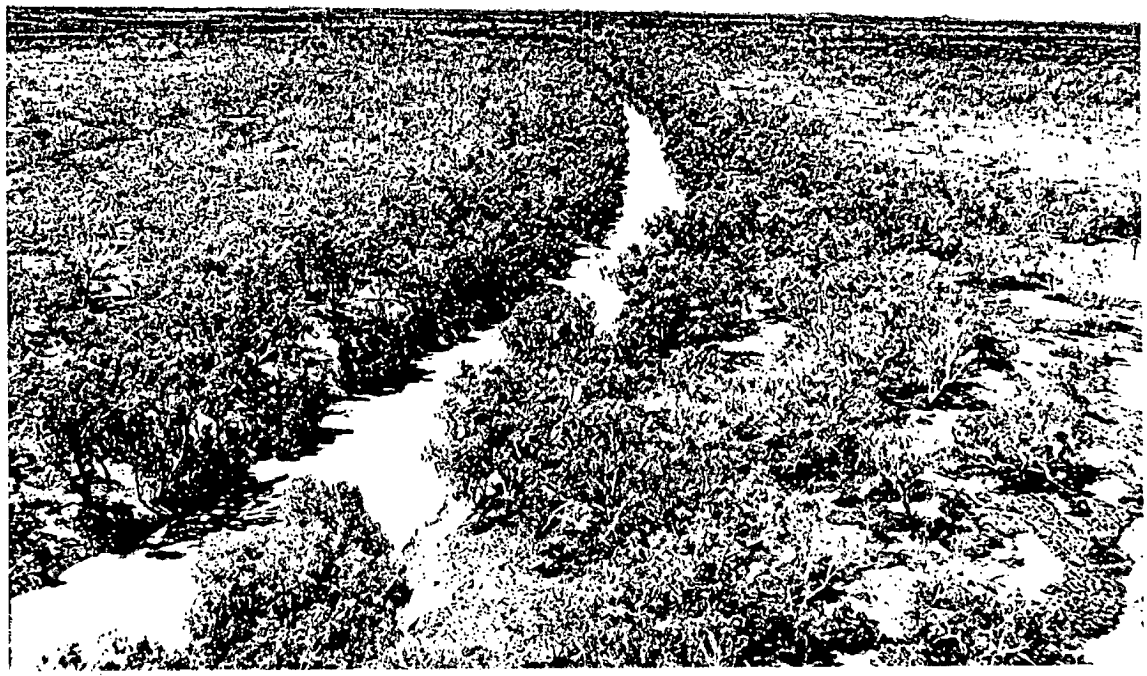


2. Claypan country at north end of pipeline
after recent rain.

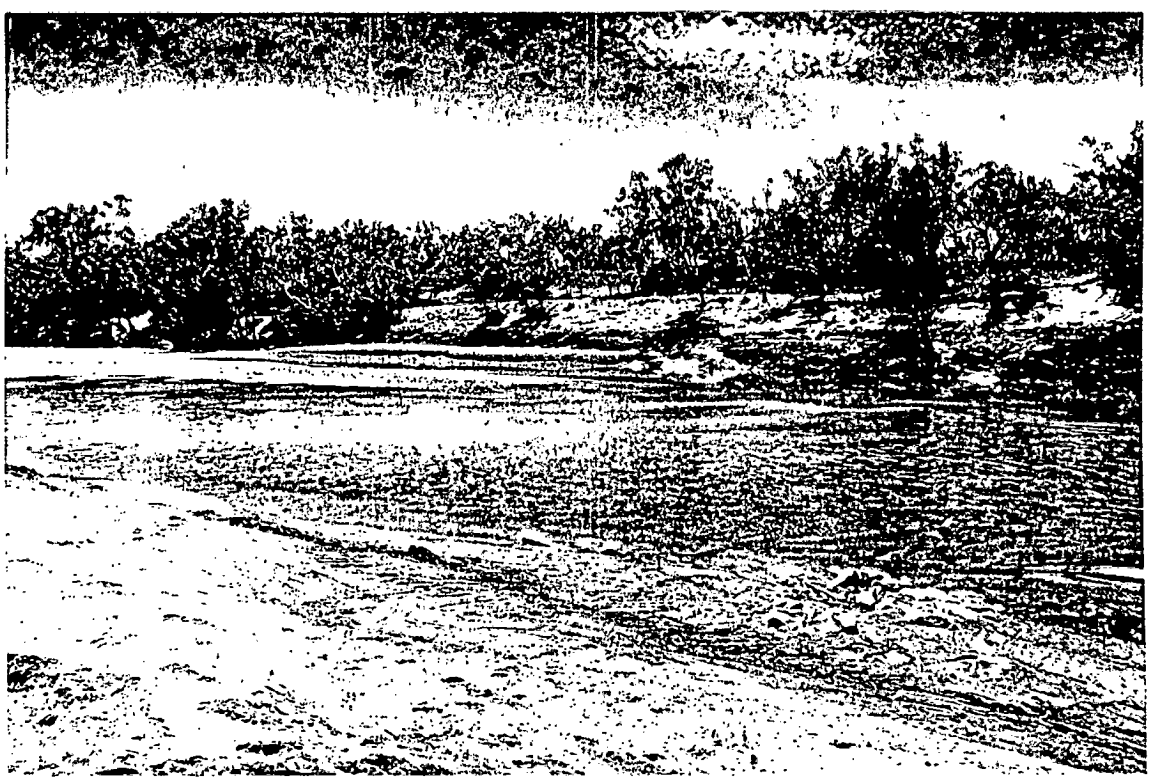


3. Snakewood (*Acacia xiphophylla*) with scattered tussock grasses, south end of pipeline west of Ashburton River.

4. *Ctenotus hanloni*, caught in Pit Trap 2 south end of pipeline, near Ashburton River.



5. Ashburton River in vicinity of original pipeline crossing. Note wide treeline on east (left) side.

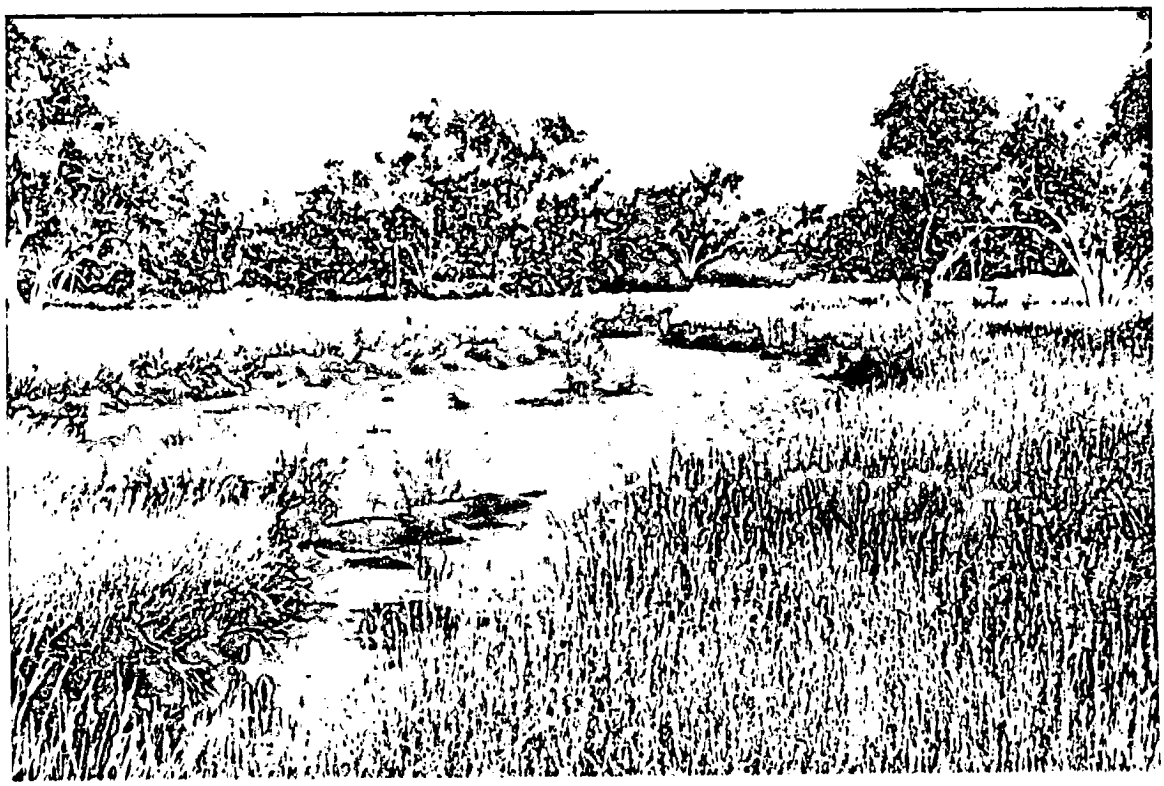


6. Chosen crossing of Ashburton River. Note shallow bank gradient and narrow treeline

7. View to plant site from Tubridgi 2 wellhead. Flowline will cross samphire flat (in distance)

8. View in south-easterly direction over proposed plant site. Hummock grassland with scattered *Acacia* spp., *Olearia* and *Hakea suberea.*

9. Scattered Coolabah with Wattle and Cassia in tussock grassland, mid-section of pipeline route.



10. Semi-permanent water course on original pipeline route. To be avoided.

APPENDIX B

GEOLOGY

Soil & Rock Engineering Pty. Ltd.

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Our ref: 2505/00/CL/st
C2505/REP

1st March 1990

Worley Engineering (Australia) Pty Ltd
14 - 16 Victoria Avenue
PERTH WA 6000

Attention: Mrs L Popa

Dear Lisa

RE: TUBRIDGI GAS FIELD PROJECT

1.0 INTRODUCTION

Please find attached four copies of our final report on the geology for the above project.

I suggest the following extract be used in the main body of the Environmental Report with the geology of the pipeline route attached in the Appendices.

2.0 EXTRACT FOR ENVIRONMENTAL REPORT

Geological Survey

The results of the desk study and site reconnaissance for the geological survey indicate the proposed pipeline route is generally located in areas containing sediments of the Quaternany Period (Pliocene/Pleistocene to Holocene Epoch) which comprise the geological units as shown on Plate 1, and detailed below.

(i) Sand dunes and residual sand plains (comprising quartz sand);

(ii) Clay pans with sand dunes (comprising clay, silt, sand and gravel);

(iii) Alluvial materials (comprising clay, silt, sand and gravel partly calcreted);

(iv) Colluvium materials (comprising poorly sorted clay silt sand and gravel).

At the site of the proposed river crossing some rock, indicated as comprising sandstone/siltstone and granule conglomerate materials of the Nanutarra Formation was observed in the river bed.

3.0 CLOSURE

We trust this report meets your approval. Should you have any questions or should you require clarification of any details of this report, please do not hesitate to contact this office.

Yours faithfully
pp SOIL & ROCK ENGINEERING PTY LTD

Christopher Lane

Christopher Lane
ASSOCIATE DIRECTOR

Attachments • Report of Geology of Pipeline Route

Our ref: 2505/00/CL/st
C2505/REP

1st March 1990

PROJECT TUBRIDGI GAS FIELD DEVELOPMENT

CLIENT: WORLEY ENGINEERING (AUSTRALIA) PTY LTD

LOCATION: ONSLOW

SUBJECT: GEOLOGY OF PIPELINE ROUTE

1.0 INTRODUCTION

This report presents the results of a desk study review of the available geological data and results of the geological reconnaissance of the proposed pipeline route linking the Tubridgi Gas Field to the existing Dampier to Perth States Energy Commission of Western Australia (SECWA) gas pipeline.

