SINCLAIR KNIGHT MERZ

Darwin Joint Terminal

Public Environmental Report

Prepared for

Shell Australia

November 1999

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SINCLAIR KNIGHT MERZ

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1.1 The Title of the Proposal

The Shell Company of Australia Limited (Shell), BP Australia Limited (BP) and Mobil Oil Australia Limited (Mobil) propose to build and operate a terminal at East Arm Port in Darwin Harbour to receive, store and load out petroleum products. The facility is referred to as the Darwin Joint Terminal (DJT).

1.2 Name and Address of Proponent

The three companies are in the process of negotiating an agreement with the Northern Territory Government concerning access to 20 ha of land within the East Arm Port precinct. Following agreement with the Government, the three companies will jointly form an appropriate business entity to construct, own and operate the facility. Shell has been appointed project manager, and as such the Proponent for this project is:

Shell Company of Australia Limited
Shell House
1 Spring Street
Melbourne
VICTORIA 3001

Attention: MLB LOMX

1.3 Project Background and Justification

The Northern Territory Government announced in August 1992 that additional port facilities would be built at East Arm in Darwin Harbour. Expansion of the port has been a long-term goal of the Northern Territory Government since self-government was achieved in 1978. The East Arm Port is being constructed in stages and will ultimately have the potential to handle projected volumes of general cargoes, livestock and bulk materials for at least the next fifty years.

Bulk petroleum shipments are currently received at the Fort Hill Berth, with product stored at and distributed from the Shell, BP and Mobil terminals at Frances Bay. The proposed DJT at East Arm will replace the three existing terminals and will be capable of handling the bulk fuel requirements for Darwin and a large proportion of Territory markets. It will be designed to grow with the Territory and will be a purpose-built facility appropriately designed and constructed to suit the needs of the users.

The site is strategically located near the new East Arm Port, which will have bulk oil tanker berthing facilities and dedicated receipt pipelines from the wharf to the terminal. It is also located adjacent to the proposed Alice Springs to Darwin railway line. Allowance has been made for the future construction of a dedicated siding and rail tank car loading gantry.

The construction of the new terminal at East Arm and the removal of the old terminals will allow land at Frances Bay to be redeveloped for the uses proposed in the Central Darwin Land Use Objectives 1996. With the relocation of the oil company Fort Hill Wharf and tank farm activities, it is expected that oil company road train movements will be significantly reduced within the city area. This will have traffic safety and residential benefits.

1.4 Description of Project

The DJT site is being prepared for the proponent by the Northern Territory Government, and this preparation includes the necessary subdivision, earthworks and off-site stormwater drainage, and connection of services. The Northern Territory Government will also provide the oil berth, the wharf/terminal supply pipelines and other ancillary works. The proponent will provide the DJT and will operate the integrated oil berth, wharf/terminal pipeline and terminal system. Therefore for the purposes of this PER the starting point for the project is the construction of terminal facilities.

The 20 ha site will provide adequate space for the immediate and future storage and distribution needs of the three oil companies.

A total of 11 tanks will be constructed initially. The terminal layout plan allows for construction of at least 2 additional tanks in the future to meet potential market demands. The basis of the design for tankage is the year 2006 offtakes, and has regard for stock cover and product supply logistics. The total storage capacity is 135 Ml of bulk fuel. The total actual and estimated throughput for the years 1996 and 2006 are 606 and 797 Ml, respectively.

The largest tanks to be constructed will have height/diameter dimensions of 22/36 m, respectively. Tank separation will conform to the relevant Australian Standards (AS 1940). Separation distances are 1.5 times the diameter of the tanks, having regard to risk management and the ability to reduce the need for ancillary fire equipment.

The gantry/distribution area will ultimately allow for the transport of fuel by road trains and rail. Road access will be provided to Berrimah Road to Department of Transport and Works Construction Agency requirements. The gantry/distribution area will also incorporate offices, a control room, a workshop, firewater tank and pump house, storage areas and other ancillary facilities.

All fuel circulation pipelines within the site will generally be constructed above ground.

The site will be secured with security fencing and complemented by security guard patrols. Vehicle and personal access will be by security key card. Site lighting will be provided and emergency security lighting will be provided in the event of a power failure.

1.5 Potential Environmental Impacts

The potential environmental impacts and proposed management associated with each stage of the development are summarised in **Table 1.1.**

The primary objectives of the proposed environmental management and monitoring programme are to control environmental impacts to levels within acceptable standards, and to minimise possible impact on the community and the workforce of foreseeable risks during the planning, design, construction and subsequent operation phases of the terminal.

The proposed construction phase of the development will extend for approximately 24 months and will result in a number of short term effects such as the generation of noise and dust caused by earthworks and building activities and may result in increased erosion through surface runoff.

The operation phase of the project has the potential to produce longer term effects on the environment than the construction phase. The main issues include risk and hazards associated with the handling and storage of flammable hydrocarbons, atmospheric emissions, contamination of the environment through spills or leaks of hydrocarbon products and management of potentially contaminated stormwater.

It should be noted that the DJT will rationalise the three existing oil company terminals at Frances Bay to the single East Arm location, and that there will be a corresponding rationalisation of risk. There will be benefits such as emergency response and a general reduction in the Darwin community's exposure to risk from fuel storage facilities and operations.

1.6 Summary of Management Commitments

The proposal seeks to establish a joint user petroleum terminal that will use proven, appropriate technology to minimise environmental impacts from the terminal. The major potential environmental impacts and risks associated with the project are well categorised and understood, and appropriate management practices will be adopted for the benefit of the community at large.

The proponent has proposed several management commitments to ensure the development of an environmentally sound project. A summary of the management commitments is presented in **Table 1.2**.

Table 1.1: Summary of Potential Impacts Associated with the DJT

Construction Phase

Issue	Potential Impact	Environmental Management and Safeguards	Monitoring
Air Quality	Dust emissions from earthworks and vehicle movements reducing air quality.	If dust emission is a problem then dust suppression using water trucks and sprinklers will be implemented.	Visually monitored by construction contractor. Ambient monitoring will be undertaken in response to complaints.
Noise	Construction activities may generate significant noise.	Construction will be carried out in accordance with Section 6 of Australian Standard 2436-1981. Site is within a designated industrial area with the nearest residence more than 5km away.	Ambient noise monitoring will be implemented in response to noise complaints.
Surface Runoff and Erosion	Siltation of mangrove areas and increased turbidity and sedimentation of the waters of East Arm from surface runoff and erosion.	Implementation of good construction practices aimed at minimising erosion impacts such as providing surface drainage system to divert runoff away from disturbed areas and provision of silt traps to minimise off-site sediment discharge.	Regular inspection of silt traps.
Acid Sulphate Soils	Leachate from acid sulphate soils impacting on the surrounding environment and causing corrosion and weakening of concrete foundations and sub-surface structures.	Investigate the acid forming potential of landfill used at the site. If potential acid forming soils are identified then an acid sulphate soil management plan will be implemented.	The acid potential of soil from DJT site will be monitored prior to construction.
Introduced Weeds, and Pests and Diseases	The importation of weed species or seed material by vehicles.	A washdown procedure for off-road vehicles to be instigated if required.	
Construction Wastes	Waste management of construction wastes will be required.	Solid wastes disposed of to approved landfill sites. Wastes oils and solvents collected and recycled or disposed to an approved liquid waste disposal site. Sewage and sullage retained in sealed tanks and disposed to an approved waste disposal site.	

Issue	Potential Impact	Environmental Management and Safeguards	Monitoring
Biting Insects	Increase in mosquitos and other biting insect numbers due to pondage of water and potential for creation of breeding sites. Potential public health problem through the transmission of diseases. Public nuisance.	Careful attention to design and maintenance of earthworks and drainage systems during construction to avoid creation of significant habitat areas for mosquito larvae. Use of larvicides may be required to prevent mosquito breeding in slit traps.	Regular site inspection for breeding areas.
Traffic	Increased traffic and associated safety issues.	Only through traffic is to adjacent cement complex or East Arm Port. Construction traffic movements will be via designated arterial roads such as Berrimah Road, Tiger Brennan Drive and Stuart Highway and will not travel through residential areas.	

Table 1.1: Summary of Potential Impacts Associated with the DJT (continued)

Operational Phase

Issue	Potential Impact	Environmental Management and Safeguards	Monitoring
Risk	Proposed facilities have the potential to pose significant hazards to workforce and general public.	Preliminary risk and hazard assessment has been undertaken. Risk management controls incorporated into detailed design and terminal operations to minimise risk to ALARP.	
Surface Runoff	The off-site discharge of drainage water could act as a vector for the movement of contaminants from the terminal into the broader environment such as the mangal area to the west of the site.	Segregated drainage system with effluent treatment facilities will be provided. The system will be designed to handle all drainage from the oily water and clean water systems.	Water quality of stormwater discharged from site.
Spills and leakages	Hydrocarbons and other toxic chemicals leaching into sub-surface from spills, leaking product lines, fill points, gantry, storage tanks, Wharf/Terminal pipelines or stored chemicals impacting soil, groundwater or surface water. Oil spill within Darwin Harbour resulting from tanker discharge operations.	All storage will be bunded and product handling and delivery facilities will be connected by the segregated drainage system to the oily waste treatment system. Design standards and operational practise to prevent product leakage. Design to include spill containment, bund impermeability and drainage system. Strict adherence to operating and maintenance procedures. Emergency contingency plans.	Groundwater up and down the hydraulic gradient of the terminal site will be monitored by a series of bores.
Waste disposal	Waste management of operational wastes will be required.	Any sludge/waste oil generated from the drainage treatment system will be recycled or disposed to an approved off-site waste disposal site.	

Issue	Potential Impact	Environmental Management and Safeguards	Monitoring
Air Quality	Volatile organic carbon (VOC) emissions will occur to the atmosphere from the storage and handling of fuels. It is estimated that at maximum throughput, less than 600 tonnes of VOC will be released per annum.	VOC emissions to the atmosphere will occur at a safe location. Minimal other VOC sources within the airshed, and minimal impact on the air quality. Tanks containing highly volatile motor gasolines will have internal floating covers. Jet and Avgas tanks to be fitted with PV valves. Allowance for construction of a VOC recovery unit at a later time.	
Noise	Operational activities may generate noise.	Site is within a designated industrial area with the nearest residence more than 5 km away. Road vehicle movements likely to be the only notable source of noise.	Ambient noise monitoring will be implemented in response to noise complaints.
Biting Insects	Potential public health problem through the transmission of diseases. Public nuisance.	Careful attention to design and maintenance of drainage systems to avoid the creation of significant habitat areas for mosquito larvae. Education of operators to the dangers of biting insects. Provision of personal repellent and protective clothing as required. Use of larvicides as required.	Inspection of drainage system during maintenance and operation.
Traffic	Increased traffic and associated safety issues.	The location of the site within a designated industrial area and its direct access to the regional road network will ensure that the proposed development is unlikely to have any adverse impact as a result of the traffic generated by the proposal.	

Table 1.2: Summary of Commitments

Pre-Construction

Issue	Objective	Commitment	Timing	Whose Advice	Measurement Compliance Criteria
Fire (ref 2.4.7)	To assess the risk of fire due to terminal operations, having regard to layout and the design basis.	A fire risk study will be conducted. The scope will include automation of foam deluge on the road gantry, top or bottom foam injection into tanks and provision of fusible shutdown systems.	During the design phase	DLPE, NT Fire and Rescue	Submission of fire risk study report.
Acid sulphate soils (ref 4.1.4)	To prevent acid generation in on-site soils and a consequential adverse effect on the environment and terminal facilities.	Samples of soil from the DJT site will be analysed for acid sulphate potential. If potential acid forming soils are identified, then an acid sulphate soil management plan will be implemented.	Prior to construction	DLPE	Issue of acid sulphate assessment report.
Hazard identification (ref 4.2.1.1)	To reduce risks associated with the construction and operation of the DJT to an acceptable level.	Significant hazards associated with the construction and operation of the terminal will be identified and management controls incorporated in facility design and for construction and operation.	Prior to construction	DLPE, WHA	Hazard identification and implementation of management controls.
Water Discharge (ref 4.2.2)	To ensure discharge water does not adversely affect the receiving environment.	The drainage system and treatment facility to be designed to ensure discharge water meets DLPE requirements.	Prior to construction	DLPE	Design and construction documentation.
Leakages from Wharf/Terminal Pipelines (ref 4.2.3.2)	To ensure no adverse impacts due to leakages from Wharf/Terminal Pipeline.	The proponent will consult with the DLPE and DTW on the route and design and construction of the Wharf/Terminal pipelines.	Prior to construction	DLPE, DTW	Consultation with the DLPE and DTW.
Air emissions (ref 4.2.5)	To reduce VOC emissions from the DJT to an acceptable level.	VOC emission reduction technology will be incorporated into the gantry and storage tank design.	Prior to construction	DLPE	Design and construction documentation.
Environmental management plan for construction (ref 5.2)	To ensure environmental management in accordance with key objectives.	An EMP will be prepared once environmental approval for the DJT has been granted. The EMP will comprise two sections - Construction and Operation.	Prior to construction	DLPE	Issue of Construction EMP.

Table 1.2: Summary of Commitments (Continued)

Construction

Issue	Objective	Commitment	Timing	Whose Advice	Measurement Compliance Criteria
Dust (ref 4.1.1)	To protect the surrounding land users such that dust emissions will not adversely impact upon their welfare and amenity or cause health problems.	Appropriate dust control measures, such as the spraying of exposed surfaces with water will be implemented should dust levels prove to be an issue.	During construction	DLPE	Site inspections.
Surface runoff and erosion (ref 4.1.3)	To ensure that the environmental impact of waste effluents is minimised.	The proponent will adopt good construction practices that will ensure the environmental impact of waste effluents generated on-site during construction will be minimised.	During construction	DLPE	Site inspections.
Construction waste (ref 4.1.6)	To adopt measures to reduce and recycle solid wastes where practicable. Dispose of remaining wastes so as to reduce any environmental impacts.	All waste materials generated during construction will be disposed of in a manner satisfactory to the DLPE.	During construction	DLPE	Receipt of waste at DLPE approved sites.

Table 1.2: Summary of Commitments (Continued)

Operation

Issue	Objective	Commitment	Timing	Whose Advice	Measurement Compliance Criteria
Emergency response (ref 4.2.1.1)	Ensure minimal risk of damage to the environment or personnel through the implementation of appropriate action in the case of an emergency.	An Emergency Response Plan will be prepared that addresses issues relating to the accidental release of hydrocarbon vapours, accidental spillage of hydrocarbon products, fires and explosions. Terminal employees will be trained in this Emergency Response Plan.	Prior to commissioning	DLPE, NT Fire and Rescue	Submission of Emergency Response Plan and delivery of training.
Hazardous materials (ref 4.2.1.1)	Ensure risks associated with hazardous materials are managed.	Hazardous materials management procedures will be developed, introduced and maintained.	Prior to commissioning	DLPE, WHA	Issue of hazardous materials management procedures.
Health and safety (ref 4.2.1.1)	Ensure the health and safety of on-site personnel is proactively managed.	An Occupational Health and Safety programme will be developed with all terminal employees trained in the procedures.	Prior to commissioning	DLPE, WHA	Issue of Occupational Health and Safety programme and delivery of training.
Oil spills in Darwin Harbour (ref 4.2.3.1)	To ensure marine oil spill response capability.	Consult with DPA to amend the Darwin Harbour Oil Spill Contingency Plan.	Prior to commissioning	DLPE, DPA	Consultation with DPA.
Leakages from Wharf/Terminal Pipelines (ref 4.2.3.2)	To ensure no adverse impacts due to leakages from Wharf/Terminal Pipeline.	The proponent will establish an asset management system and an emergency contingency plan for the Wharf/Terminal pipelines.	Prior to commissioning	DLPE, DTW	Establishment of an asset management system and issue of pipeline emergency contingency plan.
Groundwater (ref 4.2.3.3)	To ensure no adverse impact on groundwater by terminal operations.	Groundwater quality in the vicinity of the terminal will be monitored and corrective action taken if unacceptable impacts are identified.	During operation	DLPE	Issue of groundwater monitoring results.

Table 1.2 : Summary of Commitments (Continued)

Operation (Continued)

Issue	Objective	Commitment	Timing	Whose Advice	Measurement Compliance Criteria
Noise (ref 4.2.6)	To protect the amenity of neighbours from noise impacts resulting from operational activities associated with the terminal.	Plant and community sound level limits will be consistent with good industry practice and government regulations.	During operation	DLPE	Noise monitoring as required.
Environmental Management System (ref 5.1)	To control environmental impacts to levels within acceptable standards and minimise possible impact on community and the workforce of foreseeable risks.	An Environmental Management System will be developed and implemented.	During commissioning and operation	DLPE	Issue of EMS.
Environmental management plan for operation (ref 5.2)	To ensure environmental management in accordance with key objectives.	An EMP will be prepared once environmental approval for the DJT has been granted. The EMP will comprise two sections - Construction and Operation.	Prior to operation	DLPE	Issue of Operations EMP.