2.0 INFORMATION REVIEWED

Geological maps at scales of 1:250,000 (published) and 1:100,000 (unpublished compilation sheets) explanatory notes (where applicable) together with available aerial photography were used for the route selection and environmental investigation.

The maps comprised the following:-

(i) Onslow, Western Australia Sheet SF50-5; 1:250,000 Geological Survey of Western Australia (1982); accompanied by explanatory notes by Van De Graff, W.J.E., Denman, P.D., Hocking, R.M.,

(ii) Yanrey-Ningaloo Western Australia Sheet SF49-12, SF50-9; 1:250,000 Geological Survey of Western Australia (1980); accompanied by explanatory notes by Van De Graff, W.J.E., Denman, P.D., Hocking, R.M., and Baxter, J.L.,

The aerial photographs scale 1:40,000 comprised the following:-

2.1 WA 1471 and WA 1470 Onslow 1:250,000 Sheet

Run	Date	Project No.	Relevant Photograph Nos.
11	13.07.73	N29	5313 to 5315
12 East	13.07.73	N29	5292 to 5295
13 East	13.07.73	N29	5251 to 5254
15	12.07.73	N29	5044 to 5048

2.2 WA 1619 Yanrey 1:250,000 Sheet Runs

Run	Date	Project No.	Relevant Photograph Nos.
1 East	29.05.76	N31	5111 to 5116
2 East	29.05.76	N31	5136 to 5140
3 East	29.05.76	N31	5164 to 5167
4 East	29.05.76	N31	5197 to 5202
5 East	29.05.76	N31	5224 to 5227
6 East	29.05.76	N31	5269 to 5271
7 East	29.05.76	N31	5335 to 5337
8	30.05.76	N31	5353 to 5355
9	30.05.76	N31	5424 to 5426

3.0 DESK STUDY

An examination of the aerial photographs and geological maps was undertaken within the study area defined by the client. This study was concentrated on the preferred route to the south of the Ashburton River, joining the existing Dampier to Perth gas pipeline at the SECWA Compressor Station No. 2. The results of this study, comprising a sketch of the proposed route and desk study report were submitted on 2nd February, 1990.

4.0 FIELD GEOLOGICAL RECONNAISSANCE

On 10th February, 1990 a reconnaissance survey was carried out to inspect the proposed pipeline route by helicopter. At specific locations along the route, the helicopter landed to allow ground inspections to be carried out of various features and surface soils examined.

Photographs of the river crossing sites and plant sites were taken, these are presented on Plates 2 to 4.

5.0 RESULTS OF THE STUDIES

The results of the desk study and site reconnaissance indicate the proposed pipeline route is generally located in areas containing sediments of the Quaternary Period (Pliocene/Pleistocene to Holocene Epoch) which comprise the geological units as shown on Plate 1, and detailed below.

(i) Sand dunes and residual sand plains (comprising quartz sand);

(ii) Clay pans with sand dunes (comprising clay, silt, sand and gravel);

(iii) Alluvial materials (comprising clay, silt, sand and gravel partly calcreted);

(iv) Colluvium materials (comprising poorly sorted clay silt sand and gravel).

At the site of the proposed river crossing some rock, indicated as comprising sandstone/siltstone and granule conglomerate materials of the Nanutarra Formation was observed in the river bed. The proposed pipeline route avoids other rock outcrops observed during the field reconnaissance.

5.1 Plant Site

Two plant sites were examined during the field reconnaissance.

The first site examined (southern most) is located in the geological unit comprising claypans with sand dunes.

The second site examined (northern most) is located in an area which borders between the sand dunes and residual sand plains, geological unit and the claypans with sand dunes geological unit.

Either site would be suitable for the proposed plant site, provided the site selected is on an elevated piece of ground higher than the surrounding land to avoid flooding.

Environmental and economic criteria will determine the finally selected site, which should be subjected to detailed investigations for foundation design considerations.

5.2 Pipeline Route

The results of the desk study and geological reconnaissance, indicate that the materials to be encountered along the pipeline route will be easily excavated with conventional earthmoving plant.

Investigations are however, recommended to provide details of groundwater conditions for pipework design and construction.

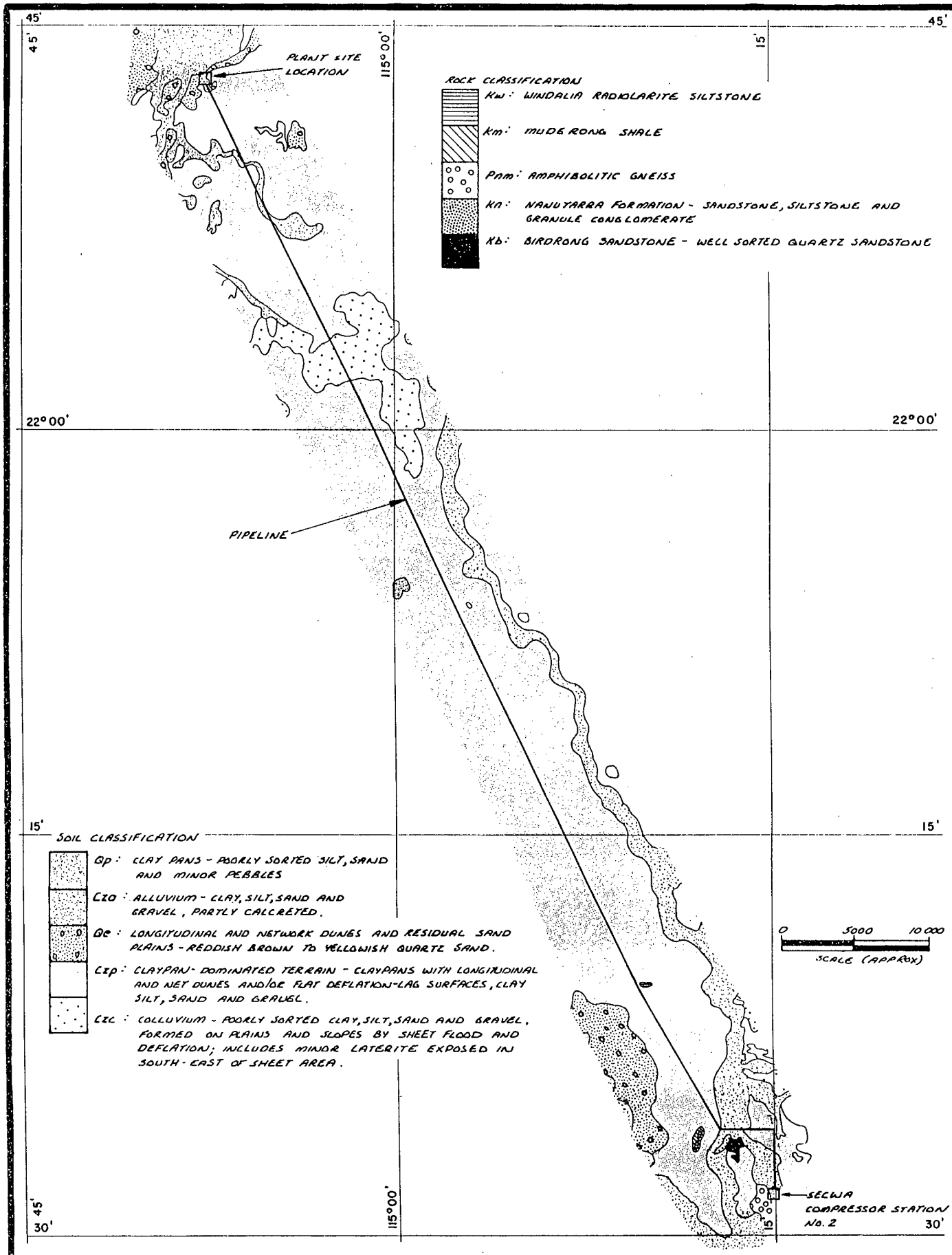
5.3 River Crossing

The site of the proposed river crossing is characterised by alluvial materials (clay, silt, sand and gravel) on the river banks, with rock outcrops and bars of sand gravel and cobbles in the stream channel.

At the time of the site reconnaissance, the Ashburton was partially flooded and flowing relatively quickly in this area, which precluded detailed investigation of the stream channel.

However, detailed investigations of the crossing site are recommended for design and construction purposes.

* * * * *



SITE LOCATION PLAN
TUBRIDGI GAS FIELD PROJECT, ONSLOW

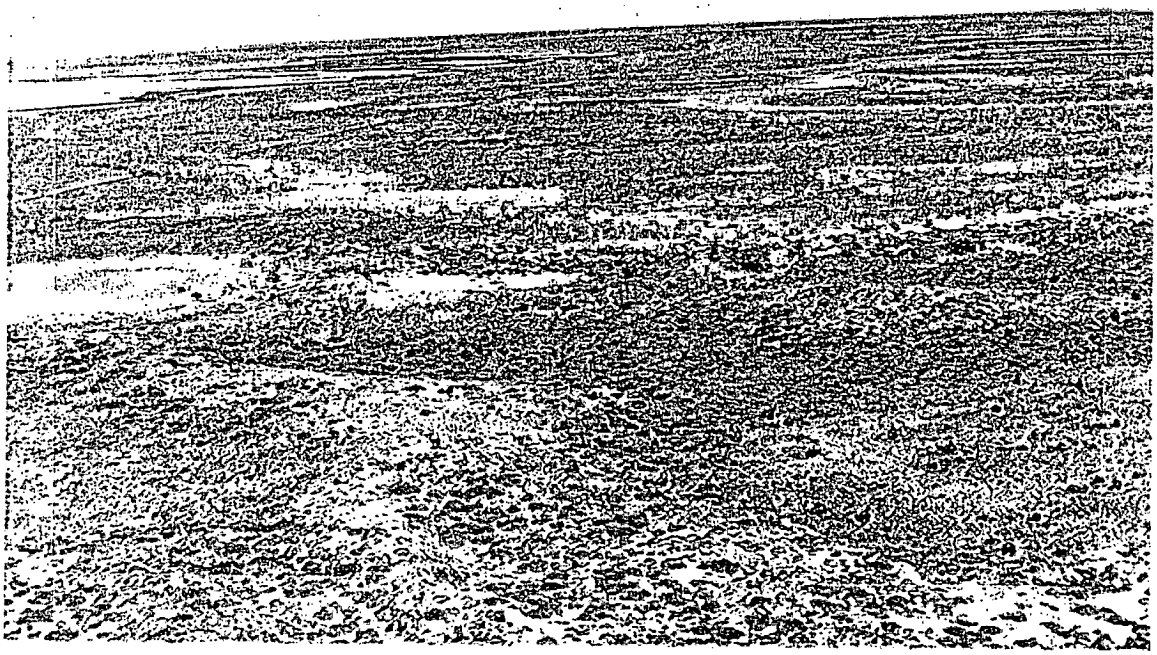
CLIENT : WORLEY ENGINEERING (AUSTRALIA) PTY LTD
JOB No : 2505/00

Soil & Rock Engineering Pty. Ltd.