1.7 Structure and Scope of PER

This Public Environmental Report (PER) has been prepared to satisfy the requirements of the Northern Territory *Environmental Assessment Act*. The report provides concise and comprehensive information concerning the design, construction and operation, and the potential environmental impacts of the DJT. This information will enable environmental issues associated with the DJT to be considered in a balanced manner and will ensure that unnecessary and unacceptable harm to the environment is avoided.

Information regarding the existing physical biological, cultural and socio-economic environment has been extensively covered in the approved East Arm Port Development Environmental Impact Statement 1994, and therefore are not covered in this report. This PER specifically focuses on the environmental impact of the proposed development on its immediate surrounds.

Consistent with the respective project scopes of the proponent and the Northern Territory Government, the scope of this PER is for the construction of the DJT and for the operation of the integrated oil berth, wharf/terminal pipeline and terminal system. The preparation of the DJT site, the provision of services, the oil berth and the wharf/terminal pipelines are not the responsibility of the proponent and are subject to separate environmental approvals.

This document has been prepared in accordance with the guidelines issued by the Minister for Lands, Planning and Environment (DLPE) in September 1999.

The PER includes the following main sections:

SECTION 1: Executive Summary
This section outlines the background and justification of the project.

SECTION 2: Project Description
This section describes the locality of the proposed development and the specific elements of the project, including the design, construction and operation of the facilities.

SECTION 3: Existing Environment
This section describes the existing environment occurring at and in the immediate vicinity of the site.

SECTION 4: Environmental Impacts and Management
This section predicts the potential environmental impacts arising from construction and operation of the terminal and outlines the management strategies to enhance the positive impacts and mitigate the negative impacts.

SECTION 5: Environmental Management of Proposed Facility
This section outlines the proposed environmental management system for the facility, describes the environmental management plans that will be developed for the construction and operational phases of the project and describes the monitoring programmes that will be implemented to evaluate the adequacy of these provisions.

SECTION 6: Summary of Environmental Commitments
This section provides a tabular summary of the Proponent's commitments to the management and monitoring strategies outlined in **Sections 4** and **5**.

SECTION 7: Glossary

SECTION 8: References
This section lists the references researched in preparing the PER.

1.8 Studies Undertaken as Part of PER

Extensive site surveys were undertaken in association with the preparation of the Draft Environmental Impact Assessment for East Arm Port. This PER draws heavily on that information and the experience gained by the three oil companies in the design and operation of similar terminals in Australia and overseas. As such, no new site-specific surveys have been undertaken as part of this PER.

This section discusses features of the project in sufficient detail to allow an assessment of its environmental impact. Description of the DJT is presented together with an outline of how construction will proceed and how the facility will be operated.

2.1 Location and Design Requirements

2.1.1 Location

The site at which the proposed DJT is to be established is located within the East Arm Port Development (**Figure 2.1**), 6 km east of the current Darwin Port. The proposed site encompasses Quarantine lsland and a low lying section of land previously containing mangrove vegetation and soft mangrove muds, south of East Arm Peninsula. Site preparation is being undertaken by the Department of Transport and Works Construction Agency for the DLPE, and includes reclamation using quality imported fill material, surcharging the mangrove muds and the construction of a bund wall to level 5.5 m AHD along the northern perimeter. The site will be cut/filled to bring it to a required elevation of RL 5.5 m AHD.

The 20 ha site is bordered by the Northern Cement Works to the south, soft mangrove mud flats to the north and west, and Berrimah Road to the east. Beyond the mudflats to the north are Blessers Creek and the Charles Darwin National Park. To the south is Hudson Creek. The nearest area zoned residential is the suburb of Berrimah, which lies approximately 4 km north east of the proposed development.

2.1.2 Land Tenure and Planning Issues

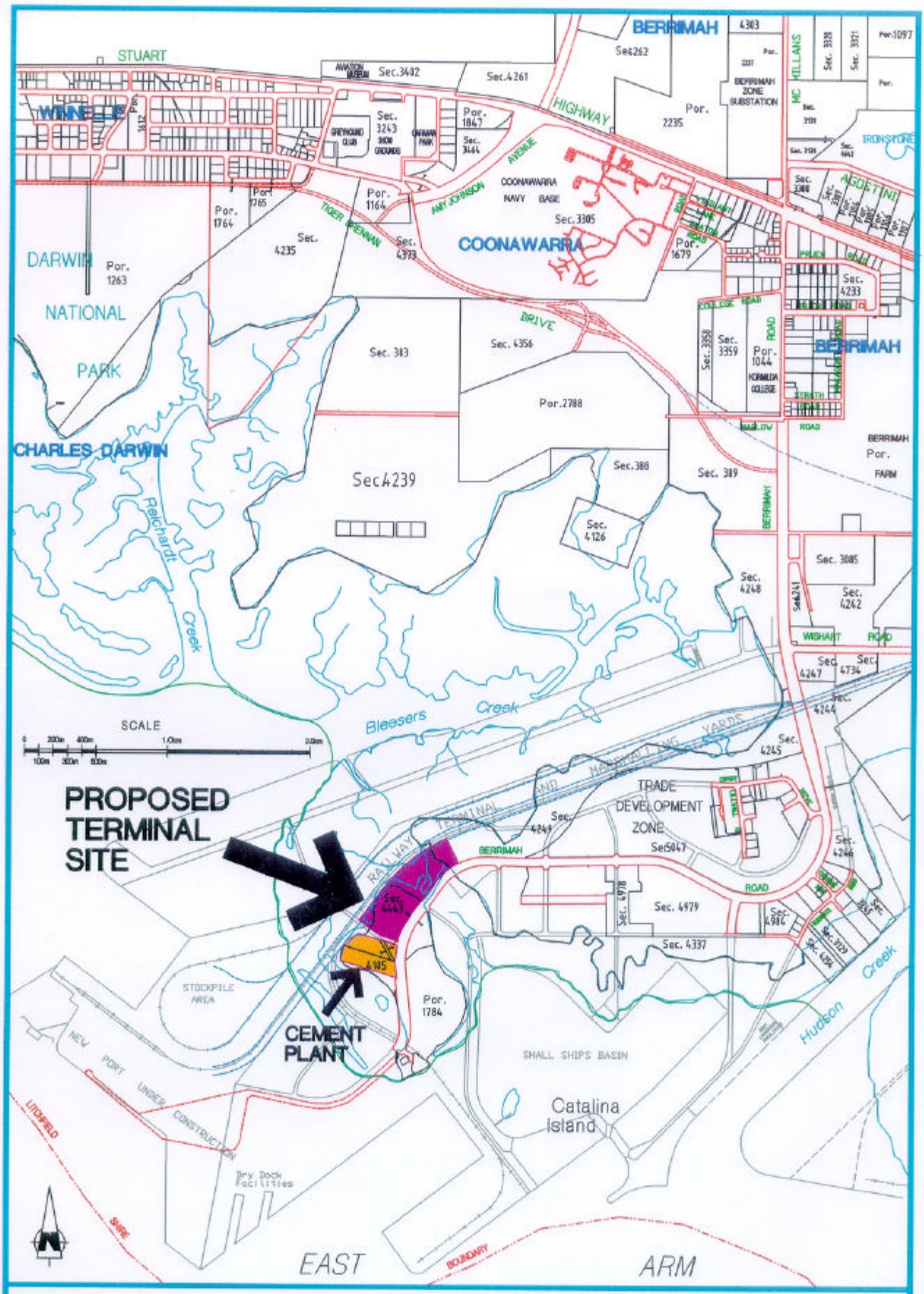
Northern Territory Government has offered the three companies a Crown lease term convertible to freehold title over 20 ha of land to the north of Northern Cement Works.

The Darwin Regional Structure Plan 1984 and the Darwin Regional Land Use Structure Plan 1990 apply over this area. Both plans were saved under Section 133 of the *Planning Act 1993* as land use objectives of the Northern Territory and identify the East Arm Peninsula area for industrial uses.

The DLPE has developed a land use concept plan for the East Arm area, as part of its ongoing planning and development of the area and new port.

The subject site has been identified by the Government as preferred location for the joint user petroleum terminal to replace the existing individual facilities at Frances Bay.

On 17 June 1998 the Minister for Lands, Planning and Environment declared the East Arm Control Plan 1998. The purpose of this plan is to enable industrial and commercial activities to proceed with the consent of the Minister, in the area zoned EA (East Arm).



DARWIN JOINT USER PETROLEUM TERMINAL

LOCALITY PLAN

Figure 2.1

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A development application for the DJT is currently before the consent authority awaiting the outcome of this PER.

In considering whether to give consent to a proposed use or development of land and the conditions, the Consent Authority (The Minister) is to have regard to:

- The purpose of the zone in which the land is situated; and
- The merits of the proposal.

Approval has already been granted for the sub-division of the 20 ha site.

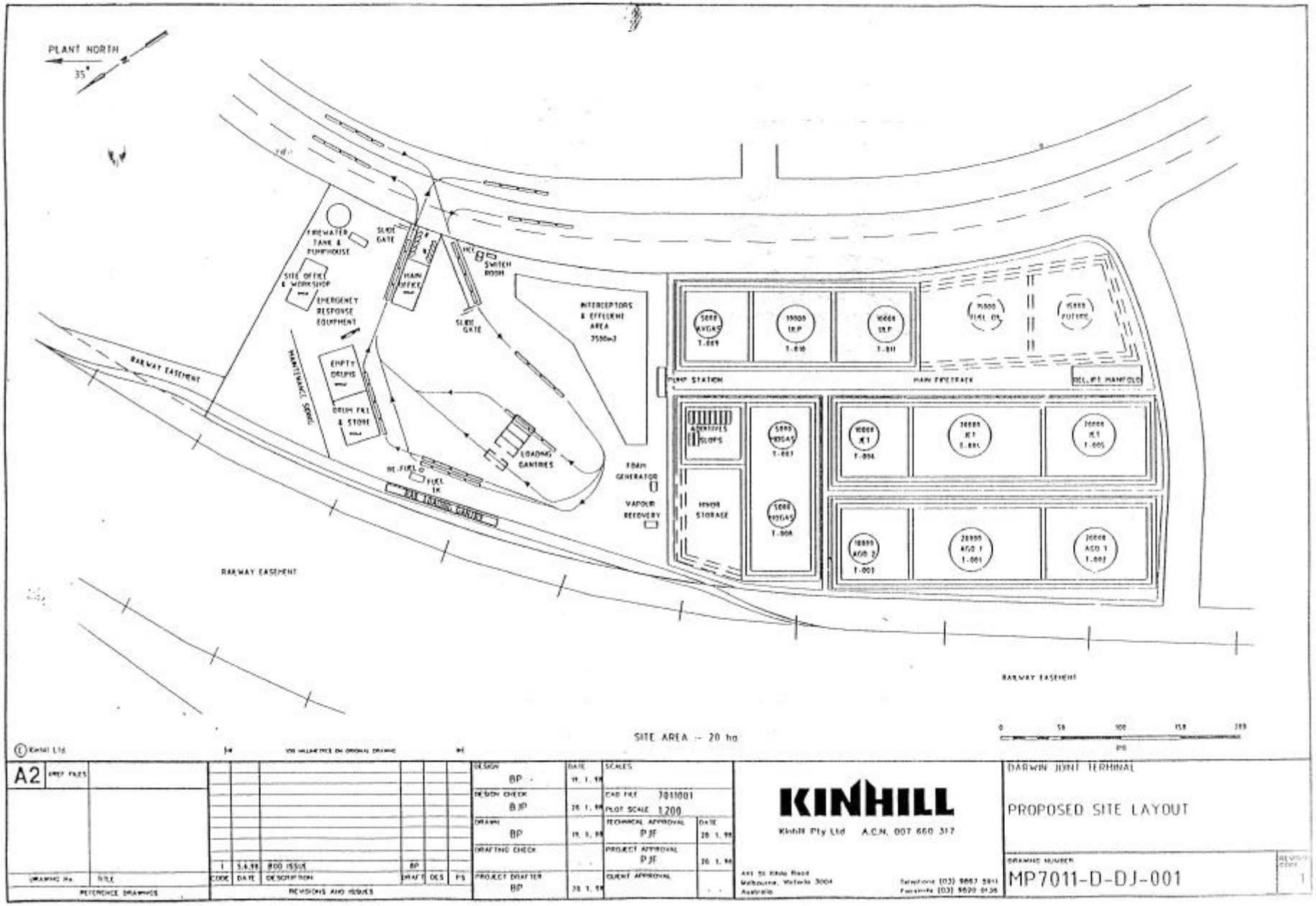
2.2 Terminal Layout

The proposed DJT will receive, store and distribute bulk hydrocarbon products. The major facilities provided by the proposed development are:

- Tanker discharge facilities;
- Tank farm;
- Minor products storage;
- Slops system;
- Pipework systems;
- Road loading gantry;
- Drum and intermediate bulk container filling and storage;
- Bunkering;
- Truck refuelling;
- Additive facilities and unloading area;
- Site office, main building and amenities;
- Product quality/laboratory and sample store; and
- Site maintenance shed.

The proposed layout of the plant is illustrated in **Figure 2.2** and a three-dimensional perspective view of the terminal is presented in **Figure 2.3**. The terminal has been designed so that the tank farm is located to the south of the site on what was previously Quarantine Island. Associated facilities such as the road loading gantry, site offices etc are located in the northern section of the site.

The terminal will have a long-term use, with the design life of the terminal facility being 50 years. The facility will be designed to accommodate the bulk loading and drum filling requirements for the Darwin supply envelope as projected for the year 2006. The site and land requirements, however, have been master planned to meet the total market requirements to the year 2020.



A2		DESIGN BP	DATE 19.1.99	SCALES		DARWIN JOINT TERMINAL	
		DESIGN CHECK BJP	DATE 20.1.99	CAD FILE 7011001 PLOT SCALE 1:200		PROPOSED SITE LAYOUT	
		DRAWN BP	DATE 19.1.99	TECHNICAL APPROVAL PJF	DATE 20.1.99		
		DRAFTING CHECK		PROJECT APPROVAL PJF	DATE 20.1.99		
		PROJECT DRAFTER BP	DATE 20.1.99	CLIENT APPROVAL		DRAWING NUMBER MP7011-D-DJ-001	REVISION 1

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REFERENCE DRAWINGS — DRAWING No. — TITLE

REVISIONS AND ISSUES

Figure 2.2

Figure 2.3

In the immediate future, features of the operation of the terminal for which planning approval is being sought, will be characterised by:

- Product loading and distribution capability 24 hours per day every day, with access to the terminal and road gantry by approved vehicles and drivers;
- Automated driver gantry loading operation without intervention by the terminal operator;
- Remote despatching of road vehicles by individual companies;
- Automated inventory control;
- Tanker discharge and product receipt operations by terminal operations staff supplemented by extra shore staff;
- Product receipt system operated by the terminal operator using a field panel and remotely actuated manifold valves;
- Drum and intermediate bulk container filling operations with casual staff as required; and
- The terminal generally unmanned for other periods.

Allowances have been made for the following longer term enhancements:

- A railway siding and rail loading gantry;
- A vapour recovery system for the road and rail gantries;
- Facilities for further treatment of water effluent;
- An appropriate area for bulk storage of lube oils, solvents, chemicals, additives and other minor products;
- Expansion of the road gantry;
- The capability to expand the number of additive storage/injection facilities; and
- Expansion of the tank farm, including the provision of a 15 kt fuel oil tank.

These additional facilities will be the subject of separate approvals, if required.

2.2.1 Design Principles

The DJT is being designed to relevant Australian and International Standards, incorporating the most recent available data and recommended practices. It will also satisfy statutory regulations and the local regulations and by-laws.

Given that the terminal will probably be the only one supplying the Darwin region, the final design will incorporate a risk management approach to reliability, redundancy, control and safety systems.

The Top End of the Northern Territory is potentially subject to a large degree of adverse weather conditions, particularly during the wet season. These include severe lightning and storms during the “build up” and the potential of cyclones and accompanying storm surges and rough seas. As such the following design considerations have been included:

Wind loadings: Have been taken from Australian Standard AS 1170.2. The area is in a Region C Tropical Cyclone area and as such the serviceability, permissible stress and ultimate basic wind velocities will be adopted as Vs = 44 m/s, Vp = 57 m/s and Vu = 70 m/s, respectively, coming from any direction.

Cyclonic tidal surges: Are associated with the passage of intense tropical cyclones on particularly critical paths, combined with a high state of the astronomical tide. Surge levels significantly above the predicted levels are possible. Cyclonic storm surge within the Greater Darwin area has been evaluated by Vipac (Vipac, 1994). The study indicated that peak combined sea level predictions at East Arm Port of 10, 100, 1,000 and 10,000 year return periods are 3.7, 4.9, 6.0 and 7.0 m AHD, respectively.

Earthquake Loads: Have been taken from AS 1170.4. A general Earthquake Design Category of "D" has been used for hazardous structures and "B" for other buildings.

The East Arm area has been set aside for primarily industrial developments around the new port and proposed railway terminus. The DJT is ideally located on a peninsula away from Darwin's main population centres, but strategically situated to service the broader Darwin region and the Top End of the Territory. Therefore, there are no design limitations imposed by adjacent land uses.

2.3 Construction Phase

2.3.1 Construction Program

Site reclamation and filling construction is currently being undertaken by the Northern Territory Government. The work commenced in July 1999, with most work to be completed by November 1999. Subsequent earthmoving works will be phased through 2000 depending on settlement performance and terminal construction activities. All site works prior to the construction of the terminal facilities are the responsibility of the Northern Territory Government and are outside the scope of this proposal.

Construction for this development is planned to commence in the third quarter of the year 2000 and continue through until the first quarter of the year 2002. Commissioning of the terminal facility is anticipated to occur over the months of March and April 2002, with commercial operations starting in May 2002.

Northern Territory Government construction of the port infrastructure (oil berth and wharf/terminal pipelines) will be planned for timely completion, consistent with the target completion date of the terminal.

2.3.2 Physical Requirements for Construction

The terminal site encompasses both remnant rock due to underlying Quarantine Island and mangrove coastal area. As stated previously, the site will have been prepared, filled and graded to level by the Northern Territory Government, prior to commencement of construction of the terminal facilities.

The civil works for the terminal site include bulk earthworks, construction of roads, pavements, parking area, bund walls, product storage tank foundations, tank compounds, foundations for equipment, buildings and structures, installation of stormwater drainage, services, landscaping and security fencing. Cranes (possibly up to 100 tonnes) will be the predominant on-site plant for materials handling.

Detailed excavation will be required to bench out for the tank bund floors. Other excavation will be limited to trenching for stormwater, water, sewerage, power and communications. Product storage and handling facilities, including piping, tanks, pumps etc will generally be above ground. Tank bunds will be constructed from imported select fill material, probably road base.

Storage tanks will be fabricated on site from steel plate, probably trucked in. The floor plates will be laid on a crushed rock base overlying an impermeable membrane with leak detection equipment installed. Pipework will be set up and the majority butt welded on site.

The balance of the facility infrastructure will comprise structural steelwork, concrete hardstands (bunded for spill containment), sealed roadways and truck parking areas, reinforced blockwork/concrete and steel sheet roofed office/amenity building and a number of steel sheds.

Temporary buildings established on site during construction will include site offices, crib huts, secure stores and ablution blocks. These will generally be demountables, some canopies and shipping containers. Laydown areas will generally be manproof fenced. The site will be fenced to comply with the construction regulations.

2.3.3 Construction Standards

The Northern Territory Work Health Act and its Regulations will govern construction standards.

The procurement, manufacture and assembly of all key equipment will be covered by a comprehensive Quality Assurance Programme where applicable.

2.3.4 Construction Workforce

The site works are not highly labour intensive and a modest workforce only is anticipated. The workforce is unlikely to exceed 100 persons at any given

time; this will put minimal strain on local facilities as a significant proportion is likely to be sourced locally from Darwin and Palmerston.

2.4 Operational Phase

2.4.1 Hours of Normal Operations

The facility will have the capability to load and distribute hydrocarbon products 24 hours per day every day, with access to the terminal and road gantry by approved vehicles and drivers.

2.4.2 Wharf and Pipeline Facilities

The simplified DJT Process Flow Scheme, including the product receipt system, is presented in **Figure 2.4**.

Hydrocarbon products will generally be imported in 40,000 DWT multi-product vessels with a full cargo capacity equivalent to 50,000 m^3. It is anticipated that two to four vessels will unload at the East Arm oil berth each month. Products will be discharged from tankers via flexible hose connections to a fixed pipeline manifold on the wharf.

The DJT will receive product from the Oil Berth at the new East Arm Port via two 300 mm diameter white oil pipelines. The pipelines from the wharf to the terminal boundary will be provided by the Northern Territory Government.

2.4.3 Product Storage

The product storage tank farm will consist of 11 above ground tanks, with provision for the future construction of at least two additional tanks to meet potential market demands. The basis of the design for tankage is the year 2006 offtakes, and has regard to stock cover and product supply logistics. The total storage capacity is 135 Ml of bulk fuel. Details of product tankage, with tank number and capacity combinations for the minimum number of tanks are provided in **Table 2.1**.

Table 2.1: Details of Product Tankage

Product	Proposed Total Storage Capacity (Ml)	Tank Number x Capacity (Ml)
Mogas	10	2 x 5
ULP	20	2 x 10
AGO 1	40	2 x 20
AGO 2	10	1 x 10
Avgas	5	1 x 5
Jet	50	2 x 20 + 1 x 10
Total	135	

Properties of the various hydrocarbon products to be handled by the terminal are given in **Table 2.2**.

There will be a minimum of two tanks per product, except for Avgas, to enable simultaneous product receipt and loading, tank batching, tank cleaning and tank maintenance while maintaining loading operations.

The largest tanks will have height/diameter dimensions of 22 /36 m, respectively. Tank separation will conform to the relevant Australian Standards (AS 1940 - 1993). Separation distances will be 1.5 times the diameter of the tanks, having regard to risk management and the ability to reduce the need for ancillary fire equipment. Safety distances from tanks to protected works will be incorporated within the site boundaries or neighbouring roads and railway reserves.

Table 2.2: Properties of Products

Product	Density at 15°C	Vapour Pressure (kPa at 40°C)	Flash Point (°C)	Auto-ignition Temperature (°C)
Mogas	0.730	75	-43	390
ULP	0.735	75	-43	390
AGO 1	0.840	Below 3.5	80	350
AGO 2	0.840	Below 3.5	80	350
Avgas	0.695	50	-46	440
Jet	0.795	Below 3.5	40	380

The 11 storage tanks will be grouped within bunds. The net bund volumes will be 110% of the safe full capacity of the largest tank within the bund. The bund height will be 1.5 m. The bund floors will slope away from the tanks pads towards drainage trenches and pits.

The major product tankage and grouping within bunds is presented in **Table 2.3.**

Table 2.3: Major Product Storage and Grouping Within Bunds

Bund	Product	Nominal Capacity (m^3)	No. of Tanks	Diameter (m)	Height (m)
1	AGO 1	20,000	2	36	22
	AGO 2	10,000	1	25	22
2	Jet	20,000	2	36	22
		10,000	1	25	22
3	Mogas	5,000	2	22.5	18
	Avgas	5,000	1	22.5	18
	ULP	10,000	2	30	18

All 11 tanks will be designed and constructed to API-650. All tanks will have fixed roofs and be fitted with:

- An automatic level gauging system;
- An automatic temperature reading system;
- Overfill protection probes;
- Automated tank isolation valves; and
- Closed system de-watering.

The tanks containing the most volatile motor gasolines Mogas and ULP will have internal floating covers and be fitted with air scoops and free vents.

An area of approximately 1 ha will be set aside for the potential storage of lube oils, solvents, chemical additives and other minor products.

A separate sample store facility will also be provided. Due to the hazardous zone considerations, samples will be stored in either the drum filling facility or in a separate shed near the tank farm.

2.4.4 Product Loadout

The simplified DJT Process Flow Scheme, including the product delivery and gantry system, is presented in **Figure 2.4**.

The gantry/distribution area allows for the transport of fuel initially by road trains and later by rail. Stored product will be loaded into road tankers through a three bay bottom-loading gantry. Each arm will only be able to be connected to one vehicle compartment at any one time. However, a number of compartments may be loaded simultaneously. The loadout flow will be metered and controlled by a set valve.

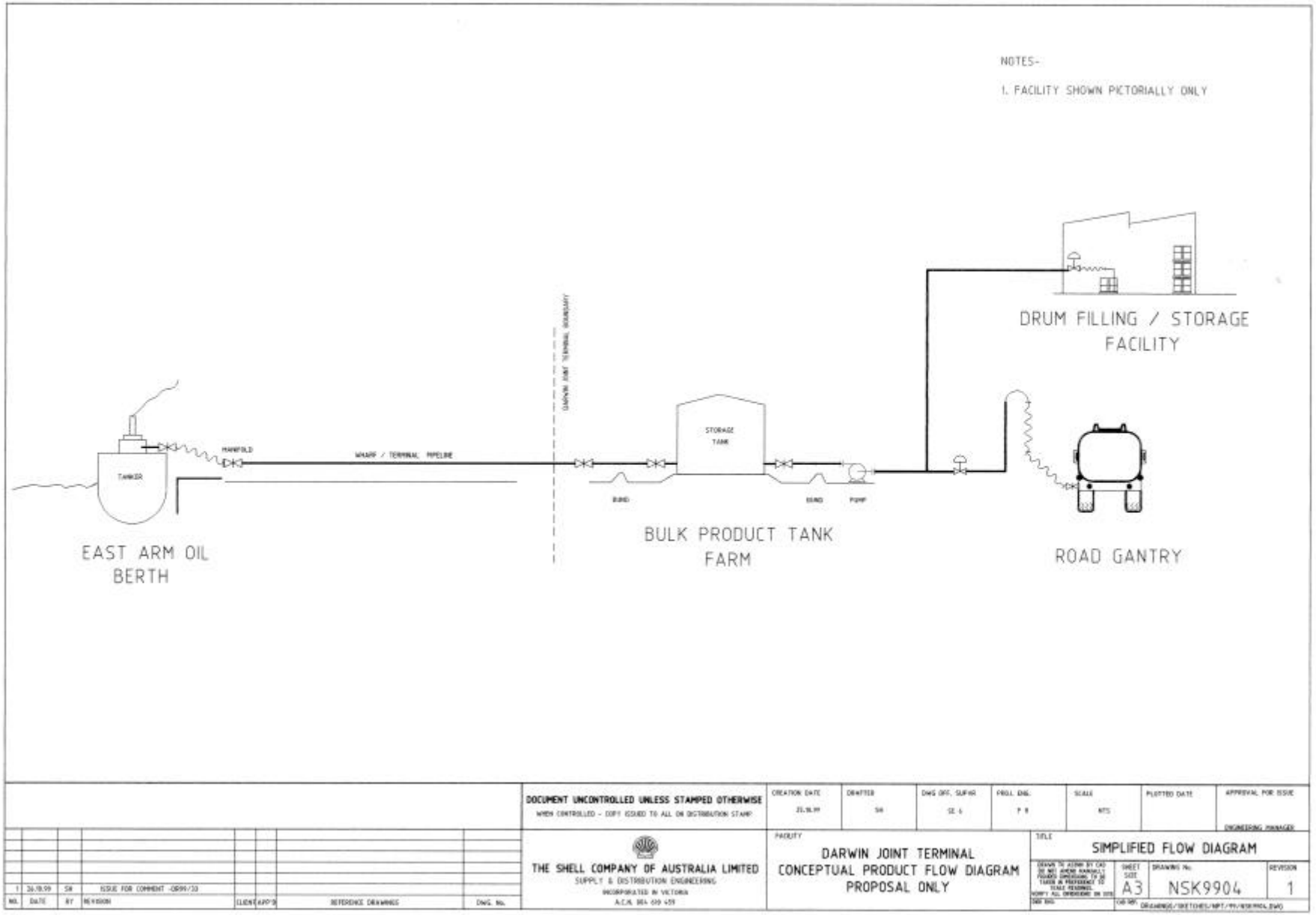
The gantry and terminal layout is designed for 55 m long triple road trains.

The gantry/distribution area will also incorporate offices, a control room, a workshop, firewater tank and pump house, storage areas and other ancillary facilities.

Vapour displaced during loading will initially be vented to the atmosphere in a safe location. Allowance has been made for the future construction of a vapour recovery system which recovers the hydrocarbons for return to a product tank.

The road gantry systems will include spill containment and be integrated with the oily drainage system. An automatic foam deluge system will also be incorporated into the gantry design.

The terminal will have the capability to deliver diesel bunker fuel to ships via either of the white oil pipelines, the wharf manifold, and then via a bunker metering trailer. Diesel bunkering will also be possible by truck.


NOTES-
1. FACILITY SHOWN PICTORIALLY ONLY
DRUM FILLING / STORAGE FACILITY
STORAGE TANK
TANKER
MANIFOLD
WHARF / TERMINAL PIPELINE
BUND
BUND
PUMP
EAST ARM OIL BERTH
BULK PRODUCT TANK FARM
ROAD GANTRY
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THE SHELL COMPANY OF AUSTRALIA LIMITED
SUPPLY & DISTRIBUTION ENGINEERING
INCORPORATED IN VICTORIA
A.C.N. 004 610 459
FACILITY
DARWIN JOINT TERMINAL
CONCEPTUAL PRODUCT FLOW DIAGRAM
PROPOSAL ONLY
TITLE
SIMPLIFIED FLOW DIAGRAM
SHEET SIZE
A3
DRAWING No.
NSK9904
REVISION
1

Figure 2.4

2.4.5 Product Circulation

All on-site services, including pipelines for product circulation, will be located above ground and in pipe racks wherever possible. Exceptions to this rule will occur at road crossings, where the use of trench pits will enable access to the service to be maintained. The location of site facilities above ground, while marginally increasing the risk of damage, allows easy access for monitoring of corrosion and pipe leakage and ongoing maintenance. The risk of damage to pipelines through collision with on-site vehicles will be minimised by the appropriate installation of guard rails.

The final design of pump locations and pipeline tracks will optimise pipeline lengths and road/rail crossings.

2.4.6 Additional Facilities

Additional facilities to be provided within the terminal boundary include a drum filling and storage area, office and amenities, firewater system, a segregated stormwater drainage and treatment system, truck fuelling facilities and general facilities.

The terminal will include a facility for the filling and storage of 200 l drums and intermediate bulk containers (IBC). Both the drum filling facilities and the filled drum storage area which will have a capacity equivalent to 600 drums, will be under cover. The area will be bunded and be integrated with the oily drainage system. The semi-automatic filling operation will incorporate a vapour extraction system. In addition, out-of-doors storage will be provided for 1,000 empty drums, stacked two high.

Additives will be stored in three 55 kl horizontal above ground tanks to enable additives to be added into product at the loading gantries and at the drum/intermediate bulk container filling facility. A separate additive storage and injection facility will also be located at the product receipt manifold for additive injection into import cargoes as required.

A covered tanker refuelling facility will be provided separate from the road loading gantry. The facility will consist of a 55 kl above ground storage tank, spill containment and drainage, and twin high-flow dispensing facilities.

The main administration building will be single storey and accommodate the control room, offices, visitor reception area, amenities, toilets, showers and locker facilities for 6 site staff, first aid room and messing facilities. A separate building will be constructed to house the product quality/laboratory facilities.

The workshop and store will accommodate a small work shop and store and allow for the garaging of the bunkering trailer, emergency response vehicle and spill recovery equipment.

2.4.7 On-site Fire System

The on-site fire system will be designed to AS2941, AS1940 - 1993 and appropriate NFPA codes. The system will consist of an above ground storage tank, supplied from the local water mains. The tank will be capable of maintaining 4 hours of hydrant water. The system will be pressurised. Water circulation facilities will be provided for routine testing of the fire pumps.

The product tanks have been spaced so as to eliminate the need for fixed cooling water, however an automatic foam deluge system will be installed in the road gantry.

A fire risk study will be conducted during the design stage. The study will assess the risk of fire due to terminal operations, having regard to layout and the design basis and will include thermal radiation intensity contours and a qualitative risk assessment. The scope will include automation of foam deluge on the road gantry, top or bottom foam injection into tanks and provision of fusible shutdown systems.

In the event of an emergency the terminal will undergo a safe shutdown. This shutdown will include the isolation of product inventories, stopping of transfer pumps and isolation of non-essential electrical power. Emergency stop push buttons will be situated in the control room and at strategic locations around the terminal.