PLATE 1

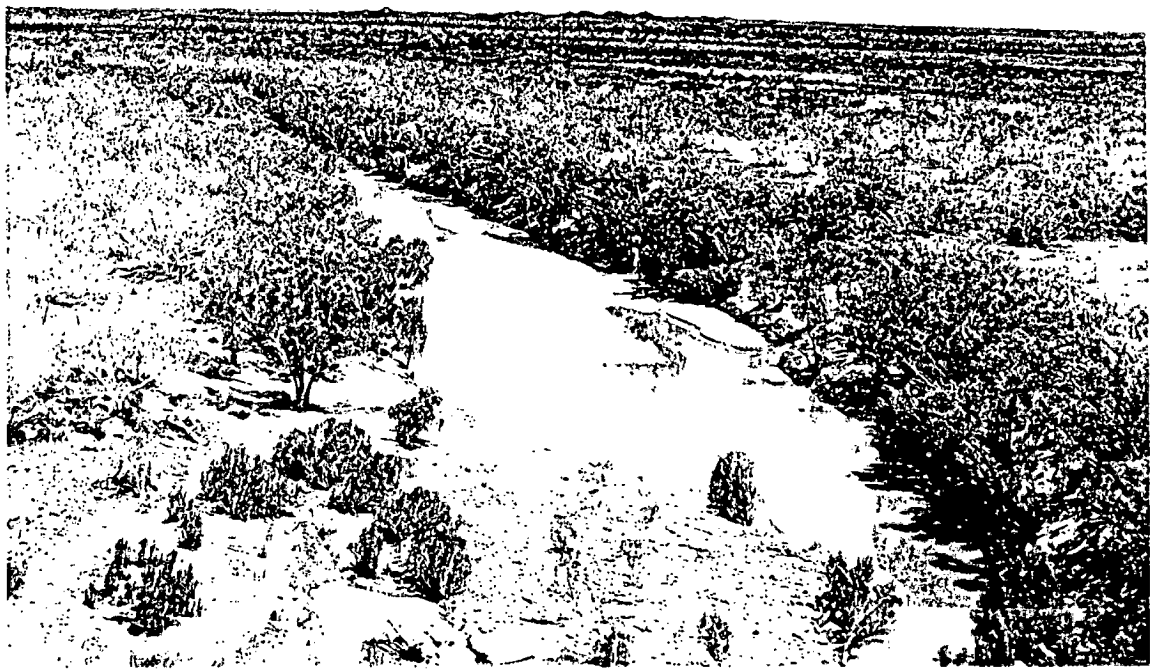
PROPOSED SOUTHERN PLANT SITE IN MIDDLE OF PHOTOGRAPH
ADJACENT TO THE CLAYPAN (TAKEN FROM HELICOPTER)

PROPOSED SOUTHERN PLANT SITE



ALTERNATIVE NORTHERN PLANT SITE (TAKEN FROM HELICOPTER)

ALTERNATIVE NORTHERN PLANT SITE



PROPOSED CROSSING SITE - ASHBURTON RIVER (TAKEN FROM HELICOPTER)

PROPOSED CROSSING SITE - ASHBURTON RIVER

APPENDIX C

ARCHAEOLOGY AND ETHNOGRAPHY

REPORT OF AN ARCHAEOLOGICAL AND ETHNOGRAPHIC SURVEY OF THE TUBRIDGI PIPELINE, ONSLOW WESTERN AUSTRALIA.

A Report to Worley Engineering (Australia) Pty. Ltd.

by

PETER VETH, LYNDA STRAWBRIDGE AND PHILIP MOORE

for

Centre for Prehistory
The University of Western Australia

March 1990

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ABSTRACT

In January 1990, Worley Engineering commissioned the Centre for Prehistory to co-ordinate an archaeological and ethnographic survey of a proposed pipeline, plant site and flowlines connecting the Tubridgi Gas Field, near Onslow, to the main Dampier-Perth gas pipeline.

The proposed pipeline survey zone was 500 m in width and 84 km from the plant site at the gas field to its interception of the Dampier natural gas line.

A review of existing site files and regional consultancy reports indicated that two previously recorded archaeological sites occur within the proposed pipeline survey zone. These comprise a quarry focussed on a large outcrop of silicified sediments (P0268) and a large, diffuse artefact scatter on the slope of a rocky rise (P5129). An additional nine archaeological sites were located during the present survey in the pipeline survey zone (Field Sites 1-9). These all comprise artefact scatters of varying size and complexity, usually associated with relict aeolian dune features, presumably formed in the late Pleistocene. One of these sites (Field site 6) has potential stratification and is argued to be highly significant. Proposed deviations to the original pipeline route, including an amended Ashburton crossing 2 km south of the original route (figures 2a, 2b and 2c), which have also received archaeological coverage, will avoid all 11 archaeological sites with an indirect impact buffer zone of no less than 200m.

A large area encompassing gas wells, possible flowline routes and the location of a new plant site (Figure 2a) has been sampled and predictive statements are offered for the avoidance of sites.

Three ethnographic sites have been previously recorded in the vicinity of the pipeline survey zone and gas field to the north. These are Urama (P1110), Jibia/Jaminn Pool (P4374) and Peepingee Rocks (P1114). These sites are located 4.5 km, 3.5 km and 4.0 km east from the pipeline route, respectively, and thus are under no threat of impact. Two newly recorded ethnographic sites in the present survey are Queerbulla Claypan (Ethnographic Site 1) and Warralee Claypan (Ethnographic Site 2). Queerbulla Claypan lies 3.0 km to the west of the pipeline survey zone and therefore is under no threat of impact. In contrast, Warralee Claypan lies directly adjacent to the original route. A proposed realignment of the pipeline to the west will protect the integrity of this ethnographic site (figure 2b). The relocation of the plant site to the north, the area of the flowlines and the amended Ashburton crossing still requires further field survey with relevant spokespeople. The proposed realignment of the first leg of the northern section of the pipeline to the east (figure 2a) should also be inspected as part of this follow up work.

If the proposed deviations are implemented there are no archaeological or ethnographic grounds, under the Western Australian *Aboriginal Heritage Act* 1972-80, for the pipeline not to proceed. The proponent, Doral Resources N.L., has acknowledged that it will ensure all significant sites are avoided.

ARCHAEOLOGICAL SURVEY

1. BACKGROUND TO THE SURVEY AND CONSULTANCY BRIEF

In January 1990, Worley Engineering commissioned the Centre for Prehistory to co-ordinate an archaeological and ethnographic survey of a proposed pipeline, plant site and flowlines easement connecting the Tubridgi Gas Field, near Onslow, to the main Dampier-Perth line.

Initially a wide corridor was considered for alternative pipeline routes; this is shown in figure 1. Desktop studies were completed by both environmental and heritage consultants to rank the desirability of alternative routes. For the archaeological and ethnographic component this involved plotting all previously recorded sites held by the Department of Aboriginal Sites on relevant 1:250,000 and 1:100,000 topographic maps. A systematic search of the site files was carried out by the Centre and all relevant site data collated. Regional consultancy reports were also reviewed. The locations of the 67 previously recorded Aboriginal sites were verified against a digitised map print out of regional sites compiled by Associated Surveys International from lists supplied directly by the Department of Aboriginal Sites.

The route that was finally chosen from the desktop study as the most desirable avoided all previously recorded ethnographic sites and major archaeological sites and crossed the Ashburton River away from substantial pools. The pipeline alignment finally surveyed is 84 km in length with a survey zone width of approximately 500m (figure 2a-2c).

The archaeological survey was carried out in two stages (i) by Lynda Strawbridge, with the assistance of Giles Sayzeland, between the 10th and 17th February, and (ii) by Lynda Strawbridge and Jenny Smith between the 8th and 12th March. The ethnographic survey was carried out by Philip Moore between the 10th and 17th February.

The consultancy brief from Worley notes:

> "The consultants are to identify any Aboriginal sites which might be disturbed by the proposed pipeline and assess the significance of these sites so that appropriate management recommendations can be made."

The Western Australian *Aboriginal Heritage Act* 1972-80 makes provisions for the recording and preservation of places and objects customarily used by, or traditional to, the original inhabitants of Australia. In the present report, Appendix 1 provides notes on the recognition of Aboriginal sites, whether archaeological or otherwise. In particular, the Act defines the obligations of the community to Aboriginal site protection, as outlined in Appendix 2.

2. REGIONAL ENVIRONMENT

The land traversed by the proposed pipeline is mainly flat and low, between sea level and 20 to 40 metres above this. Hard rock exposures are infrequent and mainly occur as isolated calcrete outcrops and sedimentary suites towards the southern end of the route. Claypans, common at the northern end, are represented as isolated features and clusters further down the route.

The pipeline route passes through three vegetation units, as defined by Beard (1975). The northern strip comprises *Atriplex* and *Kochia* on claypans with scrub

on sandy rises. The remainder of the northern third of the route comprises grass savanna mixed with spinifex. The remainder of the route is characterised by groves of snakewood and patches of grass and bare gravel.

At the time of the survey the northern strip was quite heavily vegetated and the area generally wet, especially in numerous small and medium sized claypans. South of Picul claypan was generally drier. Further south, vegetation cover increases with annual tussock grasses and pockets of *Eucalyptus microtheca.* The ground surface is characterised as gilgai, or cracking clays. This terrain continues to past K-Tree Well. To the south large vegetated claypans are surrounded by, presumably Pleistocene, red dune ridges. These dunes continue south of Warralee Well to approximately Gaston Well. The remainder of the route comprises low lying areas which have been subject to erosion (with *Acacia* sp. and sparse ground cover) to wet areas with *Acacia* sp., *Eucalypt* spp. and a ground cover of perennials and tussock grass.

3. PREVIOUS ARCHAEOLOGICAL SURVEY AND RESEARCH IN THE REGION.

A total of 67 Aboriginal sites have been previously recorded in the larger area examined for the desktop study which is shown in Figure 1. Four of these are ethnographic sites while the remainder are archaeological sites, of one type or another.

Archaeological sites occur frequently in this region and include shell middens and scatters, large scatters of stone artefacts and hearths down to isolated grinding slabs and patches, stone quarry sites, engravings, burials and one rockshelter with cultural deposit.

In the vicinity of the proposed pipeline route are five previously recorded archaeological sites (figures 2a - 2c). Moving north to south these include a shell scatter (P5562, Grid ref. 271.281), a shell and artefact scatter (P5561, Grid ref. 271.280), a quarry (P0268, Grid ref. 306.212), another quarry (P4359, Grid ref. 310.200) and an artefact scatter (P5129, Grid ref. 314.198).

A considerable number of consultancy projects have been previously carried out in the larger area (Brown 1978; Brown 1983; Mulvaney and Kee 1984a, 1984b and 1984c; Pickering 1982; Quartermaine and Kee 1985; Quartermaine and O'Connor 1987; Reynolds 1982 and Wright 1982). Most of this work has been associated with the Dampier to Perth natural gas pipeline, road clearances and regional mineral exploration.

It is clear from the areas actually surveyed that the majority of major (archaeological) occupation sites are closely tethered to the margins of drainage courses, claypans and tidal inlets.

In the hinterland portions most dunes and elevated rises near drainage features contain some evidence for occupation. All outcrops of silcrete or calcrete, with siliceous inclusions, which have been surveyed have some evidence of quarrying. Particularly noticeable is the high density of sites located on the coastal flats and adjacent inlets and on dunes. These sites include major middens with probable stratification, shell and stone artefacts in deflations and burials.

A constant, although low density, occurrence of isolated artefacts on drainage courses which have been surveyed suggests that these might be encountered at any chosen crossing of the Ashburton River. The distribution of major occupation sites along the Ashburton is more difficult to predict, although other intensive surveys of drainage lines in semi arid/arid environments (e.g. Veth 1984 and Veth

and Hamm 1989) indicate their association with more permanent pools/soakages. These are also often likely to be of ethnographic significance.