Commitment:

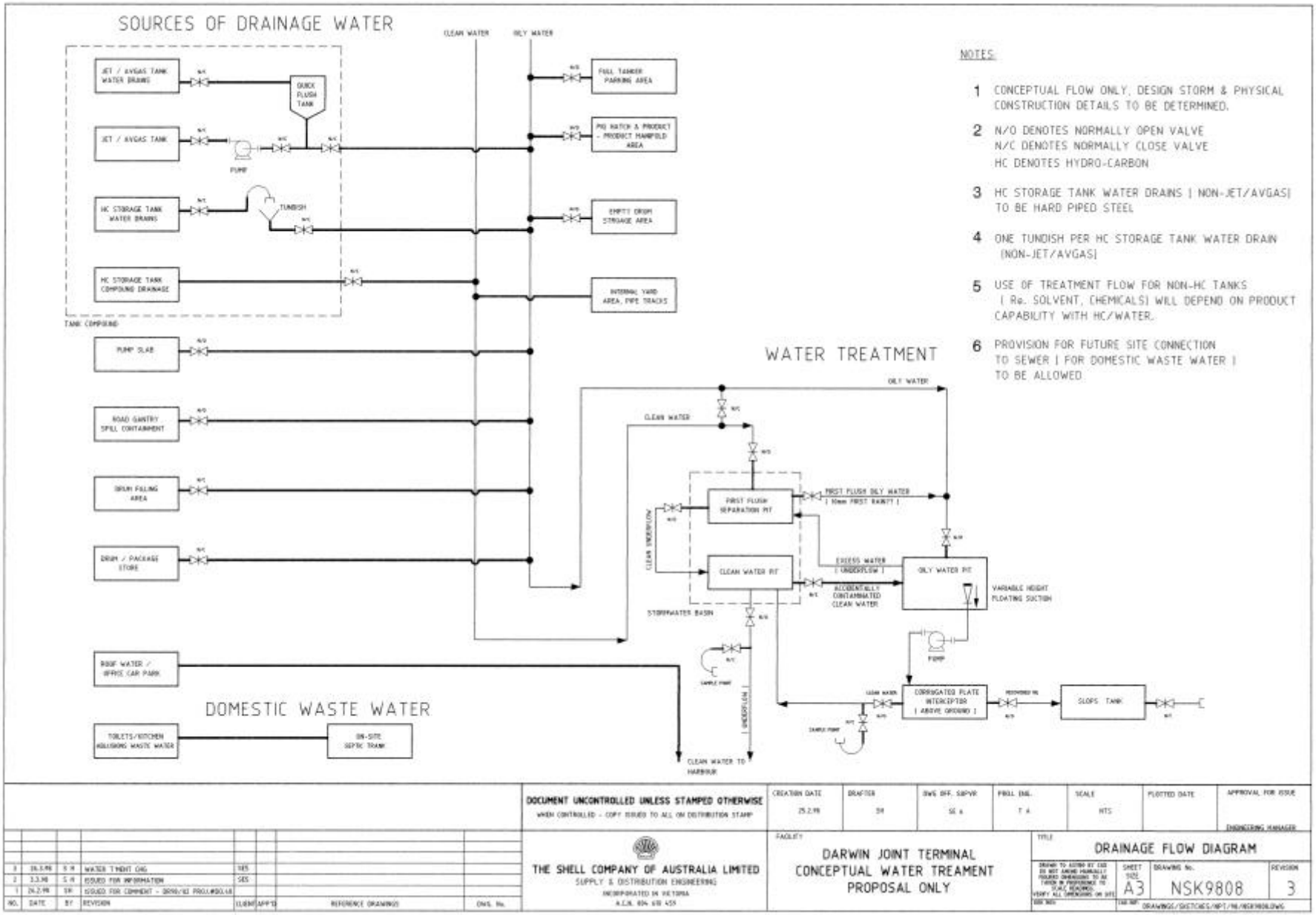
A fire risk study will be conducted during the design stage. The scope will include automation of foam deluge on the road gantry, top or bottom foam injection into tanks and provision of fusible shutdown systems.

2.4.8 Stormwater Management

Once the site has been prepared, it will generally be elevated and not susceptible to flooding. Underground stormwater design will be based on a 10 year ARI. The overland flow path will be designed for the 50 year ARI case.

In order to minimise the potential for contamination of stormwater discharge from the site (or of contaminating ground water from the drainage system from within the site), a segregated drainage system will be provided with effluent treatment facilities. The drainage flow diagram is presented in **Figure 2.5**. Bunding will be provided for any area where product is to be stored or where there is a potential for spillage to occur. The drainage system is to ensure contaminated flows are directed to the effluent treatment facility, with separation of clean stormwater runoff. The segregated drainage and effluent treatment system will include segregated systems for:

- Continuously oil contaminated effluents (the “oily water system”);
- Accidentally oil contaminated effluents (the “clean water system”);
- Roof and other clean stormwater runoff; and
- Domestic waste water.


SOURCES OF DRAINAGE WATER
CLEAN WATER
OILY WATER
JET / AVGAS TANK WATER DRAINS
QUICK FLUSH TANK
JET / AVGAS TANK
PUMP
HC STORAGE TANK WATER DRAINS
TUNDISH
HC STORAGE TANK COMPOUND DRAINAGE
TANK COMPOUND
FULL TANKER PARKING AREA
PIG HATCH & PRODUCT - PRODUCT MANIFOLD AREA
EMPTY DRUM STORAGE AREA
INTERNAL YARD AREA, PIPE TRACKS
PUMP SLAB
ROAD GANTRY SPILL CONTAINMENT
DRUM FILLING AREA
DRUM / PACKAGE STORE
ROOF WATER / OFFICE CAR PARK
DOMESTIC WASTE WATER
TOILETS/KITCHEN AGUSHING WASTE WATER
ON-SITE SEPTIC TANK
WATER TREATMENT
OILY WATER
CLEAN WATER
FIRST FLUSH SEPARATION PIT
FIRST FLUSH OILY WATER
CLEAN OVERFLOW
CLEAN WATER PIT
EXCESS WATER
ACCIDENTALLY CONTAMINATED CLEAN WATER
OILY WATER PIT
VARIABLE HEIGHT FLOATING SUCTION
STORMWATER BASIN
PUMP
CORRUGATED PLATE INTERCEPTOR
SLOPS TANK
CLEAN WATER TO HARBOUR
NOTES:
1 CONCEPTUAL FLOW ONLY. DESIGN STORM & PHYSICAL CONSTRUCTION DETAILS TO BE DETERMINED.
2 N/O DENOTES NORMALLY OPEN VALVE
N/C DENOTES NORMALLY CLOSE VALVE
HC DENOTES HYDRO-CARBON
3 HC STORAGE TANK WATER DRAINS (NON-JET/AVGAS) TO BE HARD PIPED STEEL
4 ONE TUNDISH PER HC STORAGE TANK WATER DRAIN (NON-JET/AVGAS)
5 USE OF TREATMENT FLOW FOR NON-HC TANKS (Re. SOLVENT, CHEMICALS) WILL DEPEND ON PRODUCT CAPABILITY WITH HC/WATER.
6 PROVISION FOR FUTURE SITE CONNECTION TO SEWER (FOR DOMESTIC WASTE WATER) TO BE ALLOWED
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THE SHELL COMPANY OF AUSTRALIA LIMITED
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INCORPORATED IN VICTORIA
A.C.N. 004 610 459
FACILITY
DARWIN JOINT TERMINAL
CONCEPTUAL WATER TREAMENT
PROPOSAL ONLY
TITLE
DRAINAGE FLOW DIAGRAM
SHEET SIZE
A3
DRAWING No.
NSK9808
REVISION
3
DRAWINGS/SKETCHES/WPT/98/NSK9808.DWG

Figure 2.5

The oily water system will handle oil and heavily contaminated water and will capture water from:

- Tank water drains via quick flush tanks and a hard/closed piping system;
- The bunded loading pump/filter area;
- The road gantry loading bay area;
- The road tanker refuelling area; and
- The drum filling facility.

Following rain the tank compounds will be inspected, and dependent on confirmation of the stormwater's cleanliness, the water will be discharged under supervision via the clean water system and treatment facilities.

The clean water system will be directed to a holding basin with "first flush" capacity to contain an unexpected contaminated flow. The first flush system forms part of the effluent treatment facilities, and will be defined during the design stage.

The road tanker traffic and standing areas, as well as the bunded tank from compounds will drain to the first flush basin area.

As significant leakage from pipelines in the tank farm pipetracks is not considered to be a likely event, stormwater drainage from the tank farm pipetrack and road areas are generally directed offsite as clean water. However, a facility is provided to detect and divert a contaminated flow to the first flush basin.

Clean stormwater from the roof of buildings, car park areas, etc will be directed to offsite stormwater drains.

The drainage effluent treatment facilities are designed to handle all drainage from the oily water and clean water systems. The facilities comprise:

- The first flush separation pit;
- An oily water pit;
- A corrugated plate interceptor with feed pump;
- A recovered oil (or slops) system; and
- A clean water pit.

Effluent from the treatment facilities will be monitored and discharged as clean water to offsite stormwater drainage system.

Only minimal sludge/waste oil will be generated from the drainage treatment system. Any such waste material will be disposed to an approved off-site waste disposal site.

2.4.9 Transport and Site Access

Vehicle access to the site will be from Berrimah Road, with exit from the site also directly to Berrimah Road, and will be provided to Department of Transport and Works requirements. Provision will be made in the design of the access to allow a 55 m long triple road train to move off Berrimah Road while waiting for authorisation to enter the site. Allowance will be made for parking 5 triple road trains on site. Parking will be provided for 6 cars, 2 small commercial vehicles and 1 disabled user, adjacent to the proposed office. Secure parking will also be provided for 6 cars outside the terminal gates.

The on-site vehicle route has been designed for one way traffic to avoid the hazards of cross traffic conflict and with the gantry exit directed towards the site exit gate.

Concrete pavements will be constructed in heavily trafficked operational areas, especially where minimum tanker turning circles would otherwise damage the surface.

Sealed flexible bituminous pavement with a design life of thirty years will be provided in all other main yard traffic areas. Trafficable pavement and access to other service areas will be to a sealed coat standard. A 3 m wide perimeter sealed road will be provided around all bunded areas.

2.4.10 Services and Utilities

The Northern Territory Government, as part of the subdivision and site preparation works will provide mains water and power to the site. An emergency backup generator will be provided on site by the developer.

Effluent disposal will be a septic system constructed to the approval of the Territory Health Services.

Landscaping suitable to the Darwin climate will be provided, particularly adjacent to Berrimah Road.

The site will be secured with security fencing and complemented by security guard patrols. Vehicle and personal access will be by security key card. Site lighting will be provided and emergency security lighting will be provided in the event of a power failure.

This section describes the existing environmental characteristics of the area. A description of the existing environment that may be effected by the proposal including off site locations, has been covered previously in the East Arm Port Development EIS, and where applicable has been reproduced within this chapter. Particular attention is focused on components of the environment that would either have a direct bearing on the proposal or could be most affected by it.

3.1 Climate

The climate of Darwin is characterised by a hot, humid, wet season (typically from November to March) and a hot, dry season (typically from May to September) separated by relatively short transitional periods (typically April and October).

The mean annual rainfall of 1,659 mm is highly seasonal, varying from an average of 1 mm in July to 404 mm in January. Rainfall was recorded on Quarantine Island between 1934 and 1985, with an annual mean value of 1,551 mm. Relative humidity at 9 am varies from a low of 62 % in June to a maximum of 84 % in February, with respective monthly values of 30 to 71 % at 3 pm. High precipitation rates are commonly experienced during storm events in the wet season.

Temperatures tend to remain within a relatively narrow range throughout the year, with mean daily minima varying from 19.2 °C (July) to 25.2 °C (November) and mean daily maxima for the same months varying from 30.3 °C (July) to 33.1 °C (November).

Synoptic winds during the dry season tend to be dominated by the south-east trade winds, while light west to north-westerlies predominate during the wet season. Sea breezes from the north-west occur on most afternoons throughout the year.

Tropical cyclones occur in the Darwin region on average about once per year. Australian Standard AS 1170 Part 2-1989 specifies likely maximum gusts during cyclonic events in Darwin for purposes of structural designs. The standard indicates likely maximum gusts of 180, 205 and 252 km/h for cyclones having mean return periods of 20, 100 and 1,000 years, respectively.

3.2 Landforms, Geology and Soils

Quarantine Island comprises two major land systems: the Bustard and Littoral systems (Fogarty et al, 1979). The island has formed where hills of the original terrain have been isolated by marine flooding and tidal deposits since Quaternary times (Seminiuk, 1985).

The Bustard land system forms the hinterland and hinterland margin of Quarantine Island, and is characterised by rolling hills forming a low plateau, rising to 24 m AHD. The slopes are gentle (2 to 55) and relief is up to 10 m. On the lower slopes a laterite profile has been formed while on the upper slopes the soils are lithosols. These lithosols have a high content of gravel (40 to 70%) and are shallow with sandy textures, resulting in excessive drainage. These characteristics place severe limitations for urban or intensive agricultural use (Fogarty et al, 1979).

The geology of this land system is primarily the Burrell Creek Formation, and early proterozoic sedimentary unit (Pietsch, 1983). The lithologies range from fine-grained siltstones and sandstones to coarser quartz conglomerates. From field observations along a road cutting, the rocks display considerable variation in hardness, texture and weathering.

The Littoral land system forms a fringe around Quarantine Island and is dominated by the mangrove community. At the southern end of the island the mangrove fringe is narrow due to a rockier coast.

Topographically the Littoral land system has negligible relief and slope, and is inundated by seawater at peak high tides. The mangroves grow in a substrate of mud (clay minerals and quartz silt) formed by sedimentary progradation, in a broad zone up to 750 m wide (Seminiuk, 1985). Large areas of salt flats occur on the western edge of Quarantine Island as a result of hypersaline ground water (Seminiuk, 1985).

Groundwater information is limited within the region and what is available indicates that groundwater is encountered within both the Quaternary and Proterozoic lithologies. Aquifers are low yielding, with flows reported at <0.5 l/sec. Higher yields with low storage may be available from sand lenses within the Quaternary sediments and fractures within sandstone. Groundwater depths are likely to be shallow, particularly given the proximity to the ocean.

The quality of groundwater within the shallow sediments is typically saline to hypersaline and not suitable for drinking or irrigation. The high salinity has likely resulted from landward salt-water intrusion and the dissolution of salts derived from marine sediments. The groundwater aquifers and marine environments are likely to be hydraulically connected.

Deeper groundwater resources may be available from fractured shales, siltstone and sandstones. Groundwater quality is variable within the deeper aquifers and typically brackish to saline. The hydraulic connectivity between the aquifers will depend upon the degree of structures such as fracturing within the shales.

No groundwater users are reported within the vicinity of the site.

Earthquake hazard maps produced by the Australian Geological Survey Organisation in Australian Standard 1170.4 1993 indicate that the Darwin area has an earthquake acceleration coefficient (10% probability of exceedence in 50 years) of 0.09. The higher the value of acceleration coefficient, the greater the severity of the expected earthquake.

3.3 Hydrology

The site will be cut/filled to bring it to a required elevation of RL 5.5 m AHD. Due to this, and the small catchment area, well-developed drainage channels will not be present. Runoff is via overland flow with seepage occurring through the porous soil to prevent ponding.

3.4 Vegetation

The 20 ha site will be cleared of all vegetation prior to the transfer to the three oil companies. However, there are soft mangrove mud flats approximately 200 to 500 m to the north and west of the site. Beyond the mudflats to the north are Blessers Creek and the Charles Darwin National Park.

3.5 Fauna

The clearance of vegetation will result in the removal of faunal habitat from the site. However, the mangroves that fringe the East Arm Peninsula are breeding habitats for mosquitos and midges.

3.5.1 Biting Insects

Some species of mosquito are disease vectors and therefore present a hazard to human health. Both midges and mosquitos can present a severe nuisance to occupiers and visitors to these areas. Of the some 100 or so species of mosquito found in the Northern Territory, 15 are considered to be carriers of disease or a general pest. They breed in the intertidal mangrove zone and low-lying zone between mangroves and terrestrial open forest from 3.3 m AHD to 1.0 m above maximum high tide at various times of the year (Whelan, 1988).

Although, Quarantine Island has a high density of biting midges, there are no large mosquito breeding sites in the immediate vicinity. High numbers of biting midges occur in the upper reaches of Blessers and Hudson Creeks, and cause serious human discomfort in Berrimah and Hidden Valley Speedway. Biting midges are also a perennial problem at the cement plant on Quarantine Island. Minor mosquito breeding areas have been identified near the Trade Development Zone and East Arm Leprosarium (Acer Vaughan et al, 1994).

This section outlines the potential effects of the proposed development on the physical and biological environment. Potential impacts associated with both the construction and operation phases are discussed.

4.1 Construction Phase

The construction of the DJT will be undertaken on the site previously prepared by the Northern Territory Government and project managed by Shell on behalf of the three oil companies. Construction will extend for approximately 24 months and will result in a number of short term effects such as the generation of noise and dust caused by earthworks and building activities, and increased erosion through surface runoff.

All employees and construction teams will be required to abide by Shell's Environmental Policy, Environmental Plans and Codes of Practice. Construction contracts, employee conditions of employment and site visitor information will include appropriate clauses binding them to Shell's Environmental Policy, Environmental Plans and Codes of Practice.

4.1.1 Dust

Dust will be generated during the construction phase from earthworks, movement of vehicles and by wind erosion of areas cleared of vegetation. The degree of dust generated would depend on the moisture content of the ground surface during construction.

The impact of dust during construction is expected to be minor and localised. The nearest permanent residences are over 5 km from the site and will not suffer any dust nuisance.

Dust levels will be visually monitored on the site during construction by the construction contractor. Dust suppression will be instituted, using water trucks, sprinklers and other means as necessary, in the event that:

- High levels of dust are observed;
- Strong winds and dry conditions make dust generation likely; and
- Complaints about dust are received.

Commitment:

Appropriate dust control measures, such as the spraying of exposed surfaces with water, will be implemented should dust levels prove to be an issue.

4.1.2 Noise

Construction of the terminal facilities will require the use of a range of heavy vehicles and equipment that may generate significant noise. Earthworks and construction activities will generally be restricted to day-light hours, will be carried out in accordance with Section 6 of Australian Standard 2436-1981

"*Guide to Noise Control on Construction, Maintenance and Demolition Sites*" and the equipment used will be the quietest reasonably available. Therefore, noise impacts are expected to be localised and not be detectable in residential areas.

Investigation and appropriate improvement plans will be initiated in response to noise complaints from any residents.

4.1.3 Surface Runoff and Erosion

Construction operations have the potential to impact on both surface and groundwater resources. Surface water resources can be contaminated through surface runoff. Contaminants could potentially include spilt petroleum products from construction vehicle refuelling and suspended material from soil erosion. Groundwater resources can potentially be impacted by the infiltration of contaminants into the soil. Contaminants may include petroleum products and soluble compounds leached from site materials.

The off-site discharge of surface drainage could act as a vector for the movement of contaminants from the terminal facility into the broader environment, including the adjacent mangrove areas and the waters of East Arm. Siltation of mangrove areas, increased turbidity and sedimentation in the waters of East Arm could result.