While it is premature to suggest a settlement/subsistence strategy for at least the late Holocene in this area, it does seem likely that groups focussed on coastal and hinterland drainage ecotones using environmentally homogeneous portions of the coastal plain in a more opportunistic manner, especially given the constraints of reduced groundwater levels during the dry.

4. SURVEY METHODS

Initially a number of access tracks were used to sample sections of the proposed pipeline survey zone falling in the different vegetation/substrate divisions discussed in Section 2. These samples were used to develop appropriate survey strategies for the remainder of the route. The survey zone was 500 m in width.

The route north of Picul Claypan was intensively surveyed where the ground surface was actually visible; all adjacent claypan margins were also inspected. Visibility increased between Picul and K-Tree Well and a combination of evenly spaced linear and zig-zag traverses were used in this section. Visibility between K-Tree Well and Warralee Well was similar with a noticeable association of lithic scatters and dune ridges. In addition to traverses, all dunes within and adjacent the route were intensively surveyed. Surface visibility continued to be high to Gaston Well and a similar survey strategy was employed. South of Gaston Well visibility carried from low lying, eroded areas lacking ground cover to wet areas with low *Acacia* sp. A range of values estimated for surface visibility are presented in Table 1. Distances are from the plant site, north to south.

Table 1: Surface visibility estimates

Section	Distance	Surface Visibility Range
Plant site – Picul Claypan	16 km	20 - 30%
Picul – K-Tree Well	11 km	40 - 50%
K-Tree – Warralee Well	11 km	40 - 50%
Warralee – Gaston Well	28 km	60 - 70%
Gaston – Dampier Pipeline	18 km	30 - 90%
TOTAL	84 km	

The northern gas field, flowline and new plant site location (figure 2a – top) was sampled using a combination of linear transects and purposive quadrats. Approximatley 40% of this large area has been examined.

It is estimated that 40% of the ground surface of all survey areas has actually been inspected. The survey strategies employed will have located all major archaeological sites along, and adjacent to, the proposed pipeline survey zone and will provide predictive statements for the avoidance and management of sites in the northern gas field zone.

Deviations shown in figures 2a-2c have been covered by the archaeological survey. The relocation of the Ashburton crossing two kilometres to the south of its original crossing, as shown in figure 2c, has also been covered.

5. DESCRIPTION OF CULTURAL MATERIAL

5.1. Newly recorded sites within the pipeline survey zone

A total of nine new archaeological sites were recorded within the 500 m wide pipeline survey zone. These are predominantly stone artefact scatters lying on, and adjacent to, red linear dunes. One of these sites may have some potential for

stratified cultural deposits. All of these sites will be avoided by the pipeline through rerouting.

Site 1: Grid reference: KA8972, SF50-5, 1:250,000 Metric Edition 1
KA893722, 1854, 1:100,000, Metric Edition 1

A small artefact scatter is located on fine reddish silts/gravels east of Chinty Creek. Thirty artefacts covered an area of 40 m N/S and 10 m E/W. Many of the artefacts are water worn and have been rolled. Artefacts comprised a silicified siltstone adze, a distally retouched chert flake, a utilised banded ironstone fragment and a range of unutilised flakes, broken pebbles and core fragments in BIF, silicified siltstone and chert. Two fragments of grinding material, in dolerite and quartzite, were also noted.

Site 2: Grid reference: KA9757, SF50-9, 1:250,000 Metric Edition 1
KA972575, 1953, 1:100,000, Metric Edition 1

A diffuse artefact scatter occurs on the southern tongue of a red dune situated approximately 5 km north of Warralee Well turnoff.

Approximately 50 pieces cover an area of 50 m N/S and 40 m E/W and comprise mainly unutilised pieces in dolerite, quartzite, chert and silicified banded ironstone. Several fragments of baler shell, a common utensil and trade item, were also noted. Modified pieces include grinding fragment and a retouched/utilised blade.

Site 3: Grid reference: KA9757, SF50-9, 1:250,000 Metric Edition 1
KA972569, 1953, 1:100,000, Metric Edition 1

Another red dune, located 0.5 km south from Site 2, has a scatter running along most of its 250 m length. The scatter is up to 27 m in width covering the western face of the dune and flanking onto an adjacent tributary. Where the northern tongue of this dune intersects the tributary the artefact scatter is most dense; i.e. up to 25 pieces /m^2. The average density of the site is 1 piece/m^2, giving it an estimated population of 6,000 pieces. Stone material categories are similar to those at site 2, however baler shell is absent.

The artefacts cluster into several dense concentrations along the length of the dune, which may reflect former habitation clusters, task-specific activity areas or simply result from differential erosion. Most of the artefacts are unmodified, however adzes, laterally retouched flakes and retouched/utilised fragments were noted. Grinding material is represented by several pieces.

Site 4 Grid reference: KA9855, SF50-5, 1:250,000 Metric Edition 1
KA980552, 1953, 1:100,000, Metric Edition 1

Approximately 100 artefacts are situated on a red dune which is adjacent to by a swampy depression. The scatter covers an area of 50 m N/S and 10 m E/W. Implements include an adze slug in silicified mudstone, a chalcedonic backed blade, a unifacial flake "scraper" and quartzite hammerstone. Grinding fragments in dolerite and basalt were noted as were several sandstone mullers. Cores and primary flakes occur in banded ironstone, quartzite, green chert and basalt. There is no evidence for stratification.

Site 5: Grid reference: KA9854, SF50-5, 1:250,000 Metric Edition 1
KA983545, 1953, 1:100,000, Metric Edition 1

A low density scatter of 12 artefacts covers an area of 20 m N/S and 25 m E/W on a low red dune north of Warralee Well. These include three ground fragments in silicified sandstone and dolerite, flakes in banded ironstone and basalt and broken cores in dolerite. Two fragments of baler shell were also recorded.

This site lacks the swampy setting of Site 4 and also lacks evidence for stratification.

Site 6: Grid reference: KA9954, SF50-5, 1:250,000 Metric Edition 1
KA990540, 1953, 1:100,000, Metric Edition 1

An extremely dense scatter of artefacts is located on a low red dune situated between the Ashburton River and Warralee Well Stockyards. The scatter covers an area of 100 m N/S and 270 m E/W, located mainly on the crest and southern face of the dune. Material appears to be eroding out from the dune on its upper southern slope, therefore it is likely some excavatable deposit exists here.

The scatter is dense in parts with 20 pieces per m^2 up to 200 pieces per m^2. Stone materials represented on the site include dolerite, basalt, porphyritic volcanic, quartzite, quartz, chert, chalcedony and a range of different silicified mud- and siltstones. Baler shell fragments are also relatively common.

Post-contact occupation is evidenced by fragments of porcelain insulator, metal buttons and glass fragments.

A range of flaked and ground implements were noted including tula and burren-type adzes, small discoidally retouched flakes, laterally retouched blades, a few backed pieces, varriously retouched flake "scrapers" and fragments of basal

grinding stone. This has clearly served as a major occupation site until contact. Its ethnographic significance is discussed in Section 10 of this report.

Site 7: Grid reference: KA9854, SF50-9, 1:250,000 Metric Edition 1
KA98537, 1953, 1:100,000, Metric Edition 1

Located to the east of Warralee Well is a low red dune which has been badly eroded. A scatter of 25 artefacts is located within an area of 50 m N/S and 20 m E/W on the eastern slope of the dune. The dune lies directly north of a large, vegetated claypan. Artefacts include a broken and distally retouched ground pebble muller, small flakes in black ironstone, several multiplatform basalt cores and five fragments of glass.

Site 8: Grid reference: LA0346, SF50-5, 1:250,000 Metric Edition 1
LA031459, 1953, 1:100,000, Metric Edition 1

To the west of Nanyarra Hill is a low density scatter of 12 stone artefacts adjacent a minor local depression. These include two flaked sandstone pebbles, three chert flakes, one broken chert blade, three fragments of ground sandstone and three dolerite flakes. These artefacts were spread over an area of 15 m N/S and 15 m E/W. Edge smoothing on the flakes suggests they have been water rolled.

Site 9: Grid reference: LA1035, SF50-9, 1:250,000 Metric Edition 1
LA099352, 1953, 1:100,000, Metric Edition 1

In a large blowout within a minor red sand rise are 250 artefacts covering an area of 28 m N/S and 18 m E/W. Implements include laterally retouched flake "scrapers", small retouched blades, two adze slugs and three doleritic grinding fragments. A wide range of lithologies are represented including dolerite, black

siltstone, basalt, BIF, quartz, green chert, sandstone, quartzite, porphyritic volcanic and quartz crystal. The site has no potential for stratification.

5.2. Isolated artefacts within the pipeline survey zone

Nineteen isolated artefacts were located within, and directly adjacent, the survey zone. These comprise mainly unretouched flakes and broken cores. Of interest are four grinding fragments in a range of lithologies including dolerite, quartzite and sandstone.

Other implements include a retouched basalt flake "scraper" (45 x 50 x 30 mm), a basalt core fragment "scraper" (20 x 22 x 15 mm), a retouched/ utilised single platform pebble core (50 x 80 x 65 mm) and a retouched broken core in silicified sediment (30 x 20 x 20 mm).

The density of isolated artefacts recorded within the easement is low (1 piece per 0.5 km^2) and it is likely this figure would be higher directly adjacent the river flanks. The occasionally discarded artefact, on the larger plains unit, is seen to represent land use rather than occupancy.

5.3. Newly recorded site outside the pipeline survey zone

Site 10: Grid reference: LA1716, SF50-5, 1:250,000 Metric Edition 1
LA169159, 1953, 1:100,000, Metric Edition 1

Only one site was recorded which lay outside the survey zone. A large outcrop of silicified sediment has intermittent evidence for quarrying. The outcrop is distinctive, being easily viewed from the surrounding plain as a high weathered rise against the skyline. Intensity of reduction appears to be low, with effort

focussed on fine-grained exposures amongst the parent rock. Small accumulations of silt and sand in depressions may provide some datable material. This site has not been quarried as intensively as quarry outcrop P0268 situated some 12 km to the north.

5.4. Previously recorded sites within the pipeline survey zone

Two previously recorded archaeological sites occur within the pipeline survey zone (figures 2b and 2c).

The first of these P0268 is an extensive outcrop of silicified sediment which has been quarried. Its boundaries have been plotted in figure 2b and it has been extensively photographed in the field. It is similar to Site 10 in its context, however it seems to have had a more sought after deposit as reduction appears to be more intensive and the overall quantity of ***debitage*** is much greater.

The second site P5129 was recorded by Steve Brown in 1983 and comprises an extensive artefact scatter on a hillslope. The scatter, which measures 50 m N/S and 30 m E/W, is on elevated rocky ground which will be avoided in the construction of a pipeline.

5.5. Newly and previously recorded sites within the northern gas field/flowline/plant site area and predictive statement

A total of 12 archaeological sites have been previously recorded within and adjacent to the northern gas field survey area. This survey area and the location of these sites is shown in figure 2a. These sites and their components are summarised in Table 2.