The proponent will adopt good construction practices that will ensure the environmental impact of waste effluents generated on-site during construction will be minimised. These will include:

- Providing a surface drainage system to divert runoff away from disturbed areas and protect mangroves; and
- Providing silt traps to minimise off-site sediment discharges.

Commitment:

The proponent will adopt good construction practices that will ensure the environmental impact of waste effluents generated on-site during construction will be minimised.

4.1.4 Acid Sulphate Soils

Acid sulphate soils have the potential to be encountered within estuarine muds surrounding the site. These soils once exposed to air can generate acid leachate that moves through the soil contaminating the surrounding ground and surface waters. The leachate can impact on the surrounding environment and cause corrosion and weakening of concrete foundations and sub-surface structures.

Testing of marine and estuarine soils/sediments sampled at the proposed Railway Terminal and Marshalling Yards site at East Arm, indicate the presence of potential acid sulphate materials (Dames & Moore, 1999).

This would indicate that there is likely to be potential acid sulphate material underlying the DJT site.

To confirm the acid forming potential, representative soil samples will be collected from the terminal site prior to commencement of construction. If potential acid forming soils are identified, then an acid sulphate soil management plan will be implemented. The management practices that may be undertaken include:

- Neutralisation of the acid soils with lime during the installation of footings and sub-surface structures;
- Excavation of the acid soils and disposed of them at an appropriate disposal site; and
- The use of a clay liner to prevent the downward percolation of fresh water and prevent exposure to the atmosphere.

Visual inspection for acid sulphate soils will continue throughout the construction phase of the project.

Commitment:

Samples of soil from the DJT site will be analysed for acid sulphate potential. If potential acid forming soils are identified, then an acid sulphate soil management plan will be implemented.

4.1.5 Introduced Weeds, and Pests and Diseases

A washdown procedure for off road and other non-exempt vehicles entering the site area to be instigated if required to preclude the importation of weed species or seed material attached to vehicles.

4.1.6 Construction Wastes

The generation of waste material is inevitable during the construction phase of the development. Waste material is likely to include:

- Inert waste including excess fill and building rubble;
- General refuse including scrap metal, cardboard and plastics;
- Fluids, such as waste oils and solvents; and
- Sewage and domestic wastes.

It is intended that clean waste material such as rock and rubble will be used for earthfill elsewhere on the site or at other approved East Arm locations.

Solid wastes generated during construction will be disposed of to approved landfill sites.

Waste oils and solvents will be collected in drums or tanks and will be periodically removed by a licensed contractor for recycling or disposal at an approved liquid waste disposal site.

Portable toilets and washing facilities will be provided on site during construction. These facilities will retain sewage and sullage in sealed tanks until they are removed by a licensed contractor for disposal to an approved waste disposal site.

Commitment:

All waste materials generated during construction activities will be disposed of in a manner satisfactory to the DLPE.

4.1.7 Biting Insects

During the construction of the terminal facility an increase in mosquitoes and other biting insect numbers may result due to pondage of water and potential for creation of breeding sites. The most important construction aspects are the impediment of temporary drainage by blocked silt traps or the ponding of water within foundation works. Other mosquito breeding sites may be created through the use of uncovered water tanks and careless disposal of containers.

Careful attention will be given to the design and maintenance of earthworks and drainage systems during construction to avoid the creation of significant habitat areas for mosquito larvae. The use of larvicides may be required to prevent mosquito breeding in silt traps. Regular site inspections for potential breeding areas will be undertaken.

4.1.8 Traffic

During construction vehicle traffic entering and exiting the site from Berrimah Road will temporarily increase. The only through traffic adjacent to the site is that travelling to the Northern Cement complex or East Arm Port. As such, the temporary increase in traffic is not considered to be an issue for other users of Berrimah Road.

Construction traffic movements will be via designated arterial roads such as Berrimah Road, Tiger Brennan Drive and Stuart Highway, and will not travel through residential areas.

4.2 Operational Phase

The operation phase of the project has the potential to produce longer term effects on the environment than the construction phase. The main issues include risk and hazards associated with the handling and storage of flammable hydrocarbons, atmospheric emissions and management of potentially contaminated stormwater.

4.2.1 Risk

A preliminary hazard and risk assessment for the operation of the proposed DJT has been undertaken. The hazard and risk assessment was carried out

using a tool developed by the Royal Dutch/Shell Group, known as the Shell Risk Assessment Matrix (Risk Assessment Matrix, 1999, Shell HSE Advisers Panel).

The Risk Assessment Matrix is a tool that standardises qualitative risk assessment and facilitates the categorisation of risk from threats to people, assets and the environment. As shown in the figure below, the matrix axes are those of consequence and likelihood.

A scale of consequences from '0' to '5' is used to indicate increasing severity. The consequences are potential outcomes that can develop from release of a hazard. Definitions of the consequence severity ('0' to '5') to people, assets and the environment are provided in the Shell Risk Assessment Matrix guideline.

The preliminary hazard and risk assessment has considered the potential consequences, likelihood and risk of a number of hazards using the above Shell Risk Assessment Matrix. This information and the proposed management controls to minimise risk to as low a level as reasonably possible (ALARP), are presented in **Appendix A**.

Figure 4-1: Shell Risk Assessment Matrix

CONSEQUENCE				INCREASING LIKELIHOOD				
				A	B	C	D	E
SEVERITY	People	Assets	Environment	Never heard of in Industry	Heard of in Industry	Incident has occurred in our company (Coy.)	Happens several times per year in our Coy.	Happens several times per year in a location
0	No health effect/injury	No damage	No Effect					
1	Slight health effect/injury	Slight damage	Slight effect			**Increasing Risk**		
2	Minor health effect/injury	Minor damage	Minor effect					
3	Major health effect/injury	Localised damage	Localised effect	**LOW RISK**				
4	PTD or 1-3 fatalities	Major damage	Major effect		**MEDIUM RISK**			
5	Multiple fatalities	Extensive damage	Massive effect			**HIGH RISK**		

Likelihood of potential consequences for the assessment was determined on the basis of historical evidence or experience with the Terminal facilities of Shell Australia, and the Australian oil industry.

All relevant aspects of the proposed operation have been reviewed, including product delivery at the berth and to the terminal, storage of bulk and packed product, product loading and the drainage and interceptor system. A realistic

qualitative assessment has been made, with respect to people, assets and the environment.

In summary, the hazard and risk assessment determines that the risk to people, assets and the environment is 'Low' or 'Medium' (as defined by the Shell Risk Assessment Matrix tool) for all hazards.

The preliminary hazard and risk assessment demonstrated that with respect to fatalities or serious injuries to workers, fire or explosion was the main people-related hazard identified.

There is a risk of fire and explosion on tankers during delivery operations due to the ignition of hydrocarbon vapours by static electricity, lightning or electrical sparks. The risk of such an accident will be reduced to an acceptable level by:

- Design of the tanker and oil berth facilities;
- Operating procedures including the tanker discharge safety procedures, safe work permit system for DJT controlled work, wharf operating and safety procedures, restricted wharf access during tanker discharge, security controls to enforce ban on ignition sources at wharf (ie matches, lighters, mobile phones);
- The tanker fire protection system; and
- The fire protection system (fire fighting equipment, fire alarms) installed by the Northern Territory Government during the construction of the wharf.

A potential fire or explosive situation could also occur at the tank farm, loading gantry or drum/package store due to the ignition of hydrocarbon vapours or radiant heat-auto ignition. The risk of such events occurring will be minimised to an acceptable level by:

- The tank farm design that includes a tank foam deluge system, frangible roof joints, a layout that minimises radiant heat effects and the need for fixed cooling water systems, separation from other site facilities, fire resistant valves, tanks bunds to contain the spread of any burning fuel, a drainage system designed to retard migration of fuel vapours or burning fuel, "fail safe" tank outlet shutoff valves, emergency stop shutdown system and fusible loops on pumps that shutdown the system when broken;
- Gantry design that includes a foam deluge system, separation from other site facilities, fire resistant valves, spill containment pads to contain the spread of any burning fuel, gantry spill containment pads connected to interceptor system, drainage lines designed to retard migration of fuel vapours or burning fuel, bottom loading of product, loading vapours vented to a safe distance from the gantry and "fail safe" gantry supply tank outlet shutoff valves;
- The design of the drum/package filling and store area to comply with the fire safety AS1940-1993;

- Operating procedures including a safe work permit system, documented work procedures and controls, training of DJT personnel, gas testing prior to hot work in hazardous areas, security system for controlled site access, no ignition sources in hazardous areas (i.e. matches, lighters, mobile phones);
- Fire protection system installed at the terminal. The system includes break glass fire alarms, alarms connected to emergency services, a 4-hour storage firewater tank, pressurised firewater hydrant system and on-site fire fighting equipment; and
- The fire risk study to be undertaken as part of the front end design.

The risk and hazard analysis demonstrated that there are no events within the terminal site likely to have disastrous repercussions on the neighbouring industries (once established) or the residential areas beyond. Preventative measures for limiting and controlling the consequences of any fire or explosion occurring within the terminal are sufficient to ensure that the risks associated with off-site impacts are acceptable.

It should be noted that the DJT will rationalise the three existing oil company terminals at Frances Bay to the single East Arm location, and that there will be a corresponding rationalisation of risk. There will be benefits such as emergency response and a general reduction in the Darwin community's exposure to risk from fuel storage facilities and operations.

4.2.1.1 Project Risk Management

In order to achieve the desired best risk management outcome for the Project it is imperative that all relevant aspects of health, safety and environment (HSE) are properly considered and quantified for inclusion in the key decision making processes.

Studies will continue to be performed to identify and assess all significant hazards associated with the design, construction and operation of the terminal. The result of this work will be utilised to ensure the design of the facilities minimise the risk to personnel, the asset and the environment.

Hazard identification processes to be used will include:

- **HAZard & Operability Studies (HAZOP):** Major and minor HAZOPs will be performed during the Detailed Engineering Phase of the Project. An independent Chairperson will be provided for the duration of the HAZOP workshops;

- **Design Reviews:** Safety design review workshops will be held to review selected design operability and construction aspects; and

- **Hazard Identification:** Hazards for both the construction and operation phases of the terminal will be identified, including hazards recognised during design reviews and changes.

Prior to commissioning, an Emergency Response Plan will be prepared that addresses issues relating to the accidental release of hydrocarbon vapours, accidental spillage of hydrocarbon products, fires and explosions. Terminal employees will be trained in the Emergency Response Plan.

Hazardous materials management procedures will be developed, introduced and maintained to the satisfaction of the DLPE.

An Occupational Health and Safety programme will be developed prior to commissioning with all terminal employees trained in the procedures, to the satisfaction of the DLPE.

Commitment:

Significant hazards associated with the construction and operation of the terminal will be identified and management controls incorporated in facility design and for construction and operation.

An Emergency Response Plan will be prepared that addresses issues relating to the accidental release of hydrocarbon vapours, accidental spillage of hydrocarbon products, fires and explosions. Terminal employees will be trained in the Emergency Response Plan.

Hazardous materials management procedures will be developed, introduced and maintained to the satisfaction of the DLPE.

An Occupational Health and Safety programme will be developed prior to commissioning with all terminal employees trained in the procedures.

4.2.2 Surface Runoff

The proposal would increase stormwater run-off due to the increase in sealed surfaces within the terminal area. This surface runoff will potentially contain contaminants that may include petroleum hydrocarbons resulting from on-site spillages and runoff during heavy rainfall events. The off-site discharge of surface drainage could act as a vector for the movement of contaminants from the terminal into the broader environment such as the mangal area to the west of the site.

The drainage system proposed for the terminal is described in **Section 2.4.8**. The system will cater for sheet flow conditions, storm flooding and pollution control through the use of a segregated drainage system that incorporates effluent treatment facilities. The underground stormwater design will be based on a 10 year ARI and the overland flow path will be designed for the 50 year ARI case.

The drainage system incorporates a first flush basin with the capacity to hold runoff conservatively determined for a 1 in 10 year storm.

The drainage effluent treatment facilities are designed to handle all drainage from the oily water and clean water systems. Effluent from the treatment facilities will be monitored and discharged as clean water to offsite stormwater drainage system.

Commitment:

The drainage system and treatment facility is to be designed to ensure discharge water meets DLPE requirements.

4.2.3 Spills and Leakages

4.2.3.1 At Berth or Within Harbour

Fuel spills at East Arm Port due to tanker operations may occur as a result of a marine accident such as grounding, hard contact with the berth or tug during manoeuvring or structural failure. Spills may also occur during tanker discharge, or the bunkering of small vessels. Such spills have the potential to impact on marine biota.

Within Darwin Harbour the grounding of a vessel may occur due to passage through an area of restricted navigation or under cyclonic conditions. Navigation simulations are currently being undertaken by the Darwin Port Authority to identify any navigation risks associated with Walker Shoal and the Swing Basin. These simulation runs are expected to confirm that there is no significant navigation issue within East Arm Port.

The East Arm Port will be exposed to tropical cyclones from December through April. In the event of a tropical cyclone warning, tankers alongside the port will be ordered to put to sea. In cyclonic conditions there is always the risk of a ship leaving anchorage being driven ashore in high winds. Should a tanker strand on, or strike a rock outcrop on grounding, it is possible that shell plating may be fractured or the vessel's back could be broken, a situation that could potentially result in a significant release of fuel or oil. However, since the bed of East Arm consists predominantly of soft mud, the likelihood of release of fuel or oil from tanker grounding is negligible.

The penetration or fracture of the shell plating of a tanker's bunker fuel tank during berthing due to a total power failure, a failure of bridge/engine room communication, or the failure of the tug engine control system could result in the immediate release of heavy fuel oil or diesel oil.

Discharge operations of petroleum products will be continuously monitored, however hose, pipeline, valve or communication failure could result in a possible release of distillate. A distillate spill could also occur during bunkering activities as a result of an overflow or communication failure.

Research indicates that the risk of an oil spill in the marine environment is greatest from oil tanker loading and unloading, then from bunkering

operations and finally from shipping accidents (IPIECA, 1991). The potential of oil spilt at East Arm oil berth affecting marine flora and fauna in the harbour would depend on the size of the spill, the type of oil, weather conditions and response time of emergency clean up services.

The type of oil, its persistence and fate characteristics, are also important determinants for assessing marine impact. The hydrocarbon products to be supplied to and stored by the DJT include motor gasolines, aviation fuels, automotive distillate and marine diesel fuels, all of which have moderate to high evaporation rates, and low persistence (one to three days) in the sea. A primary concern surrounding the release of these more volatile gasoline products is the potential for fire and explosion. However, most of these products have high aquatic toxicity and a spill can have a serious impact on marine life, particularly in the intertidal zone. The fuel oils and lube oils actually used by tankers tend to have low evaporative capacity, low solubility in water, high emulsion potential and relatively high persistence (approximately a week) in sediments.

Proper management of port related activities will minimise the potential for marine environmental damage. Management encompasses general port marine traffic and pilotage matters, as well as specific aspects relating to this proposal, such as:

- Oil berth design including spill containment and drainage system;
- Operating procedures such as tanker discharge safety procedures and Wharf operating safety procedures;
- Routine maintenance procedures including regular integrity testing of all hoses; and
- Emergency contingency plans that address oil pollution and spills.

The Marine Division of Transport and Works is responsible for procedures associated with oil pollution matters. In the port of Darwin, the Darwin Port Authority is the responsible Primary Agency which has formulated the Darwin Harbour Oil Spill Contingency Plan. The Plan is a sub-set of the “National Plan to Combat Pollution of the Sea by Oil”. The National Plan is the joint Commonwealth, State/NT, oil and shipping industries plan that lays down the general administrative arrangements, organisational structures, procedures, roles and responsibilities for responding to marine oil spills anywhere in Australian waters.

The Darwin Harbour Oil Spill Contingency Plan will be amended to encompass East Arm operations. Objectives of the plan will be to meet the following in the most cost effective manner:

- Identify the potential sources of spills;
- Ensure an effective notification and reporting system;
- Outline practical and prompt response arrangements to restrict the impact; and
- Remove and dispose of resultant waste.

Commitment:

The proponent will consult with DPA to amend the Darwin Harbour Oil Spill Contingency Plan.

In the event of an oil spill, the Darwin Harbour Oil Spill Contingency Plan would be activated. Responses will vary depending on the location and severity of the spill, however, actions that may be undertaken include:

- The control of the source of pollution;
- The use of containment devices such as booms and skimmers;
- The use of dispersants;
- Beach clean-up; or
- Monitor only.

In relation to immediate oil spill response, the Darwin Port Authority, the Navy, and the oil companies have equipment and supplies on hand in Darwin to deal with the likely operational oil spills.

The National Plan provides for a tiered response strategy and allows for various scales of response and for the transition from one response tier to another. In the event of a spill requiring a response beyond that immediately available in Darwin, the Darwin Port Authority and the Oil Companies are able to resource the necessary additional equipment, supplies and personnel at short notice through the National Plan arrangements. Key parties included in these arrangements and in response are:

- The Australian Maritime Safety Authority;
- Other State Government authorities and port authorities; and
- The oil industry which has the AMOSPlan cooperative arrangements - to which Shell, BP and Mobil are all party; AMOSPlan embraces the oil spill response and training activities of the Australian Marine Oil Spill Centre Pty Ltd (AMOSC), and the company to company mutual assistance arrangements.