Table 2: Archaeological sites located within and adjacent to northern gas field survey area

W.A.M. Site Number	Grid ref: 1:250,000 Imperial (SF 50-5)	Description
P0752	269.284	Urala dune burial
P5561	271.280	Stone artefact/shell scatter
P5562	271.281	*Terebralia* scatter
P5563	274.282	Stone artefact/shell scatter
P5569	269.283	Stone artefact/shell scatter
P5570	270.285	Stone artefact/shell scatter
P5571	272.286	Stone artefact/shell scatter
P5572	272.285	Shell scatter
P5632	268.284	Dune burial
P5888	266.281	Stone artefact/shell scatter
P5889	267.282	Stone artefact/shell scatter

All of these sites are located on dunes, usually within deflated hollows or in dune sections exposed through water erosion. These scatters vary in density from sparse through to very dense, intermittent clusters of mangrove habitat shellfish, stone artefacts, marine mammal bone and sometimes basal stones. All of the sites located **within** the northern gas field survey area were re-inspected (i.e. P5561, P5562, P5569, P5888 and P5889) and their boundaries plotted accurately on aerial photographs which have been forwarded to Worley. Two of these sites (P5562 and P5569) have some potential for stratification.

Four sites were recorded during the present survey and these are described below. Their locations are also shown on figure 2a. They similarly comprise shell/artefact scatters exposed on dune deflations and flanks.

Site 11: Grid reference: KA7691, SF50-5, 1:250,000 Metric Edition 1
KA758909, 1854, 1:100,000, Metric Edition 1

A shell and artefact scatter is located on a NE–SW trending dune, in greatest densities within several major exposures along its crest. Paler red sands appear to contain *Terebralia, Anadara* and oyster fragments, in addition to quartzite and silcrete artefacts, and these **overlie** a darker red sand unit which also appears to contain cultural material. Sandstone grinding fragments were also noted within deflations. The scatter measures approximately 50 m NE–SW and varies in width up to 25 m. The site appears to be clearly stratified with at least two geomorphic units exposed.

Site 12: Grid reference: KA7591, SF50-5, 1:250,000 Metric Edition 1
KA747910, 1854, 1:100,000, Metric Edition 1

A small concentration of *Anadara* and baler shell fragments, in addition to oyster, cover an area of 10 m x 5 m on a dune south of Urala Station. One piece of glass located on the site has no evidence for retouch/utilisation. A small number of shell fragments occur as isolated finds between adjacent dunes. The site has no potential for stratification.

Site 13: Grid reference: KA7890, SF50-5, 1:250,000 Metric Edition 1
KA779895, 1854, 1:100,000, Metric Edition 1

Located on a deflation on a dune ridge is a medium to low density scatter of *Anadara, Terebralia*, baler and oyster. A wide range of lithologies present include basalt, BIF, banded cherts, quartz and silicified siltstone. Pieces are mainly debitage although several laterally retouched flakes were noted. One muller and several grinding fragments were also recorded. The site measures approximately 200 m NE–SW and is up to 40 m in width, normal to this axis. A seismic line runs N–S through this site, which is consequently very disturbed.

Site 14: Grid reference: KA8090, SF50-5, 1:250,000 Metric Edition 1
KA800905, 1854, 1:100,000, Metric Edition 1

Along a NE oriented sand ridge are small exposures of stone artefacts and shell fragments. Two main clusters cover an area of 1.2 km NE–SW, with a 400 m gap in between; the exposures are rarely greater than 20 m in width across the dune crest. Main shellfish represented are *Terebralia*, with low numbers of both *Anadara* and baler shell fragments. At the base of the dune are numerous oyster fragments in addition to muller fragments and one intact muller. Only fragments of cores and primary flakes (all in quartzite and silcrete) were noted on the dune crests. The site has no potential for stratification.

All sixteen sites recorded within and adjacent to the northern gas field survey area are associated with clearly discernable dune features. Given that 40% of this area has been inspected, it is extremely unlikely that major archaeological

sites occur on different landform units. It is predicted, therefore, that the likelihood of finding other major, and/or stratified, sites on dunes with an elevation equal to, or greater than 1.5 –2 m is high and that these features should be avoided when the flowline routes are being designed.

6. Significance of Cultural Material

A total of eleven archaeological sites are located within the **original** pipeline survey zone. Modifications in the design of the pipeline were made by Worley so that all of these sites would be avoided by **at least** a 200 m buffer zone. These proposed deviations are shown in figures 2a and 2b. The proposed deviations were suggested by Worley during the field survey so that alternate routes received full archaeological coverage. A total of four newly recorded and twelve previously recorded archaeological sites are located within, and adjacent, the northern gas field survey area. It is recommended below that the design of the flowline routes should aim to avoid these sites, in addition to missing dune features.

The timely and relevant regional research questions by which the archaeological significance of these sites may be assessed are summarised, as follows:

1. What is the antiquity of occupation in this semi-arid plains area? Is it of the same order as the Hamersley Plateau shelters of the eastern Pilbara?

2. Does occupation continue during the glacial maximum when the Onslow sandsheet would have been several hundred kilometres from the sea, and when sand dunes were re-activated due to intensive aridity, between 22,000 to 15,000 years ago?

3. Is there evidence for early Pleistocene occupation associated with the paleo drainage of the Ashburton as might be expected with coastally/litorally

adapted groups, or are all geomorphic units of the Pilbara in use before 25,000 years ago?

4. Have settlement/subsistence patterns since the sea reached its present position between 6 –7,000 years ago remained the same or have economic changes occurred due to changes in coastal geomorphology, as has been documented across much of northern Australia?

5. Are late Holocene occupation patterns closely tethered to coastal/riverine ecotones or are major occupation sites located across all landscape units?

6. Is there evidence in stratified sites for increased intensity of occupation during the last 2,000 years, as has been documented in other arid areas, implying possible population growth and/or increasing efficiencies of resource extraction?

In assessing the sites within the pipeline survey zone, apart from noting their presence and assemblage characteristics (i.e. Question 5), sites 1, 2, 4, 5, 7 and 8 are unable to answer any of the other questions and are therefore seen to be of low archaeological significance. Site 10 and P0268, both quarries with some potential stratification, may be able to address question 6 and are seen to be of moderate archaeological significance.

Sites 3, 6 and P5129 are large artefact scatters probably representing major occupation sites. Assemblage analysis of these assemblages may be able to address questions of 4, 5 and 6. They are therefore argued to be of moderate archaeological significance.

Site 6, a large artefact scatter which appears to be eroding from a dune, may be able to address, through excavation, aspects of all six questions.

It is therefore argued to be highly significant. Given that all previously and newly recorded archaeological sites will be avoided through alterations to the pipeline route, further consideration of the archaeological significance of these sites is not necessary.

In assessing sites within the northern gas field area it is argued that sites P5562 and P5569 are moderately significant in their ability to address questions 4, 5 and 6. There are extensive and relatively undisturbed shell/artefact scatters which also probably represent major occupation sites. These sites have some potential for stratification.

Newly recorded site 11 is argued to be highly significant in that it appears to contain stratified cultural assemblages, some of these within a lower dark red sand unit exposed in a major dune deflation. It is therefore likely to span at least the Holocene time period and may, in fact, be able to address all six research questions.

7. RECOMMENDATIONS

Nine newly recorded, and two previously recorded, archaeological sites are located within the survey zone of the original pipeline route proposed by Worley. One of these sites (Site 6) is argued to be highly significant, three sites (Sites 3, 6 and P5129) to be of moderate significance and six sites (Sites 1, 2, 4, 5, 7 and 8) to be of low archaeological significance.

Worley has made alterations to the original route which would deviate the pipeline around all of these sites. The site boundaries and proposed deviations are shown in figures 2a, 2b and 2c. The precise boundaries of the sites have also been plotted on aerial photographs held by Worley and are recorded on a

digitised regional map constructed specifically for the Tubridgi project by Associated Surveys International. The deviations miss the closest site boundaries by at least 200 m in each case.

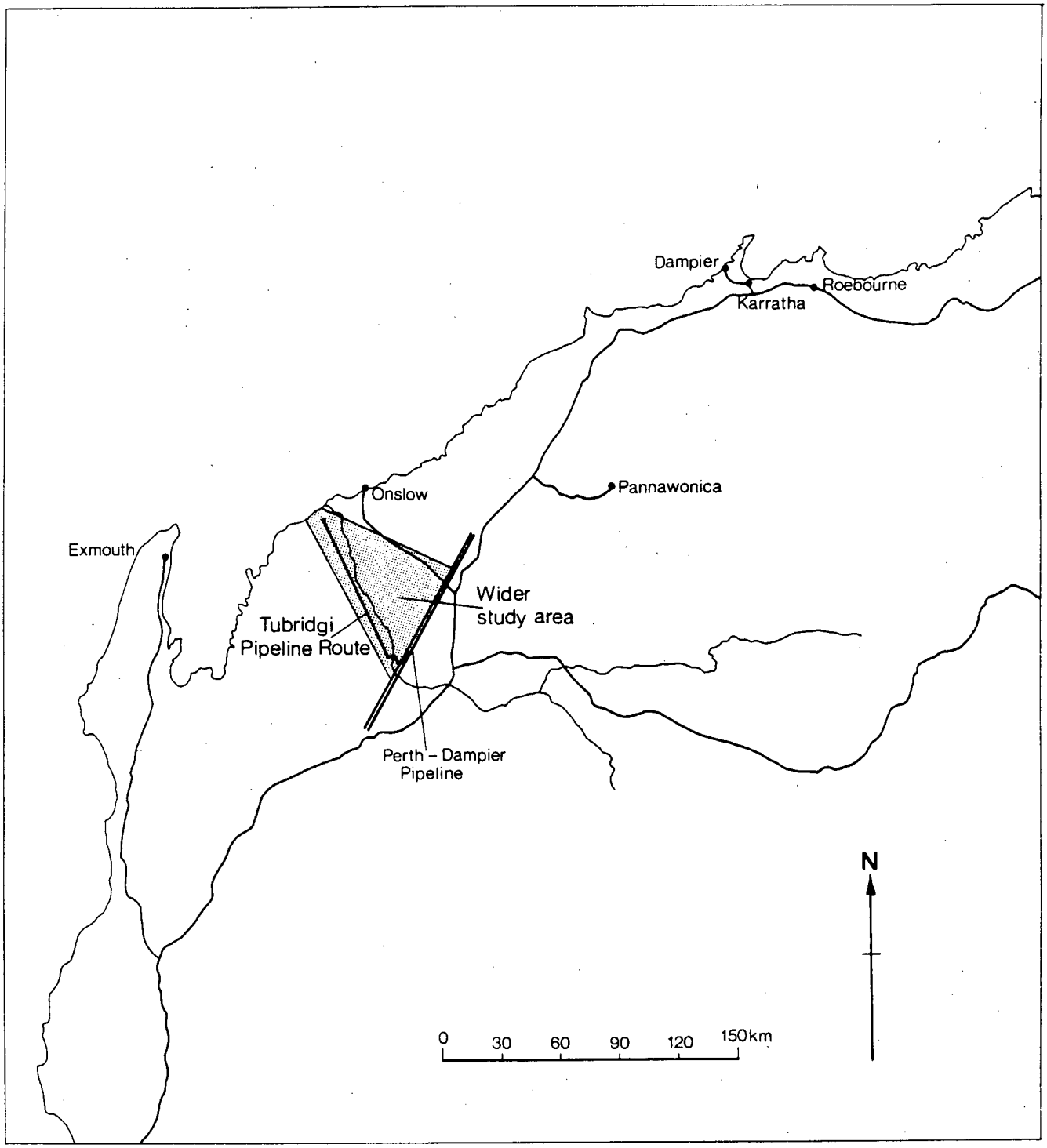
The locality of the proposed **new plant site**, shown in figure 2a, actually overlaps with the boundary of the shell/artefact scatter registered as P5562, when this site is plotted on relevant aerial photographs and following a site inspection on the ground.

In order to avoid impact on this site **it is recommended** that the new plant site be relocated to the west on adjacent high ground. This preferred locality is shown in figure 2a as "Preferred locality for new plant site" to the west of the "Possible new plant site", which was itself an alternative to the original plant site located to the south-east. This "preferred locality" is on elevated ground, does not occur near any archaeological material and is better placed to accept flowlines from the gas wells which will avoid red siliceous dunes (which often have archaeological material on them). It has been marked on the relevant aerial photograph and forwarded to Worley.

The sample survey of the gas field allowed a predictive statement to be formulated for the location, and avoidance, of potentially significant archaeological sites. **It is recommended** that the flowlines are designed to avoid all dunes with an elevation of greater than 1.5 to 2 metres. Ideally, the final route of the flowlines (when pegged in the field) should be inspected by an Archaeological Consultant to ensure that potentially significant archaeological sites are avoided.

It was mentioned by local pastoral owners that some mining personnel in the past had collected artefacts from middens in the proximity of the survey area and, indeed, from some of the significant sites discussed above. **It is recommended** that Doral Resources instruct all employees and contractors on site that they have obligations under the W.A. *Aboriginal Heritage Act* 1972-80 to protect Aboriginal Sites and that unauthorised removal of artefacts is an offence.

Figure 1 : Location of proposed Tubridgi Pipeline Route and Wider Study Area



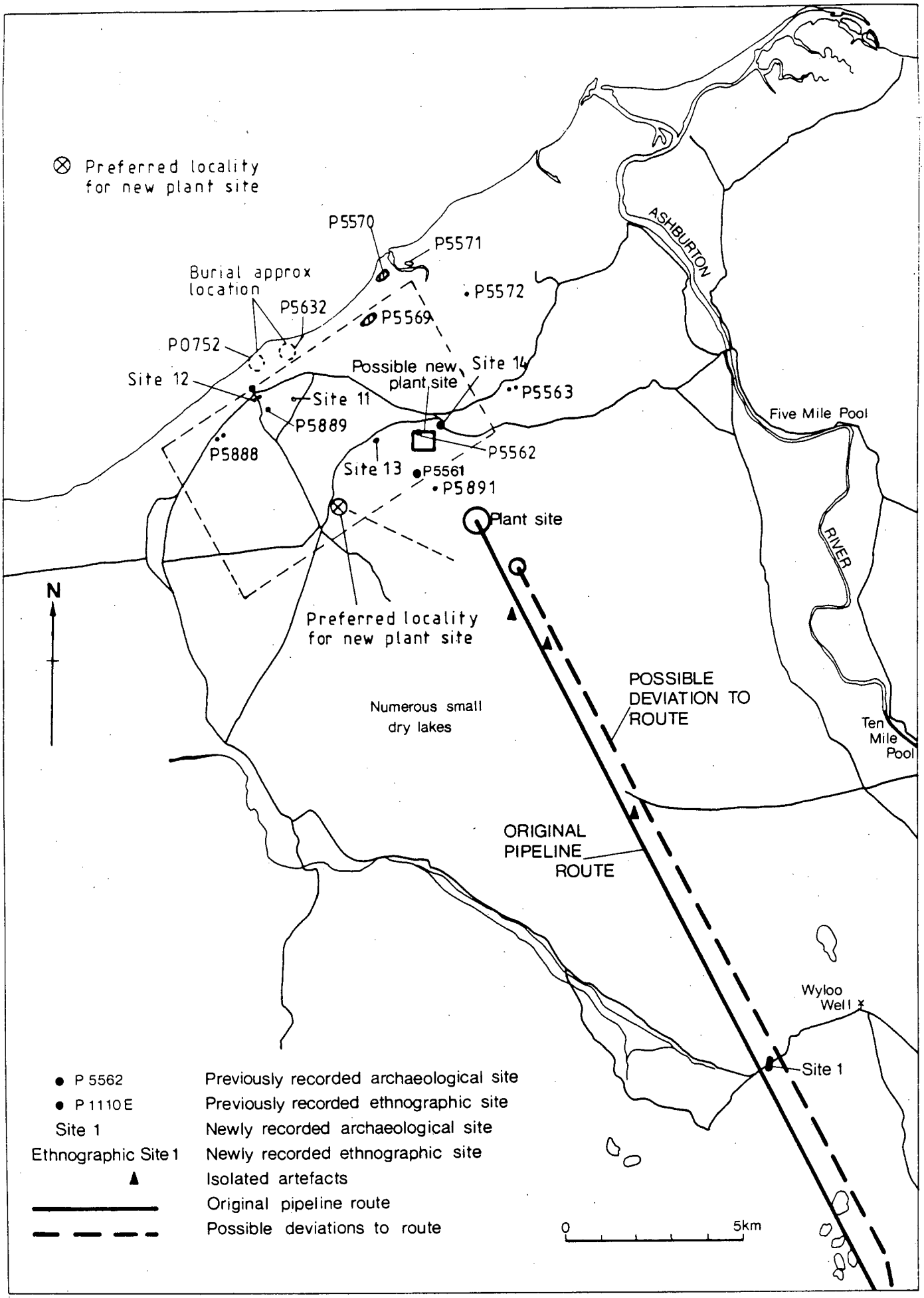


Figure 2a : Northern section of pipeline route showing possible deviations

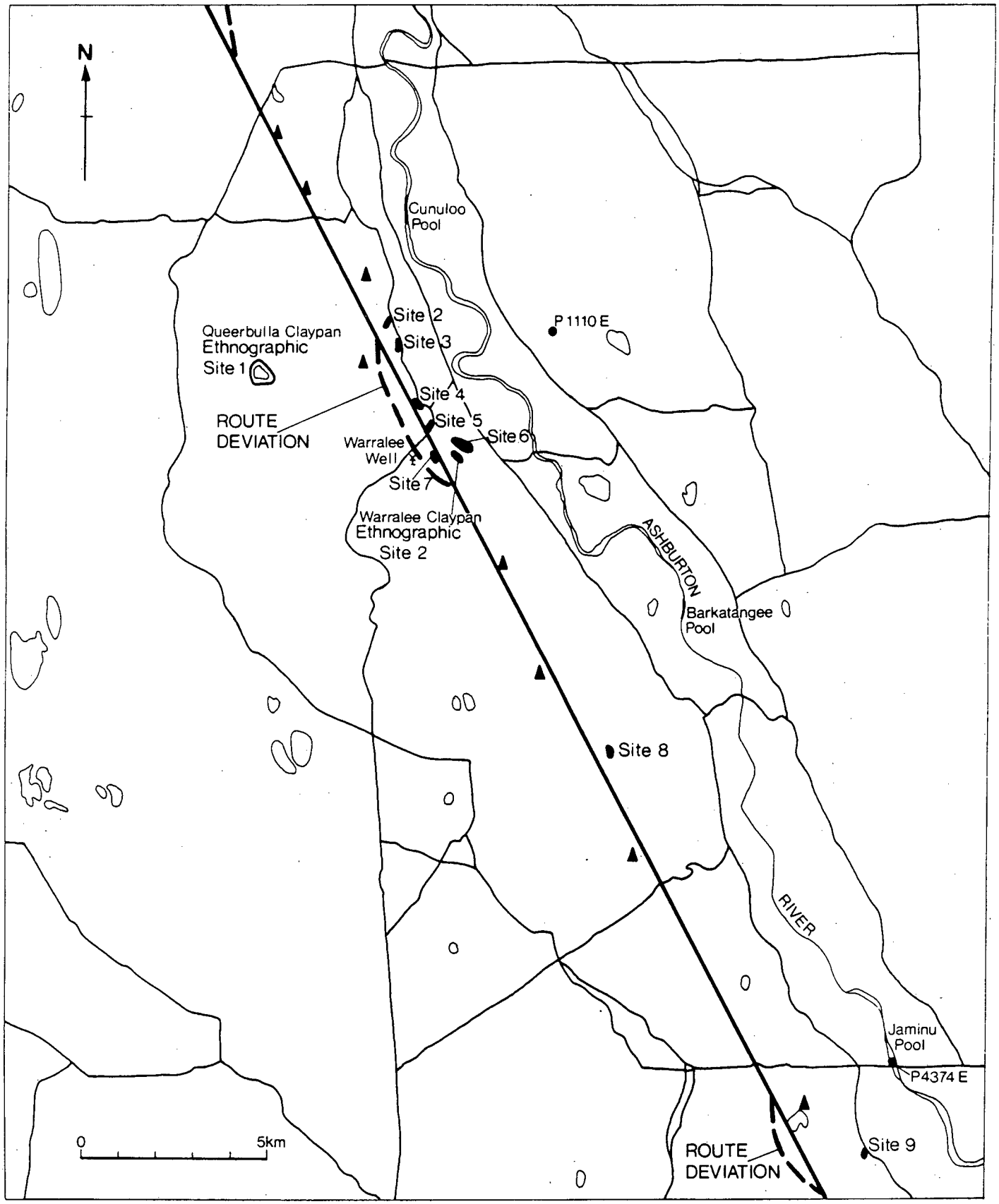


Figure 2b: Central section of pipeline route showing possible deviations

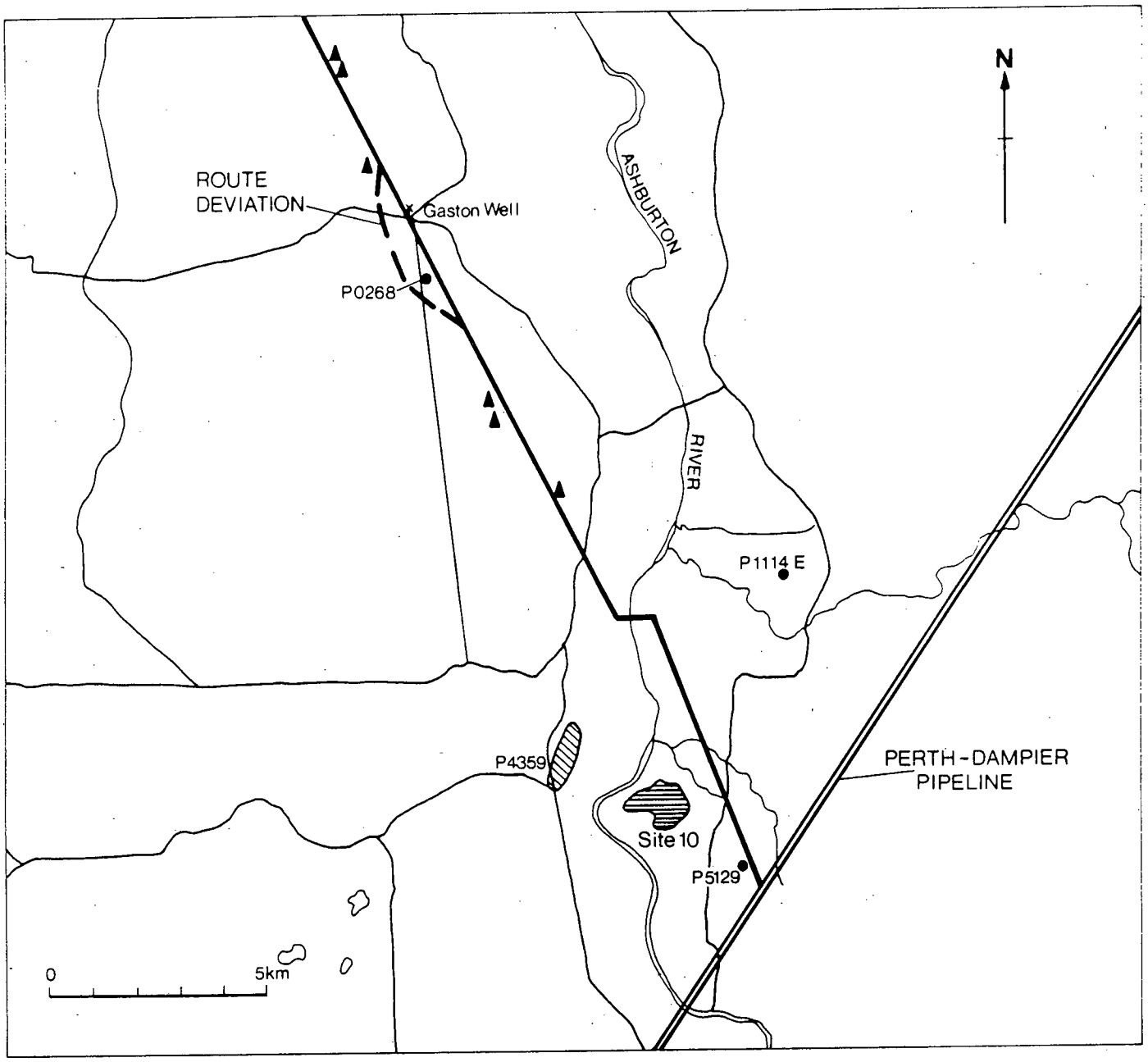


Figure 2c: Southern section of pipeline route showing possible deviation

ETHNOGRAPHIC SURVEY

8. INTRODUCTION

This report documents the results of an ethnographic survey of a proposed pipeline route to connect the Tubridgi Gas Field to the existing North-West Gas Pipeline. The proposed route of this pipeline is approximately 84 kilometres long, running much of the time parallel to the Ashburton River in the west Pilbara, Western Australia (see Figure 1). The survey area for this report is a 500 metre corridor comprised of a 250 metre easement either side of the proposed pipeline. The survey was carried out for Worley Engineering through the Centre for Prehistory, University of Western Australia.

The purpose of this survey was to identify and locate any places within the survey area which have significance for living Aboriginal people and to assess such information in terms of the *Aboriginal Heritage Act* 1972-1980 of Western Australia. The collection of materials for this survey included:

(1) a search and examination of the documentation for previously reported Aboriginal sites in this region, a task greatly aided by the production of a "desk-top" study for this project which mapped all previously recorded sites,

(2) a review of previous historical and ethnographic reports for the region, and

(3) a visit to the location of the proposed pipeline in the company of those persons deemed by the regional Aboriginal communities to be the relevant spokespeople for the area.

The ethnographic survey was carried out in February 1990 and was organized with the help, both in person and on the telephone, of Mr Roger Solomon, Pilbara

Heritage Officer for the Department of Aboriginal Sites, W.A. Museum, and Mr Slim Parker of the Onslow Aboriginal community. Both these individuals made the task of contacting the relevant people and organizing the inspection of the survey area, a much easier task than it otherwise could have been. In an early telephone conversation with Mr Parker the trip was delayed for several days in order to accommodate our interests with those of the Aboriginal community which was involved in their annual Culture Camp at Peedamulla Station.

9. HISTORICAL AND CULTURAL BACKGROUND

In Tindale's survey of the Aboriginal "tribes" of Australia he identifies the people residing throughout the area of the present survey as belonging to a group known as Talandji (1974). The traditional country of the Talandji people is centred on the Ashburton River. This close association between people and water courses was common in the Pilbara. Von Brandenstein has noted that the common description "riverine" is particularly apt for these cultures because so much life was focussed on the river systems. Indeed, he notes that "All rivers in the north-west of Western Australia are the creation of a serpent from the sea" (1972:228) and that as such are of great concern to Aboriginal people in this area. Indeed, several of the Aboriginal consultants who worked on the present survey asserted their claim as the right people to talk to partly in terms of "we all belong to this river" and one of them bore the name of the river itself.

While the Talandji people no longer all live in their traditional territory many still retain strong ties with their country. In over 100 years of contact with European settlement, the traditional pattern of Aboriginal people over the landscape has changed enormously. Like other areas in Australia the people who once lived dispersed in small groups over the country now reside predominantly in the

larger settlements of the area. In the Pilbara, this has meant a movement from the Hammersley Plateau and river systems into such settlements as Roebourne, Carnarvon and Onslow (see von Brandenstein 1967; Gray 1976, 1978; Wright 1982). Writing of Carnarvon in particular, but of the west Pilbara in general, Gray, for example, notes that:

> As a result of being dispossessed of their tribal lands and because of their desire to partake of some of the material benefits of Euro-Australian culture, Aborigines began to congregate in the vicinity of station homesteads or began to drift slowly towards towns such as Carnarvon.
>
> (1978:188)

Gray goes on to indicate that:

> This movement continued down into recent times and gained momentum in the last 20 years until today there are few Aborigines residing permanently on the pastoral stations in the region. At the same time there was a parallel movement from the upper Ashburton to the town of Onslow .
>
> (*ibid*: : 189)

The Pastoral Award of the late 1960s, which deemed that Aboriginal labour was to be paid the same as non-Aboriginal labour, rather than in rations, was a significant social factor in producing this movement of people as the stations could no longer afford to employ Aboriginal workers under these conditions.

Aboriginal people had traditionally inherited rights of access to country from both patrilineal kin and matrilineal kin in this region of Australia (see Palmer 1983: 172-179). In moving to the regional centres of population and away from their traditional lands this pattern of access to or "ownership" of country did not simply

disappear. Rather, knowledge of country was preserved and passed down albeit it is a different way than in traditional times. Many Aboriginal men worked as stockmen on the Stations that now occupy their traditional lands. Similarly, knowledge of the importance of certain places on the Stations have been passed down and communicated to others who at times worked on Stations located outside their traditional lands. In this way Aboriginal traditional knowledge in this region has remained strong.