4.2.3.2 Wharf/Terminal Pipelines

Failure of the Wharf/Terminal Pipelines may occur as a result of interference by external parties, corrosion, or design/operation/maintenance inadequacies. Depending on the nature of the pipeline failure, the extent of product loss and its location, there is the potential to adversely impact on the soil, the groundwater or the marine environment as described in **sections 4.2.3.1** and **4.2.3.3**.

It should be noted that the Northern Territory Government is responsible for the provision, i.e. the design and construction, of the Wharf/Terminal Pipelines, and the proponent will be responsible for their operation and maintenance.

Key design issues are the route of the Pipelines and whether they are installed above or under ground. The proponent will consult with the Government on the route of the Pipelines, and on their design and construction, having regard to other East Arm developments. During the design phase of the Pipelines, a HAZOP will be carried out and will include the DJT integration and interface issues.

External corrosion is an important design issue, with design allowances, protective coating and cathodic protection requirements being influenced by the pipeline installation (above or under ground) and the resulting exposure to corrosive atmosphere or soils. The products to be handled are not corrosive, and with product to product interfaces during tanker discharge operations, internal corrosion is not a significant issue.

The potential impact by third parties on the Pipelines is important from both a design and operations perspective. Special considerations, some of which are dependent on the pipeline installation, include depth of cover/protection, separation distances from vehicular or rail activities, protective rails, signage including emergency contacts, controlled access or works by third parties, communication with affected parties, right of way conditions, and patrols.

As noted above, the potential impact of a leak depends on the nature of the pipeline failure, the extent of product loss and its location. The extent of product loss also depends on whether a failure occurs during operation when the product is being pumped under pressure. During tanker discharge operations, pipeline patrols will be scheduled. These operational inspections are in addition to the scheduled maintenance inspection and testing programmes which are designed to ensure the integrity of the pipeline system. After discharge and when not in operation, the Pipelines will be secured by closed valves and left resting on AGO; this is in accordance with best practice, avoids internal pipeline corrosion and significantly reduces terminal effluent discharge.

In order to prevent the accidental loss of hydrocarbon from the Wharf/Terminal Pipelines and avoid either spills which impact on the marine environment or seepage of product into the ground which may impact on groundwater, the proponent will:

- Consult with the DLPE, DTW and the nominated design consultant on the route of the Pipelines, and on their design and construction;
- Establish pipeline operating procedures, integrating the tanker discharge and terminal operations;
- Establish a pipeline asset management system, incorporating an inspection and testing programme and maintenance procedures to ensure the integrity of the pipeline system; and
- Establish a pipeline emergency contingency plan that addresses pipeline failure and oil spills.

Commitment:

The proponent will consult with the DLPE and DTW on the route and design and construction of the Wharf/Terminal pipelines.

The proponent will establish an asset management system and an emergency contingency plan for the Wharf/Terminal pipelines.

4.2.3.3 At Terminal Site

During site operations, hydrocarbons and other toxic chemicals may leach into the sub-surface from spills, leaking product lines, fill points and gantry, storage tanks and stored chemicals. Both soil and groundwater may become impacted from site operations.

If a chemical or toxic compound enters the sub-surface, the shallow groundwater and neighbouring marine environment may be come impacted. The shallow groundwater has the potential to provide a pathway for the migration of contaminants from the source into the marine environment.

The DJT will incorporate the following safeguards to contain accidental hydrocarbon spillage or leaks and thereby prevent seepage into the ground:

- Primary containment systems with integrity ensured through design and planned inspection/maintenance;
- Tank foundations to incorporate synthetic liners under each tank floor, with tell-tale drains;
- Tank compound and bund construction;
- Leak-proof drainage systems;
- Surface coatings and cathodic protection for buried pipelines (if buried installation is unavoidable); and
- The provision of an oil recovery system in the drainage and effluent treatment system.

It is proposed to install groundwater monitoring bores up and down the hydraulic gradient of the terminal site. A groundwater monitoring programme will be initiated at the site and corrective action will be taken if unacceptable impacts are identified.

Commitment:

Groundwater quality in the vicinity of the terminal will be monitored and corrective action taken if unacceptable impacts are identified.

4.2.4 Solid Waste Disposal

There will be a small amount of sludge and waste oil generated from the drainage treatment system. It will be recycled where appropriate or disposed to an approved off-site waste disposal site

Naturally Occurring Radioactive Material (NORM) is occasionally found in natural gas, generally associated with condensate. The radioactive material

is radon, an inert, monatomic gas with an atomic weight around 210, which is produced by radioactive decay within source rock.

NORMs are not an issue at Australian oil refineries or terminals in terms of worker exposure or sludge disposal as they are not associated with refined petroleum products. The longest lived radon isotope has a half life of less than 4 days therefore it is highly unlikely for it to survive the refining process and associated time lags, even if present in the original crude oil.

4.2.5 Air Quality

Volatile organic carbon (VOC) emissions will occur to the atmosphere from the storage and handling of fuels.

Evaporative VOC losses from fuel will be generated by the following processes:

- Fuel storage tank breathing and working losses;
- Loading of tankers at the road gantry;
- Filling of drums and other fuel containers (minimal emissions); and
- Fugitive emissions from pipelines and equipment (minimal emissions);

The emission of VOCs was estimated based on the Terminal activity forecast for the year 2006 (design capacity) using the model Tanks 4.03 for Windows by the USEPA (1999), Emission Factor and Inventory Group, Office of Air Quality Planning and Standards. This model has been endorsed by Environment Australia for emission calculations for National Pollutant Inventory (NPI) reporting.

The model estimated VOC emissions in the order of 585 VOC tonnes for the year 2006. The breakdown of emissions from the road gantry and storage tanks for the bulk products, is presented in **Table 4.1**.

Table 4.1: Estimated Emissions of VOCs due to Terminal Operations

SOURCE	VOC EMISSION (Tonnes per annum)
Road Gantry	523.83
Tank AGO 1	1.91
Tank AGO 2	0.63
Tank Avgas	31.88
Tank Jet 1	1.63
Tank Jet 2	0.68
Tank Mogas 1	9.45
Tank Mogas 2 (ULP)	15.13
TOTAL	585.24

VOC emissions from the most volatile Mogas (petrol and unleaded petrol) fuel storage tanks will be minimised by the installation of internal floating covers. These floating covers suppress evaporative fuel VOC losses. The Jet and Avgas tanks will be fitted with pressure/vacuum relief valves that also act to reduce evaporative fuel VOC losses.

A bottom loading gantry will be provided which, together with an automatic load control system, and having regard to the existing three terminal operation, will ensure reduced road gantry emissions as well as improved safety for the road gantry loading activity.

The road gantry will also be designed to allow for future installation of a vapour recovery unit (VRU). A VRU prevents the escape of VOC loading emissions to atmosphere and returns them to fuel storage.

The VOCs emitted by the road gantry and storage tanks should pose minimal environmental effects. The DJT is in an industrial area, not in close proximity to any other significant sources of VOCs and is located in an airshed with minimal photochemical smog issues. VOCs are a contributor to photochemical smog production in highly urbanised areas. For comparison purposes, total emissions from the Kwinana industrial area in Western Australia are approximately 30 times those estimated for the DJT.

Only minimal releases of Greenhouse Gases will occur as a result of terminal operations.

Commitment:

VOC emission reduction technology will be incorporated into the gantry and storage tank design.

4.2.6 Noise

It is anticipated that only minimal noise will be generated by terminal operations and there will be no perceptible impact in any existing residential areas.

Plant and community sound levels will be consistent with good industry practice and government regulations.

Commitment:

Plant and community sound levels will be consistent with good industry practice and government regulations.

4.2.7 Biting Insects

The most effective measure to reduce problems associated with mosquitoes and other biting insects is the consideration of appropriate engineering solutions during the design phase of the project.

Facilities that will have the potential to create new breeding sites include:

- Stormwater drains and final discharge point;
- Bunded areas; and
- Oily water and clean water pits.

Careful attention will be given to the design and maintenance of the drainage systems to avoid the creation of significant habitat areas for mosquito larvae. A suitable grade will be established to ensure that the site is well drained. The wastewater pits will be designed to prevent the establishment of marginal semi-aquatic vegetation that will promote mosquito breeding.

The above design considerations will prevent the creation of new breeding sites for mosquitoes, however, they will not eliminate the potential problem with biting midges. Any potential or real biting insect problems are best mitigated through the education of operators and authorised visitors to the dangers of biting insects and the provision of personal repellent and protective clothing as required.

4.2.8 Traffic

The DJT has been designed for the year 2006 offtakes, and it is anticipated that the maximum number of tankers entering and exiting the terminal per day will be between 50 and 80. The actual number will depend upon demand for fuel and the capacity of the road trains. Given the semi-automatic nature of site operations and the subsequent low workforce, it is expected that motor vehicle trips generated by employees, service vehicles and visitors would be minimal.

The Department of Transport and Works has included the duplication of Berrimah Road on its Forward Works Program. The duplication will include provision for a turning lane of sufficient length to safely accommodate a 55 m long triple road train. Provision will also be made in the design of the access to the terminal to allow a 55 m triple road train to move off Berrimah Road while waiting for authorisation to enter the site.

It is important to emphasise that the terminal will be established in an area set aside for primarily industrial developments around the new port and that all traffic movements will be via the designated arterial roads and road train routes of Berrimah Road, Tiger Brennan Drive and Stuart Highway. Therefore, no heavy vehicle traffic generated by the proposed development would need to travel through residential areas. In fact, the relocation of the Fort Hill Wharf and tank farm activities will significantly reduce oil company road train movements from the city area resulting in traffic safety and residential amenity benefits.

This section outlines the key management control and safeguards that will be initiated by the three oil companies to manage the project's key environmental issues. A summary table of commitments on all major environmental issues is also provided in Section 1.6.

5.1 Environmental Management System

The proposal seeks to establish a Joint User Petroleum Terminal that will use proven, appropriate technology. The primary objectives of the environmental management and monitoring policy are to control environmental impacts to levels within acceptable standards, and minimise possible impact on the community and the workforce of foreseeable risks during the planning, design, construction and subsequent operation phases of the terminal. These objectives will be achieved by a proactive management policy based upon international experience gained from operating similar facilities.

Central to the environmental management approach will be the development and implementation of an Environmental Management System.

The EMS will provide a structured framework to assist the operator of the DJT to proactively manage the environmental impacts to achieve specified environmental performance outcomes. The key elements of the EMS will be:

- Environmental policy;
- Planning;
- Implementation and operation;
- Checking and corrective action;
- Management review; and
- Continual improvement.

The basis of the EMS will be Health Safety and Environmental Management Systems that have been established at the Australian and overseas terminals of the three oil companies.

Environmental management will be integrated with all aspects of the proposal. Environmental issues have been identified at an early stage in project planning enabling project management to ensure that they are addressed, along with other business priorities, in the early screening and design stages. Progress will continue to be periodically reviewed and documentation updated during project design and execution.

For activities identified as potentially harmful to the environment, detailed Environmental Management Plans will be prepared to the three Companies and where appropriate, regulatory agency requirements.

Commitment:

An Environmental Management System will be developed and implemented.

5.2 Environmental Management Plans

The three oil companies recognise that an Environmental Management Plan that details the application of existing management procedures to DJT and reflects existing commitments is required. An Environmental Management Plan (EMP) will be prepared. The EMP will be a separate document that addresses the management of potential impacts defined in the PER through specific environmental objectives, commitments and methods of implementation. The EMP will be structured in two sections, Construction and Operation. The EMP will be prepared after environmental approval for the DJT has been granted, and the sections will be prepared prior to the respective Construction and Operation phases of the project.

The management of potential impacts will focus on the principles of plan, do, check and act in the following ways:

- Prevention – appropriate procedures and safeguards to prevent potential impacts from occurring;
- Detection – adequate monitoring to detect impacts early and initiate remedial action;
- Review – periodic auditing of the procedures and monitoring to check for compliance and to continually improve the environmental management at the site; and
- Reporting – periodic reporting of the environmental compliance and status of the site to senior company representatives.

A management plan will be developed for each potential environmental impact identified within this PER, and will include:

- Objectives;
- Environmental issue;
- Potential impacts and proposed management; and
- Performance Indicators.

An organisational structure indicating roles and responsibilities for all aspects of environmental management and reporting will be provided and updated as required.

Each potential impact will be addressed in the EMP as follows:

- The establishment of environmental objectives;
- Detailed description of the potential impact and its consequences;
- Preventative measures or procedures to minimise occurrence;
- The setting of performance indicators;

- Monitoring methods to be utilised to rapidly detect occurrence; and
- Remedial action and contingency plans in the case of occurrence.

The EMP will be a working document with procedures that personnel on site need to both understand and undertake environmental management. As such, appropriate training will be undertaken to ensure personnel are in a position to adequately manage the environmental issues of the site and effectively monitor for and mitigate impacts.

Commitment

An Environmental Management Plan (EMP) will be prepared once environmental approval for the DJT has been granted. The EMP will comprise two sections - Construction and Operation - to be prepared prior to commencement of the respective project phases.

5.3 Monitoring Programme

In order to ensure that the environmental impacts are kept to an acceptable level, the following monitoring will be undertaken through the total life of the Project. The monitoring programme will be developed in consultation with the Environment Protection Division of the DLPE.

5.3.1 Construction Phase

Dust: Dust emissions will be visually monitored by the construction contractor. Ambient monitoring will be undertaken in response to complaints from neighbouring sites.

Noise: Ambient noise monitoring will be implemented in response to noise complaints from neighbouring development sites.

Acid Sulphate Soil Potential: The acid sulphate potential of the soil at the terminal site will be tested prior to commencement of construction. If potential acid forming soils are identified, site management processes will be developed.

Surface Water Discharge: Regular inspections to DLPE's satisfaction will be made of stormwater diversion and drainage systems and the associated silt traps and steps will be undertaken to ensure that there is no trapped water on site.

Mosquito Breeding Sites: Regular inspections of the construction site for potential mosquito breeding sites will be undertaken.

5.3.2 Operation Phase

Stormwater Discharge: The quality of the stormwater being discharged from site will be monitored to ensure compliance with appropriate standards.

Groundwater: Monitoring bores will be installed within and surrounding areas prone to impact due to site activities. These monitoring bores will serve as monitoring facilities and enable groundwater samples to be collected and analysed for a range of contaminants.

The monitoring bores will be installed:

- Around the perimeter of the terminal site; and at
- A location adjacent to the tank farm.

Groundwater samples will be collected from the monitoring bores at appropriate intervals and analysed for the following parameters by a NATA accredited laboratory:

- Total recoverable hydrocarbons (TPH);
- BTEX compounds;
- Metals barium copper, chromium, cadmium, nickel, lead and zinc;
- Total PAHs; and
- Electrical conductivity and pH.

Depths to groundwater will also be collected during sampling.

Noise: It is unlikely that any ambient noise monitoring will be required during the life of the terminal.

Mosquito Breeding Sites: Regular inspections of the DJT for potential mosquito breeding sites will be undertaken.

The following commitments have been developed by Shell, BP and Mobil to reduce the potential environmental impacts and risk associated with the construction and operation of the DJT.

The proposal seeks to establish a Joint User Petroleum Terminal that will use proven, appropriate technology to minimise environmental impacts from the terminal to an acceptable level. The major potential environmental impacts and risks associated with the project are well categorised and understood, and appropriate management practices will be adopted for the benefit of the community at large.

The proponent has proposed the following commitments (summarised in **Table 1.2**) to ensure the development of an environmentally sound project.

Pre-Construction

A fire risk study will be conducted during the design stage. The scope will include automation of foam deluge on the road gantry, top or bottom foam injection into tanks and provision of fusible shutdown systems.

Samples of soil from the DJT site will be analysed for acid sulphate potential. If potential acid forming soils are identified, then an acid sulphate soil management plan will be implemented.

Significant hazards associated with the construction and operation of the terminal will be identified and management controls incorporated in facility design and for construction and operation.

The drainage system and treatment facility is to be designed to ensure discharge water meets DLPE requirements.

The proponent will consult with the DLPE and DTW on the route and design and construction of the Wharf/Terminal pipelines.

An Environmental Management Plan (EMP) will be prepared once environmental approval for the DJT has been granted. The EMP will comprise two sections - Construction and Operation - to be prepared prior to commencement of the respective project phases.

VOC emission reduction technology will be incorporated into the gantry and storage tank design.

During Construction

All waste materials generated during construction activities will be disposed of in a manner satisfactory to the DLPE.

Appropriate dust control measures, such as the spraying of exposed surfaces with water, will be implemented should dust levels prove to be an issue.

The proponent will adopt good construction practices that will ensure the environmental impact of waste effluents generated on-site during construction will be minimised.

Operation

An Emergency Response Plan will be prepared that addresses issues relating to the accidental release of hydrocarbon vapours, accidental spillage of hydrocarbon products, fires and explosions. Terminal employees will be trained in the Emergency Response Plan.

Hazardous materials management procedures will be developed, introduced and maintained to the satisfaction of the DLPE.

An Occupational Health and Safety programme will be developed prior to commissioning with all terminal employees trained in the procedures.

The proponent will consult with DPA to amend the Darwin Harbour Oil Spill Contingency Plan.

The proponent will establish an asset management system and an emergency contingency plan for the Wharf/Terminal pipelines.

Plant and community sound level limits will be consistent with good industry practice and government regulations.

Groundwater quality in the vicinity of the terminal will be monitored and corrective action taken if unacceptable impacts are identified.

An Environmental Management System will be developed and implemented.

AGO	Automotive Gas Oil
ALARP	As Low As Reasonably Possible
AMOSC	Australian Marine Oil Spill Centre Pty Ltd
AMSA	Australian Maritime Safety Authority
API	American Petroleum Institute
ARI	Australian Rainfall Intensity
AS	Australian Standard
DJT	Darwin Joint Terminal
DLPE	Department of Lands Planning and Environment
DPA	Darwin Port Authority
DTW	Department of Transport and Works
EMP	Environmental Management Plan
EMS	Environmental Management System
ha	Hectares
HAZOP	HAZard and Operability study
IPIECA	International Petroleum Industry Environmental Conservation Association
Ml	Megalitres
Mogas	Motor Gasoline
NORM	Naturally Occurring Radioactive Material
NPI	Nation Pollutant Inventory
PER	Public Environment Report
PV	Pressure Vacuum
RL AHD	Relative Level Australian Height Datum
ULP	Unleaded Petrol
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Carbon
VRU	Vapour Recovery Unit
WHA	Work Health Authority

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Potential Hazard	Potential Consequence(s)	Risk Assessment Matrix Score			Management Control(s) to Minimise Risk
		People	Assets	Environ.	
PRODUCT DELIVERY					
Fire or explosion of tanker at Wharf during delivery of product to Terminal	• Radiant heat or spread of fire- fire or explosion at land backed Wharf facilities. • Equipment failure due to fire or explosion- loss of containment- impact to site soil, groundwater or harbour. • Injury to Wharf or tanker discharge staff.	A4 Low A1 Low A5 Med.	A5 Med. A4 Low -	A4 Low A4 Low -	• Fire protection system- as installed by NT Govt during Wharf construction (ie. fire fighting equipment, fire alarms). • Tanker fire protection system- fire water system, fire fighting equipment. • Operating procedures- tanker discharge safety procedures, safe work permit system for JUT controlled work, Wharf operating and safety procedures, restricted Wharf access during tanker discharge, security controls to enforce ban on ignition sources at Wharf (ie. matches, lighters, mobile phones). • Emergency response plans- harbour oil spill response.
Corrosion of Wharf-Terminal delivery line	• Corrosion hole- loss of containment- hydrocarbon impact to off-site soil, groundwater or harbour.	C1 Low	C4 Med.	C3 Med.	• Maintenance- inspections as per AS1940-1993 and regulatory requirements, recoating of paint surface, pipeline pressure testing, cathodic protection systems testing. • Leak detection systems- stock control reconciliation after product receipts. • Pipeline design- design and construction standards. • Anti corrosion controls- painting pipe surfaces, cathodic protection systems, wrapping, pipeline trench backfill material. • Emergency response plans- harbour oil spill response.
Physical damage of Wharf-Terminal delivery line	• Loss of containment- hydrocarbon impact to off-site soil, groundwater or harbour.	B1 Low	B4 Med.	B3 Low	• Pipeline design- protection to design against collision with vehicular or shipping traffic, pipeline warning signage, notification to JUT operator prior to site works or excavation in pipeline vicinity.

Potential Hazard	Potential Consequence(s)	Risk Assessment Matrix Score			Management Control(s) to Minimise Risk
		People	Assets	Environ.	
PRODUCT DELIVERY					
Failure of flexible tanker delivery hoses (connect tanker to Wharf-Terminal delivery line)	• Loss of containment- hydrocarbon impact to harbour. • Injury to Wharf or tanker discharge staff.	C1 Low C4 Med.	C4 Med. -	C2 Low -	• Hose design- hose specifications to meet tanker pumping pressures. • Maintenance- routine hose pressure testing and integrity measurements. • Operating procedures- constant communication (UHF ship-shore radios) with tanker to shut down product pumping if required, no discharge during storm events, allowance for high wind load effects on hoses during tanker discharges. • Emergency response plans- harbour oil spill response.
Tanker equipment failure (ie. ballast water valves, physical damage)	• Loss of containment- hydrocarbon impact to off-site soil, groundwater or harbour.	C1 Low	C4 Med.	C4 Med.	• Maintenance- inspection and testing of tanker equipment. • Operating procedures- tanker operations carried out by trained tanker and shore based personnel. • Emergency response plans- harbour oil spill response.
Tanker hitting Wharf during mooring	• Physical damage to Wharf structure. • Tanker equipment failure or damage- loss of containment- hydrocarbon impact to off-site soil, groundwater or harbour. • Injury to Wharf or tanker discharge staff.	- C1 Low A4 Low	C3 Med. C4 Med. -	- C4 Med. -	• Operating procedures- Minimum safety distances of shore based personnel from Wharf face during mooring, tanker mooring carried out and guided by appropriate Port Authority and tanker personnel (ie. tug boat, Harbour pilots). • Emergency response plans- harbour oil spill response.
Static electricity	• Ignition of hydrocarbon vapours- fire or explosion aboard tanker and or on Wharf.	A5 Med.	A5 Med.	A4 Low	• Tanker design-fibre ropes for manual tank dipping and sampling equipment, bonding and 'earthing' of onboard tanks and pipelines. • Operating procedures—drainings of product into earthed, metal containers only.
Lightning	• Ignition of hydrocarbon vapours- fire or explosion aboard tanker or on Wharf.	A5 Med.	A5 Med.	A4 Low	Operating procedures- no receipt of tanker product during electrical storms.

Potential Hazard	Potential Consequence(s)	Risk Assessment Matrix Score			Management Control(s) to Minimise Risk
		People	Assets	Environ.	
PRODUCT DELIVERY					
Electrical equipment	• Spark due to electrics- ignition of hydrocarbon vapours- fire or explosion aboard tanker or on Wharf.	A5 Med.	A5 Med.	A4 Low	• Facility design- all electrical equipment located in hazardous areas (Wharf and onboard tanker) to be hazardous area rated. • Maintenance- inspection and testing of electrical equipment, safe work permit as per AS1940-1993 for all JUT controlled work on electrical equipment, use of maintenance staff trained in hazardous area electrics as required, isolation and tagging procedures.

Potential Hazard	Potential Consequence(s)	Risk Assessment Matrix Score			Management Control(s) to Minimise Risk
		People	Assets	Environ.	
TANK FARM					
Fire or explosion in Tank Farm	• Radiant heat- auto ignition of other JUT tanks- fire or explosion. • Radiant heat or spread of fire- fire or explosion at neighbouring facilities. • Equipment failure due to fire or explosion- loss of containment- impact to site soil and groundwater. • Injury to JUT staff. • Injury to neighbouring facility staff.	C4 Med. B3 Low C0 Low B4 Med. A3 Low	C4 Med. B4 Med. C3 Med. - -	C3 Med. B3 Low C3 Med. - -	• Fire protection system- break glass fire alarms, alarms connected to emergency services, 4 hours storage firewater tank, firewater, pump, pressurised firewater hydrant system, on-site fire fighting equipment. • Tank Farm design- tank foam deluge system, frangible roof joints, tank layout minimises radiant heat effects and need for fixed cooling water system, separation from other site facilities, fire resistant valves, tank bunds to contain spread of any burning fuel, drainage system designed to retard migration of fuel vapours or burning fuel, 'fail safe' tank outlet shutoff valves, emergency stop shutdown system, fusible loops on pumps that shutdown system when broken. • Operating procedures- safe work permit system, documented work procedures and controls, training of JUT personnel, gas testing prior to hot work in hazardous areas, security system for controlled site access, no ignition sources in hazardous areas (ie. matches, lighters, mobile phones). • Fire risk study- to be carried out as part of front end design.
Fire or explosion at neighbouring facility	• Radiant heat- auto ignition of JUT tanks- fire or explosion. • Ignition of hydrocarbon vapours in JUT tank farm- fire or explosion at JUT Tank Farm. • Injury to JUT staff.	A4 Low A4 Low A3 Low	A4 Low A4 Low -	A3 Low A3 Low -	• Fire protection system- break glass fire alarms, alarms connected to emergency services, 4 hours storage firewater tank, firewater, pump, pressurised firewater hydrant system, on-site fire fighting equipment. • Tank Farm design- tank foam deluge system, frangible roof joints, tank layout minimises radiant heat effects and need for fixed cooling water

Potential Hazard	Potential Consequence(s)	Risk Assessment Matrix Score			Management Control(s) to Minimise Risk
		People	Assets	Environ.	
TANK FARM					
					• system, separation from neighbouring facilities and their boundaries, fire resistant valves, tank bunds to contain spread of any burning fuel, drainage system designed to retard migration of fuel vapours or burning fuel, 'fail safe' tank outlet shutoff valves, emergency stop shutdown system, fusible loops on pumps that shutdown system when broken. • Fire risk study- to be carried out as part of front end design.
Corrosion of tanks or pipelines (ie. tank floors, underground lines)	• Corrosion hole- loss of containment- hydrocarbon impact of site soil and groundwater.	D0 Low	D3 Med.	D3 Med.	• Maintenance- tank inspections as per AS1940-1993 and regulatory requirements, recoating of paint/epoxy linings, pipeline pressure testing, cathodic protection systems testing. • Leak detection systems- stock control reconciliation, auto tank gauging system leak alarms, groundwater monitoring wells. • Tank and pipeline design- to API-650, tank floorplates laid on built up base, appropriate pipe support design, impermeable liner beneath tank floorplate 'tell tale' pipes beneath tank foundations to detect floorplate leakage, tank compound bunds as per AS1940-1993 to containment product spillage, bund floor permeability of no more than 1x10E-7 m/s. • Anti corrosion controls- epoxy lining of Jet, Avgas and Mogas tank floors and first strake, painting treatment of tank and pipe surfaces, cathodic protection systems.

Potential Hazard	Potential Consequence(s)	Risk Assessment Matrix Score			Management Control(s) to Minimise Risk
		People	Assets	Environ.	
TANK FARM					
Pressurisation of tanks and pipelines	• Tank or pipe rupture- loss of containment- hydrocarbon impact of site soil and groundwater.	C1 Low	C3 Med.	C2 Low	• Tank and pipeline design- pressure vacuum vents or free vents on tanks, frangible roof joints, vacuum breaker on internal floating covers, surge control equipment, thermal relief systems. • Maintenance- inspection and testing of vents, internal floating covers, thermal relief valves. • Operating procedures- monitoring of tank pressures during product delivery.
Overfilling of tanks	• Loss of containment- hydrocarbon impact of site soil and groundwater.	C1 Low	C3 Med.	C2 Low	• Tank design- auto tank level gauging, auto tank gauging alarms, independent tank high level alarms with automatic shutdown control, back manual tank dip tape. • Compound design- tank compound bunds as per AS1940-1993 to containment product spillage, bund floor permeability of no more than 1x10E-7 m/s. • Operating procedures- supervision of tank filling by appropriately trained staff, monitoring of auto tank gouging displays.
Maintenance activities	• Unintentional equipment damage to tanks or pipelines- loss of containment- impact of site soil or groundwater. • Unintentional introduction of a source of ignition- fire or explosion.	C1 Low C4 Med.	C3 Med. C4 Med.	C2 Low C3 Med.	• Operating procedures- safe work permit system as per AS1940-1993, documented maintenance procedures and controls, training of maintenance staff, gas testing prior to hot work in hazardous areas, supervision of maintenance activities by JUT staff, use of hazardous area rated electrical tools in hazardous areas, security entry procedures to enforce ban on ignition sources on site (ie. matches, lighters, mobile phones).

Potential Hazard	Potential Consequence(s)	Risk Assessment Matrix Score			Management Control(s) to Minimise Risk
		People	Assets	Environ.	
TANK FARM					
Lightning strike	• Ignition of hydrocarbon vapours- fire or explosion.	A4 Low	A4 Low	A3 Low	• Tank design- earthing cables and stakes to 'earth' lightning strikes, internal floating covers or PV vents. • Operating procedures- no filling of tanks during electrical storms, no access to tanks during electrical storms.
Static electricity	• Ignition of hydrocarbon vapours- fire or explosion.	C4 Med.	C4 Med.	C3 Med.	• Tank and pipeline design- natural fibre ropes for manual tank dipping and sampling equipment, floating suctions for tank product withdrawal bonded to tank roof and shell, bonding and 'earthing' of tanks and pipelines. • Operating procedures- controlled initial flow rates into tank, no 'jetting' of product into tank and no product circulation when product levels are low, 'relaxation time' after product delivery before manual dipping or sampling, addition of ant-static additive to tank product if required. • Maintenance- draining of product into earthed, metal containers only.
Electrical equipment	• Spark due to electrics - ignition of hydrocarbon vapours- fire or explosion.	B4 Med.	B4 Med.	B3 Low	• Facility design- all electrical equipment (ie. pump motors, junction boxes, tank gauging, high level alarms) located in hazardous areas to be hazardous area rated, segregation of 240V and hazardous area rated electrics. • Maintenance- inspection and testing of electrical equipment, safe work permit as per AS1940-1993 for all work on electrical equipment, use of maintenance staff trained in hazardous area electrics as required, isolation and tagging procedures.

Potential Hazard	Potential Consequence(s)	Risk Assessment Matrix Score			Management Control(s) to Minimise Risk
		People	Assets	Environ.	
TANK FARM					
Hot work (ie. welding, naked flames)	• Ignition of hydrocarbon vapours- fire or explosion.	C4 Med.	C4 Med.	C2 Low	• Operating procedures- safe work permit system as per AS1940-1993 for all hot work, gas testing prior to hot work in hazardous areas, supervision of hot work by JUT staff, security procedures to enforce ban on ignition sources on site (ie. matches, lighters, mobile phones), fire fighting equipment at ready (ie. fire hoses) or additional fire fighting equipment imported to site during hot work (ie. extra fire extinguishers).
Hazardous waste disposal (ie. tank sludges)	• Consequences of inappropriate disposal dependent upon disposal location- impact of soil, groundwater, water bodies- vegetation damage- human and animal health effects.	C2 Low	C3 Med.	C3 Med.	• Operating procedures- hazardous waste disposal to be in accordance with DLPE and NT Health requirements, use of waste disposal contractors accredited by JUT operator, DLPE and NT Health, minimisation of hazardous waste generation during operation and maintenance (ie. slops recycling on site, low water usage tank cleaning methods).
Floating cover failure	• Loss of VOCs to atmosphere.	C1 Low	C2 Low	C3 Med.	• Maintenance- inspection and testing of internal floating covers and pressure/vacuum vents, 'landing' of floating covers to tank floor and floating cover recommissioning only under JUT staff supervision.
Tank water draining	• Valve failure or operator error could lead to a loss of containment – impact of site soil and groundwater.	C0 Low	C3 Med.	C2 Low	• Water drain design – two valves on tank water drain outlet as 'fail safe' mechanism, drain end capped when not in use. • Operating procedures – tank water draining only carried out under constant supervision of trained staff, communication maintained with control room (ie. UHF radio) during water draining, water drain valves padlocked closed when not in use. • Drainage system – water drainings diverted via hard piping to interceptor for quick flush tanks.

Potential Hazard	Potential Consequence(s)	Risk Assessment Matrix Score			Management Control(s) to Minimise Risk
		People	Assets	Environ.	
TANK FARM					
Tank gauge failure	• Overfilling of tank- impact of site soil and groundwater.	C1 Low	C3 Med.	C2 Low	• Tank design- independent tank high level alarms (with automatic shutdown control) as back up for auto tank gauging, manual tank dip tape as back up, alarms upon failure of auto tank gauging system. • Maintenance- inspection and testing of auto tank gauging system.
Sabotage	• Equipment damage to tanks or pipelines- loss of containment- impact of site soil or groundwater. • Introduction of a source of ignition- fire or explosion.	A0 Low A4 Low	A3 Low A4 Low	A2 Low A3 Low	• Facility design- security fencing and lighting, security system controlled access to site. • Operating procedures- security patrols as required, security entry procedures to enforce ban on ignition sources on site (ie. matches, lighters, mobile phones).
Earthquake	• Equipment damage to tanks or pipelines- loss of containment- impact of site soil or groundwater.	A0 Low	A3 Low	A2 Low	• Facility design- to AS1170.4 for earthquake loads. • Compound design- tank compound bunds as per AS1940-1993 to containment product spillage, bund floor permeability of no more than 1x10E-7 m/s.
Cyclone	• Equipment damage to tanks or pipelines- loss of containment- impact of site soil or groundwater.	B0 Low	B3 Low	B2 Low	• Facility design- to AS1170.2 for wind loads, site levels and bund walls designed to protect against 1:10,000 yr storm surge. • Compound design- tank compound bunds as per AS1940-1993 to containment product spillage, bund floor permeability of no more than 1x10E-7 m/s. • Operating procedures- no filling of tanks or tank farm operations during a cyclone; maintenance of minimum stock for tank stability. • Emergency response plans- site preparations and cyclone response included.