Many Aboriginal people in this region retain contact with their traditional lands through a retention of traditional knowledge concerning significant and important places as well as through ritual and ceremonial associations. Even if the country is not visited frequently, the traditional Aboriginal owners do not consider that they have foregone their traditional rights in their country. In the area around Onslow, where the present survey was conducted, Aboriginal people continue to visit the country, engaging in hunting and other activities.

10. THE SURVEY

Meetings were held in Roebourne and Onslow to determine the correct Aboriginal people to be consulted for this survey. Several names were suggested and finally, in a meeting held in Onslow, a group of four men were decided upon. All of these individuals resided in Onslow. I indicated that residing in Onslow was not a criterion for this work and that what mattered was the knowledge and right to speak for the country to be surveyed. The selected consultants indicated that they were the right people to talk to for this area and indicated that they had all worked on the surrounding stations and belonged to the country: "we all belong to the river". The names of these individuals are not reported here; their names and other relevant information concerning their ties to

the country of the survey area will be submitted to the Department of Aboriginal Sites, W.A. Museum.

Throughout discussions of the proposed survey and the inspection of the survey area the Aboriginal consultants emphasized that they were only examining the proposed route of the pipeline (in Figure 1) and that they were not offering a blanket site clearance for the route of the proposed pipeline should this route be moved or altered. There is a long tradition of mistrust in the west Pilbara concerning the recording of Aboriginal sites. In the past some Aboriginal spokespeople have refused to involve themselves in such surveys because they believed that too many recorded sites were being disturbed or destroyed. Aboriginal people in this area are currently willing to take part in surveys such as this but choose to confine themselves to the specific areas where development is proposed. Therefore, this survey has been confined to the proposed pipeline route nominated by Worley Engineering based on a "desktop" study and indicated on Plan No. 8351 – 2, dated 2.2.90.

Once the Aboriginal consultants were selected the survey was conducted by driving over the survey area and indicating the location of the proposed pipeline in relation to easily identifiable landmarks in the area. In this way the Aboriginal consultants visited the route of the proposed pipeline and saw first-hand any potential areas of concern.

We began the survey with a difficult crossing of the Ashburton River, which was flowing due to a considerable fall of rain a few weeks earlier. Following a thorough survey of the area surrounding the north end of the proposed pipeline, as shown in Figure 2a, we returned to Onslow and made arrangements to continue the survey the following day. This section of the survey area was deemed to be clear of any sites of significance or importance by the Aboriginal

consultants. It is important to note that the area north of the proposed Plant Site was not included in this survey.

The next day, after a short meeting with Mr David Forrest, the pastoralist on Minderoo Station, the Aboriginal consultants and I examined the middle section of the proposed pipeline route, shown in Figure 2b. In the course of this portion of the survey we visited Warralee Claypan, a site of some concern to the Aboriginal consultants. The metric grid references for Warralee Claypan locate it at KA9854, Map-sheet 1501, Series SF 50-9, edition 1, 1:250,000. As a semi-permanent water source this was said to be the "main camping place" in the area and they indicated that it had been so for a long time. This would seem to be corroborated by the findings of the Archaeological Survey presented in this report. The Aboriginal consultants requested that the route of the proposed pipeline be moved approximately 500 metres to the west, past Warralee Well. It is important to the Aboriginal consultants that the proposed route be moved further away from, rather than closer to, the Ashburton River.

Another site of particular concern for the Aboriginal consultants located in this portion of the survey is known as Queerbulla Claypan. The metric grid reference to locate the site of Queerbulla Claypan is KA9456, Map-sheet Series 1501, Sheet 50-9, edition 1, 1:250,000. The proposed route for the gas pipeline will not , according to the plan in Figure 1, affect this site. While this site is not located within the corridor surveyed for this report, the Aboriginal consultants became concerned that there be no attempts to re-route the proposed pipeline through this site. Queerbulla Claypan was said to be an important camping place in the past; several of the Aboriginal consultants had camped there themselves in the recent past.

We continued the survey down to the location of the proposed crossing of the Ashburton River and no further sites of significance or importance were identified by the Aboriginal consultants. They did, however, express considerable concern about the Ashburton River in general and several named pools in the river in particular. Following this we returned to Onslow for the night, hunting during the course of our return.

The next morning we set out to complete the survey of the southern portion of the survey area, Figure 2c. As there was quite a bit of water in the Ashburton River, it was necessary to drive out from Onslow and down the main road almost to Nanutarra before making our way into the site where the proposed Tubridgi Gas Pipeline is to join the existing North-West gas pipeline at the Pumping Station No. 2. After examining the area around the Pumping Station, and determining it to be free of any sites of significance for the Aboriginal consultants, we attempted to drive from the pumping station to the place where the proposed pipeline is to cross the Ashburton River. This proved to be impossible as the country was made impassable by the effect of considerable amounts of rain on the drainage channels and creeks in the region. The only way to reach the crossing was to return to the main road and enter along a track starting just south of Nanutarra Roadhouse. This portion of the proposed pipeline route was deemed to be clear of any significant sites by the Aboriginal consultants but again concern was expressed about the location of the crossing of the Ashburton River. Peepingee Pool and Whistler Pool — identified as Whiskey Pool on many maps — were identified as two places of particular concern.

On our way back to Onslow that day, with the survey completed, we stopped in the shade for a final discussion of what we had done. This stop was instigated by the Aboriginal consultants themselves in order to make sure that I fully understood their concerns and desires. In this discussion we talked of

Queerbulla Claypan, Warralee Claypan and the importance of the river to the Aboriginal people. It was emphasized by the Aboriginal consultants that we had, in the course of this survey, examined only the proposed route marked on the map (see Figure 1).