Potential Hazard	Potential Consequence(s)	Risk Assessment Matrix Score			Management Control(s) to Minimise Risk
		People	Assets	Environ.	
TANK FARM					
Aircraft strike	• Equipment damage to tanks or pipelines- loss of containment- impact of site soil or groundwater. • Introduction of a source of ignition- fire or explosion.	A0 Low A4 Low	A3 Low A4 Low	A2 Low A3 Low	• Site location- not in immediate vicinity of airports. • Compound design- tank compound bunds as per AS1940-1993 to containment product spillage, bund floor permeability of no more than 1x10E-7 m/s. • Fire protection system- break glass fire alarms, alarms connected to emergency services, 4 hours storage firewater tank, firewater, pump, pressurised firewater hydrant system, on-site fire fighting equipment.

Potential Hazard	Potential Consequence(s)	Risk Assessment Matrix Score			Management Control(s) to Minimise Risk
		People	Assets	Environ.	
PRODUCT LOADING					
Fire or explosion at road gantry	Radiant heat or spread of fire- fire or explosion at other gantry bays or close tanker vehicles. Equipment failure due to fire or explosion- loss of containment.	C4 Med. C1 Low	C4 Med. C3 Med.	C3 Med. C3 Med.	• Fire protection system- break glass fire alarms, alarms connected to emergency services, 4 hours storage firewater tank, firewater, pump, pressurised firewater hydrant system, on-site fire fighting equipment. • Gantry design- foam deluge system, separation from other site facilities, fire resistant valves, spill containment pads to contain spread of any burning fuel, gantry spill containment pads connected to interceptor system, drainage lines designed to retard migration of fuel vapours or burning fuel, bottom loading of product, loading vapours vented a safe distance from gantry, 'fail safe' gantry supply tank outlet shut off valves. • Operating procedures- unattended tanker vehicles not parked at gantry, security ban enforced on ignition sources at gantry (ie. matches, lighters, mobile phones), safe work permit system. • Fire risk study- to be carried out as part of front end design.
Overfilling of vehicle tank	Loss of containment.	D1 Low	D1 Low	D1 Low	• Gantry design- gantry spill containment pads connected to interceptor system, tanker vehicle high level shutdown system, metered loading, pre-setting of product load volumes via gantry control system, '3 minute button alarm' system requiring regular driver activation product loading, emergency stop system to shutdown loading, 'fail safe' gantry supply tank outlet shut off valves.

Potential Hazard	Potential Consequence(s)	Risk Assessment Matrix Score			Management Control(s) to Minimise Risk
		People	Assets	Environ.	
PRODUCT LOADING					
	•				• Operating procedures- constant driver attendance during vehicle loading, drivers trained in spill response/cleaner and loading procedures, JUT operator accreditation of tanker vehicles and driver training. • Emergency response- spill containment equipment provided at gantry for spill containment and/or clean up.
Pressurisation of vehicle tank compartments	• Compartment rupture- loss of containment.	C1 Low	C1 Low	C1 Low	• Vehicle tank design- vapour and emergency vents on tanker vehicles, vents designed for appropriate filling flow rates. • Gantry design- controlled filling flow rates, gantry spill containment pads connected to interceptor system. • Operating procedures- accreditation of tanker vehicles by AIP, regulatory authorities and or JUT operator prior to loading at gantry. • Maintenance- inspection and testing of tanker vehicle vapour vents.
Pressurisation of gantry pipework	• Pipe rupture- loss of containment.	C1 Low	C1 Low	C1 Low	• Gantry design- thermal relief systems on pipelines, surge control equipment (ie. alleviators, valve controls) as required, gantry spill containment pads connected to interceptor system. • Maintenance- inspection and testing of thermal relief valves and surge control equipment. • Operating procedures- monitoring of tank pressures during product delivery, training.

Potential Hazard	Potential Consequence(s)	Risk Assessment Matrix Score			Management Control(s) to Minimise Risk
		People	Assets	Environ.	
PRODUCT LOADING					
Failure of product delivery arms	• Arm rupture- loss of containment.	C1 Low	C1 Low	C1 Low	• Gantry design- loading arms and hoses designed for filling flow rates and operating pressures, gantry spill containment pads connected to interceptor system, drive-away protection bar fitted to tanker vehicle inlets. • Maintenance- inspection and testing of gantry loading arms. • Operating procedures- monitoring of tanker vehicle pressures during product delivery.
Corrosion of gantry pipework	• Corrosion hole- loss of containment.	B0 Low	B1 Low	B1 Low	• Maintenance- recoating of paint surfaces, pipeline pressure testing, cathodic protection systems testing. • Gantry design- appropriate pipe support design, gantry spill containment pads connected to interceptor system. • Anti corrosion controls- painting of pipe surfaces, cathodic protection systems for underground pipework (as required).
Lightning	• Ignition of hydrocarbon vapours- fire or explosion at gantry.	A4 Low	A4 Low	A3 Low	• Gantry design- gantry structure and pipework 'earthed', flame arrestor fitted to vapour discharge vent. • Operating procedures- no loading during electrical storms.
Earthquake	• Equipment damage to gantry or pipelines- loss of containment.	A1 Low	A1 Low	A1 Low	• Gantry design- to AS1170.4 for earthquake loads, gantry spill containment pads connected to interceptor system.

Potential Hazard	Potential Consequence(s)	Risk Assessment Matrix Score			Management Control(s) to Minimise Risk
		People	Assets	Environ.	
PRODUCT LOADING					
Cyclone	• Equipment damage to gantry or pipelines- loss of containment.	A1 Low	A1 Low	A1 Low	• Gantry design- to AS1170.2 for wind loads, site levels designed to protect against 1:700 yr storm surge. • gantry spill containment pads connected to interceptor system. • Operating procedures- no gantry loading during a cyclone. • Emergency response plans- site preparations and cyclone response included.
Static electricity	• Ignition of hydrocarbon vapours- fire or explosion at gantry.	C4 Med.	C4 Med.	C3 Med.	• Gantry design- bonding strap between gantry and tanker vehicle connected prior to loading, secondary continuity through tanker vehicle high level shutdown system. • Operating procedures- controlled filling flow rates into tanker vehicles, bottom loading of product. • Maintenance- continuity testing of any hoses used in loading or furl transfer, inspection and continuity testing of bonding straps.
Electrical equipment	• Ignition of hydrocarbon vapours- fire or explosion at gantry.	A4 Low	A4 Low	A3 Low	• Gantry design- all electrical equipment located in hazardous areas to be hazardous area rated, segregation of 240V and hazardous area rated electrics. • Operating procedures- drivers trained and security measures enforced to ensure no vehicle maintenance in the gantry, vehicle air conditioners, two way radios and mobile phones turned off, no ignition sources such as matches, lighters and cigarettes in the gantry.

Potential Hazard	Potential Consequence(s)	Risk Assessment Matrix Score			Management Control(s) to Minimise Risk
		People	Assets	Environ.	
PRODUCT LOADING					
					• Maintenance- inspection and testing of electrical equipment, safe work permit as per AS1940-1993 for all work on electrical equipment, use of maintenance staff trained in hazardous area electrics as required, isolation and tagging procedures.
Maintenance activities	• Unintentional equipment damage to gantry or pipelines- loss of containment. • Unintentional introduction of a source of ignition- fire or explosion at gantry.	C1 Low A4 Low	C1 Low A4 Low	C1 Low A3 Low	• Operating procedures- safe work permit system as per AS1940-1993, documented maintenance procedures and controls, training of maintenance staff, gas testing prior to hot work in hazardous areas, supervision of maintenance activities by JUT staff, use of hazardous area rated electrical tools in hazardous areas, security entry procedures to enforce ban on ignition sources at gantry (ie. matches, lighters, mobile phones).
Hot work (ie. welding, naked flames)	• Ignition of hydrocarbon vapours- fire or explosion at gantry.	A4 Low	A4 Low	A3 Low	• Operating procedures- safe work permit system as per AS1940-1993 for all hot work, gas testing prior to hot work in hazardous areas, supervision of hot work by JUT staff, security procedures to enforce ban on ignition sources at gantry (ie. matches, lighters, mobile phones), fire fighting equipment at ready (ie. fire hoses) or additional fire fighting equipment imported to site during hot work (ie. extra fire extinguishers), no gantry loading during hot work.

Potential Hazard	Potential Consequence(s)	Risk Assessment Matrix Score			Management Control(s) to Minimise Risk
		People	Assets	Environ.	
PACKED PRODUCT					
Fire or explosion during drum/package filling	• Radiant heat or spread of fire- fire or explosion at other site facilities or close vehicles. • Drum/package rupture due to fire or explosion- loss of containment. • Injury to drum/package filling and other JUT staff.	A4 Low A1 Low A4 Low	A3 Low A1 Low -	A3 Low A1 Low -	• Fire protection system- break glass fire alarms, alarms connected to emergency services, 4 hours storage firewater tank, firewater, pump, pressurised firewater hydrant system, on-site fire fighting equipment. • Drum/package filling design- area to comply with the fire safety AS1940-1993 requirements, bonding of drum/packages and filling equipment. • Operating procedures- security enforced bans on ignition sources in the filling area and store (ie. matches, lighters, mobile phones), safe work permit system. • Fire risk study- to be carried out as part of front end design.
Fire or explosion in drum/package store	• Radiant heat or spread of fire- fire or explosion at other site facilities or close vehicles. • Drum/package rupture due to fire or explosion- loss of containment. • Injury to drum/package filling and other JUT staff.	C4 Med. C1 Low A4 Low	C3 Med. C1 Low -	C3 Med. C1 Low -	• Fire protection system- break glass fire alarms, alarms connected to emergency services, 4 hours storage firewater tank, firewater, pump, pressurised firewater hydrant system, on-site fire fighting equipment. • Drum/package filling store design- area to comply with the fire safety AS1940-1993 requirements, 'earthing' of store structure. • Fire risk study- to be carried out as part of front end design.
Overfilling of drums/packages	• Loss of containment.	C1 Low	C1 Low	C1 Low	• Drum/package filling area design- pre-set meters for filling, overfill protection controls on filling equipment as required, spill containment in filling area. • Emergency response- spill containment equipment provided close to filling area for spill containment and/or clean up.

Potential Hazard	Potential Consequence(s)	Risk Assessment Matrix Score			Management Control(s) to Minimise Risk
		People	Assets	Environ.	
PACKED PRODUCT					
Drum/package rupture inside drum/package store	• Loss of containment.	D1 Low	D1 Low	D1 Low	• Drum/package store design- spill containment in store as per AS1940-1993, store layout and forklift access ways designed to minimise risk of collision with drum/packages. • Operating procedures- restrictions on drum/package storage heights, forklift driver and store personnel training, forklift operating procedures. • Emergency response- spill containment equipment provided close to or in store for spill containment and/or clean up.
Drum/package rupture in Terminal yard	• Loss of containment.	D1 Low	D1 Low	D1 Low	• Yard design- low permeability concrete yard cover. • Operating procedures- forklift driver and store personnel training, forklift operating procedures. • Emergency response- spill containment equipment provided close to store and for yard use in spill containment and/or clean up.
Forklifts	• Source of ignition- Ignition of hydrocarbon vapours- fire or explosion.	A4 Low	A3 Low	A3 Low	• Forklift design- electrical components and motor rated for use in a hazardous area (ie. inside drum/package store).
Static electricity	• Ignition of hydrocarbon vapours- fire or explosion.	A4 Low	A3 Low	A3 Low	• Drum/package filling area and store design- bonding between drum/packages during filling, 'earthing' of store. • Maintenance- draining of product into earthed, metal containers only, inspection and continuity testing of bonding straps and equipment.

Potential Hazard	Potential Consequence(s)	Risk Assessment Matrix Score			Management Control(s) to Minimise Risk
		People	Assets	Environ.	
PACKED PRODUCT					
Electrical equipment	• Ignition of hydrocarbon vapours- fire or explosion.	A4 Low	A3 Low	A3 Low	• Drum/package filling area and store design - all electrical equipment (including forklifts) located in hazardous areas to be hazardous area rated, segregation of 240V and hazardous area rated electrics. • Maintenance- inspection and testing of electrical equipment, safe work permit as per AS1940-1993 for all work on electrical equipment, use of maintenance staff trained in hazardous area electrics as required, isolation and tagging procedures.
Hot work (ie. welding, naked flames)	• Ignition of hydrocarbon vapours- fire or explosion.	A4 Low	A3 Low	A3 Low	• Operating procedures- safe work permit system as per AS1940-1993 for all hot work, gas testing prior to hot work in hazardous areas, supervision of hot work by JUT staff, security procedures to enforce ban on ignition sources in store and filling area (ie. matches, lighters, mobile phones), fire fighting equipment at ready (ie. fire hoses) or additional fire fighting equipment imported to site during hot work (ie. extra fire extinguishers), no drum/package filling during hot work.
Sabotage	• Damage to drums/packages- loss of containment. • Introduction of a source of ignition- fire or explosion.	C1 Low C4 Med.	C1 Low C3 Med.	C1 Low C3 Med.	• Facility design- security fencing and lighting, controlled and monitored security access to site. • Operating procedures- security patrols as required, security entry procedures to enforce ban on ignition sources on site (ie. matches, lighters, mobile phones).

Potential Hazard	Potential Consequence(s)	Risk Assessment Matrix Score			Management Control(s) to Minimise Risk
		People	Assets	Environ.	
PACKED PRODUCT					
Lightning	• Ignition of hydrocarbon vapours- fire or explosion.	A4 Low	A3 Low	A3 Low	• Drum/package filling area and store design- store structure 'earthed', electrical bonding between filling devices and drum/packages. • Operating procedures- no drum/package filling during electrical storms.
Earthquake	• Damage to drums/packages- loss of containment.	A1 Low	A1 Low	A1 Low	• Drum/package filling area and store design- to AS1170.4 for earthquake loads, filling area and store spill containment to AS1940-1993, low permeability concrete paving. • Emergency response- spill containment equipment provided close to store and for yard use in spill containment and/or clean up.
Cyclone	• Damage to drums/packages- loss of containment. • Damage to the facilities/DJT personnel.	A1 Low C3 Med	A1 Low C2 Low	A1 Low C1 Low	• Drum/package filling area and store design- to AS1170.2 for wind loads, site levels designed to protect against 1:700yr storm surge, filling area and store spill containment to AS1940-1993, low permeability concrete paving. • Operating procedures- no drum/package filling during a cyclone; drum storage controls. • Emergency response plans- site preparations and cyclone response included, spill containment equipment provided close to store and for yard use in spill containment and/or clean up.

Potential Hazard	Potential Consequence(s)	Risk Assessment Matrix Score			Management Control(s) to Minimise Risk
		People	Assets	Environ.	
PACKED PRODUCT					
Aircraft strike	• Damage to drums/packages- loss of containment. • Introduction of a source of ignition- fire or explosion.	A1 Low A4 Low	A1 Low A3 Low	A1 Low A3 Low	• Site location- not in immediate vicinity of airports. • Drum/package filling area and store design- low permeability concrete paving, spill containment in store and filling area to AS1940-1993. • Fire protection system- break glass fire alarms, alarms connected to emergency services, 4 hours storage firewater tank, firewater, pump, pressurised firewater hydrant system, on-site fire fighting equipment, compliance with the fire safety AS1940-1993 requirements.

Potential Hazard	Potential Consequence(s)	Risk Assessment Matrix Score			Management Control(s) to Minimise Risk
		People	Assets	Environ.	
DRAINAGE AND INTERCEPTOR SYSTEM					
Interceptor failure	• Loss of containment- off-site migration of hydrocarbon impacted water or product to harbour.	C1 Low	C4 Med.	C4 Med.	• Interceptor system design- designed to handle 10yr ARI (underground) and 50yr ARI (overland) storms, isolation valve on system outlet line to harbour, segregation of oily and clean water streams to avoid interceptor overload, cleaner bottom water from oily water pits diverted during system overflow conditions. • Operating procedures- regular removal (ie. skimming) of product from oil water pit, regular tank compound water draining procedures. • Maintenance- inspection, testing and regular cleaning of interceptor unit and associated equipment (ie. pump, float switch, system valves). • Emergency response- harbour spill response plans.
Oily water entering the clean water drainage system	• Loss of containment- off-site migration of hydrocarbon impacted water or product to harbour.	C1 Low	C4 Med.	C4 Med.	• Interceptor system design- segregated oily and water systems, capability to treat clean water before off-site disposal if impacted with oily water, isolation valve on system outlet line to harbour, cleaner bottom water from oily water pits diverted during system overflow conditions. • Emergency response- harbour spill response plans, spill containment and clean up at on-site spill source.
Drainage pipeline failure	• Loss of containment- hydrocarbon impact of site soil and groundwater. • Migration of hydrocarbon vapours through drainage system- fire or explosion of vapours due to ignition source.	C0 Low C4 Med.	C3 Med. C4 Med.	C2 Low C3 Med.	• Drainage pipelines design- pipelines anti-corrosion treated as required (ie. paint coating, galvanising, wrapping). • Leak detection systems- groundwater monitoring wells. • Maintenance- regular cleaning and product removal from pipelines and pits, integrity testing of drainage pipelines (ie. hydrotesting and leak monitoring).