11. CONCLUSIONS AND RECOMMENDATIONS

This ethnographic survey located several sites which the local Aboriginal people hold as significant. Queerbulla Claypan and Warralee Claypan should be avoided by the proposed pipeline. The Aboriginal consultants were satisfied that Queerbulla Claypan would not be adversely affected by the surveyed route of the pipeline. More concern was expressed concerning the location of the proposed pipeline in relation to Warralee Claypan. The Aboriginal consultants would desire that the proposed pipeline be moved to the west of Warralee Well and it is my understanding that the company has, for a number of reasons, already agreed to this move.

The Ashburton River is of particular importance to the Aboriginal people of this area and they are concerned that it not be damaged or interfered with in any way. In conversations about the crossing of this river by the proposed pipeline they were eager to make sure that the crossing took place at a suitable place. The site of the proposed crossing in Figure 1 was acceptable and any movement or relocation of this crossing will have to be discussed further with the Aboriginal consultants.

As Aboriginal people continue to hunt and gather traditional foods from some of the country to be crossed by the proposed pipeline, they are concerned that access to many areas and parts of the river will be adversely affected. They

request that access through the country crossed by the pipeline and to the river be ensured through the provision of gates in any fences affected.

Some concern was expressed by the Aboriginal consultants to the effect that they had no idea where the flowlines would actually go on the gas field. No ethnographic survey has been conducted to clarify Aboriginal concerns in the area around the Northern plant site and gas field survey area. An ethnographic survey of this area is planned to be carried out in late March.

Subject to the concerns of the Aboriginal people noted above being dealt with, the route of the proposed pipeline shown in Figures 2a–2c is acceptable to the Aboriginal consultants. Therefore, providing further consultation is carried out concerning any proposed relocation of the pipeline route, **it is recommended** that the company be permitted to proceed with this project as indicated in Figure 2a–2c.

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APPENDIX 1

NOTES ON THE RECOGNITION OF ABORIGINAL SITES

There are various types of Aboriginal sites, and these notes have been prepared as a guide to the recognition of those types likely to be located in the survey area.

An Aboriginal site is defined in the Aboriginal Heritage Act, 1972-1980, in section 5 as:

"(a) any place of importance and significance where persons of Aboriginal descent have, or appear to have, left any object, natural or artificial, used for, or made or adapted for use for, any purpose connected with the traditional life of the Aboriginal people, past or present;

(b) any sacred, ritual or ceremonial site, which is of importance and special significance to persons of Aboriginal descent;

(c) any place which, in the opinion of the Trustees, is or was associated with the Aboriginal people and which is of historical, anthropological, archaeological or ethno-graphical interest and should be preserved because of its importance and significance to the cultural heritage of the State;

(d) any place where objects to which this Act applies are traditionally stored, or to which, under the provisions of this Act, such objects have been taken or removed."

Habitation Sites

These are commonly found throughout Western Australia and usually contain evidence of tool-making, seed grinding and other food processing, cooking, painting, engraving or numerous other activities. The archaeological evidence for some of these activities is discussed in detail under the appropriate heading below.

Habitation sites are usually found near an existing or former water source such as a gnamma hole, rock pool, spring or soak. They are generally in the open, but they sometimes occur in shallow rock shelters or caves. It is particularly important that none of these sites be disturbed as the stratified deposits which may be found at such sites can yield valuable information about the inhabitants when excavated by archaeologists.

Seed Grinding

Polished or smoothed areas are sometimes noticed on/near horizontal rock surfaces. The smooth areas are usually 25 cm wide and 40 or 50 cm long. They are the result of seed grinding by the Aboriginal women and indicate aspects of the past economy.

Habitation Structures

Aboriginal people sheltered in simple ephemeral structures, generally made of branches and sometimes tussocks of grass. These sites are rarely preserved for more than one occupation period. Occasionally rocks were pushed aside or used to stabilise other building materials. When these rock patterns are located they provide evidence for former habitation sites.

Middens

When a localised source of shellfish and other foods has been exploited from a favoured camping place, the accumulated ashes, hearth stones, bones and other refuse can form mounds at times several metres high and many metres in diameter. Occasionally these refuse mounds or middens contain stone, shell or bone tools. These are most common near the coast but examples on inland lake and river banks are not unknown.

Stone Artefacts Factory Sites

Pieces of rock from which artefacts could be made were often carried to camp sites or other places for final production. Such sites are usually easily recognisable because the manufacturing process produces quantities of flakes and waste material which are clearly out of context when compared with the surrounding rocks. All rocks found on the sandy coastal plain for example, must have been transported by human agencies. These sites are widely distributed throughout the state.

Quarries

When outcrops of rock suitable for the manufacture of stone tools were quarried by Aborigines, evidence of the flaking and chipping of the source material can usually be seen in situ and nearby. Ochre and other mineral pigments used in painting rock surfaces, artefacts and in body decoration are mined from naturally occurring seams, bands and other deposits. This activity can sometimes be recognised by the presence of wooden digging sticks or the marks made by these implements.

Marked Trees

Occasionally trees are located that have designs in the bark which have been incised by Aborigines. Toeholds, to assist the climber, were sometimes cut into the bark and sapwood of trees in the hollow limbs of which possums and other arboreal animals sheltered. Some tree trunks bear scars where sections of bark or wood have been removed and which would have been used to make dishes, shields, spearthrowers and other wooden artefacts. In some parts of the state platforms were built in trees to accommodate a corpse during complex rituals following death.

Burials

In the north of the state it was formerly the custom to place the bones of the dead on a ledge in a cave after certain rituals were completed. The bones were wrapped in sheets of bark and the skull placed beside this. In other parts of Western Australia the dead were buried, the burial position varying according to the customs of the particular area and time. Natural erosion, or mechanical earthmoving equipment occasionally exposes these burial sites.

Stone Structures

If one or more stones are found partly buried or wedged into a position which is not likely to be the result of natural forces, then it is probable that the place is an Aboriginal site and that possibly there are other important areas nearby. There are several different types of stone arrangements ranging from simple cairns or piles of stones to more elaborate designs. Some were constructed in connection with food gathering. Low weirs which detain fish when tides fall are found in coastal areas. Some rivers contain similar structures that trap fish against the current. It seems likely that low stone slab structures in the south-

west jarrah forests were built to provide suitable environments in which to trap small animals. Low walls or pits were sometimes made to provide a hide or shelter for a hunter.

Elongated rock fragments are occasionally erected as a sign or warning that a special area is being approached. Heaps or alignments of stones may be naturalistic or symbolic representations of animals, people or mythical figures.

Paintings

These usually occur in rock shelters, caves or other sheltered situations which offer a certain degree of protection from the weather. The best known examples in Western Australia occur in the Kimberley region but paintings are also found through most of the state. One or several coloured ochres as well as other coloured pigments may have been used at a site. Stencilling was a common painting technique used throughout the state. The negative image of an object was created by spraying pigment over the object which was held against the wall.

Engravings

This term describes designs which have been carved, pecked or pounded into a rock surface. They form the predominant art form of the Pilbara region but are known to occur from the Kimberleys in the north to about Toodyay in the south. Most engravings occur in the open, but some are situated in rock shelters.

Caches

It was the custom to hide ceremonial objects in niches and other secluded places. The removal of objects from these places, or photography of the places or objects or any other interference with these places is not permitted.

Ceremonial Grounds

At some sites the ground has been modified in some way by the removal of surface pebbles, or the modelling of the soil, or the digging of pits and trenches. In other places there is not noticeable alteration of the ground surface and Aborigines familiar with the site must be consulted concerning its location.

Mythological Sites

Most sites already described have a place in Aboriginal mythology. In addition there are many Aboriginal sites with no man-made features which enable them to be recognised. They are often natural features in the landscape linked to the Aboriginal account of the formation of the world during the creative 'Dreaming' period in the past. Many such sites are located at focal points in the creative journeys of mythical spirit beings of the Dreaming. Such sites can only be identified by the Aboriginal people who are familiar with the associated traditions.

APPENDIX 2

OBLIGATIONS RELATING TO SITES UNDER THE ABORIGINAL HERITAGE ACT 1972 - 1980

"Report of Findings

15. Any person who has knowledge of the existence of anything in the nature of Aboriginal burial grounds, symbols or objects of sacred, ritual or ceremonial significance, cave or rock paintings or engravings, stone structures or arranged stones, carved trees, or of any other place or thing to which this Act applied or to which this Act might reasonably be suspected to apply shall report its existence to the Trustees, or to a police officer, unless he has reasonable cause to believe the existence of the thing or place in question to be already known to the Trustees.

Excavation of Aboriginal Sites

16. (1) Subject to Section 18, the right to excavate or to remove any thing from an Aboriginal site is reserved to the Trustees.

(2) The Trustees may authorise the entry upon and excavating of an Aboriginal site and the examination or removal of any thing on or under the site in such manner and subject to such conditions as they may direct.

Offences Relating to Aboriginal Sites

17. A person who -

(a) excavates, destroys, damages, conceals or in any way alters any Aboriginal site; or

(b) in any way alters, damages, removes, destroys, conceals, or who deals with in a manner not sanctioned by relevant custom, or assumes the possession, custody or control of, any object on or under an Aboriginal site, commits an offence unless he is acting with the authorisation of the Trustees under Section 16 or the consent of the Minister under Section 18.

Consent to Certain Uses

18. (1) For the purposes of this section, the expression "the owner of any land" includes a lessee from the Crown, and the holder of any mining tenement or mining privilege, or of any right or privilege under the Petroleum Act 1967, in relation to the land.

(2) Where the owner of any land gives to the Trustees notice in writing that he requires to use the land for a purpose which, unless the Minister gives his consent under this section, would be likely to result in a breach of Section 17 in respect of any Aboriginal site that might be on the land, the Trustees shall, as soon as they are reasonably able, form an opinion as to whether there is any Aboriginal site on the land, evaluate the importance and significance of any such site, and submit the notice to the Minister together with their recommendation in writing as to whether or not the Minister should consent to the use of the land for that purpose, and, where applicable, the extent to which and the conditions upon which his consent should be given.

(3) Where the Trustees submit a notice to the Minister under subsection (2) of this section he shall consider their recommendation and having regard to the general interest of the community shall either -

(a) Consent to the use of the land the subject of the notice, or a specified part of the land, for the purpose required,subject to such conditions, if any, as he may specify; or

(b) wholly decline to consent to the use of the land the subject of the notice for the purpose required, and shall forthwith inform the owner in writing of his decision.

(4) Where the owner of any land has given to the Trustees notice pursuant to subsection (2) of this section and the Trustees have not submitted it with their recommendation to the Minister in accordance with that subsection the Minister may require the Trustees to do so within a specified time, or may require the Trustees to take such other action as the Minister considers necessary in order to expedite the matter, and the Trustees shall comply with any such requirement.

(5) Where the owner of any land is aggrieved by a decision of the Minister made under subsection (3) of this section he may, within the time and in the manner prescribed by rules of court, appeal from the decision of the Minister to the Supreme Court which may hear and determine the appeal.

(6) In determining an appeal under subsection (5) of this section the Judge hearing the appeal may confirm or vary the decision of the Minister against which the appeal is made or quash the decision and substitute his own decision which shall have effect as if it were the decision of the Minister, and may make such an order as to the costs of the appeal as he sees fit.

(7) Where the owner of the land gives notice to the Trustees under subsection (2) of this section, the Trustees may, if they are satisfied that it is practicable to do so, direct the removal of any object to which this Act applies from the land to a place of safe custody.

(8) Where consent has been given under this section to a person to use and land for a particular purpose nothing done by or on behalf of that person pursuant to, and in accordance with any conditions attached to, the consent constitutes an offence against this Act."

APPENDIX D

DRAWING NO 8351

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REFERENCES

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