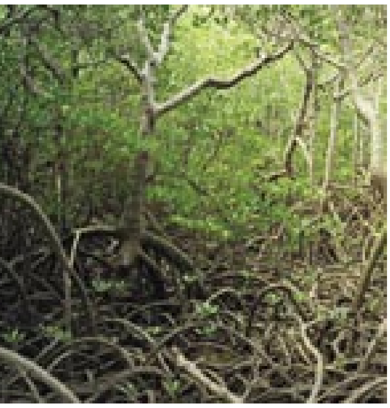
Section 11

Marine Impacts, Preventative & Management Measures

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11. Marine Impacts, Preventative & Management Measures

11.1 Introduction

This section provides a description and assessment of the relevant marine environmental impacts that may potentially occur as a result of the Blacktip Project and presents and discusses the associated preventative and management measures that will be implemented.

This impact assessment covers those activities described in **Section 4**, which broadly comprises:

- Drilling and operation of up to six platform wells connected to an unmanned wellhead platform.
- Construction and operation of 107.5 km subsea export pipeline to transport reservoir fluids from the wellhead platform to shore.
- Treatment of PW to remove free oil and contaminants, and discharge of the treated PW to sea through a pipeline.
- Stabilisation of condensate onshore and export through an offshore pipeline to a condensate export mooring, located 4.5 km offshore, where it will be loaded onto tankers approximately four times per annum.

The majority of potential impacts on the marine environment identified through the assessment process can be categorised as having no adverse long term impact on the environment and can be managed through the implementation of routine management procedures and safeguards.

The only impacts identified through the assessment process as having a higher level of potential impact, and thus requiring detailed assessment are:

- beach disturbance due to the potential for impact on a small number of nesting and hatchling turtles;
- small hydrocarbon spills.

With the implementation of appropriate management measures and safeguards none of the project activities are likely to result in unacceptable long term negative impacts on the local marine environment.

In support of the overall assessment approach and to meet the Draft EIS Guidelines requirements, all of the potential impacts identified were subjected to a semi quantitative risk assessment, the approach to this risk assessment is detailed in **Section 10**. The results of this risk assessment support the findings of the overall assessment in terms of the potential impact on the marine environment from the proposed development and the severity of these potential impacts.

11.2 Physical Presence

Impacts

Fishing, commercial shipping and tourism can potentially be affected by the presence of either temporary or permanent surface or subsurface structures in the vicinity of the project area.

Vessels and equipment that will be used during construction and operations are summarised in **Table 11-1**.

- **Table 11-1 Vehicles and Vessels Used for Offshore Construction and Operations**

	Installation and Support Vessels	Purpose	Characteristics
Offshore Vessels	Mobile Offshore Drilling Unit (MODU)	Drilling of production wells Possible installation of wellhead platform	Onsite during installation and commissioning
	Derrick Laybarge	Installation of the subsea export pipeline Possible installation of wellhead platform	Onsite during installation and commissioning, working 24 hours per day Will accommodate up to 250 offshore construction workforce
	Bulk Pipe Carrier	Installation of the subsea export pipeline	Onsite during installation
	Pipe Haul Barges and Tugs	Installation of the subsea export pipeline	Onsite during installation Tugs
	Support Vessels Survey Vessel Dive Support Vessel	Supply of materials and provisions to drill rig and laybarge Accommodation of offshore maintenance personnel	Two or three support vessels. Required during drilling and installation Dive support vessel may be needed for installation of the subsea export pipeline and wellhead platform Infrequent visits for wellhead platform maintenance during operation phase and to accompany trading tankers during condensate loading
	Trading Tankers and Tugs	Loading and export of condensate	Approximately one tanker and support tug(s) two to four times per annum
	Excavator Dredge	Nearshore pipe installation	Onsite for dredging in shallow water >8m water depth (at low tide)
	Helicopter	Access to wellhead platform, drill rig and laybarge when required	No fuel storage on the wellhead platform. Refuelling facilities may be required on the laybarge.

Surface facilities and vessels in the vicinity of the gas field will include the Jack-up, wellhead platform, installation and support vessels, and condensate export mooring and trading tankers. The majority of vessels and structures will only be on site during drilling and installation activities, including the Jack-up (approximately two months) and pipe laybarge (approximately two months). These will therefore represent a short term, minor inconvenience to shipping and fishing in the project area.

Once in place, the wellhead platform will represent a medium to long term navigation obstacle, although it will not be visible from the coastline. It is estimated that support vessels will be required to travel to and from the facility ten times per year for maintenance purposes. However, as the area is not heavily used for shipping (**Section 9.6**), the activity of supply vessels is expected to have a negligible effect on users of the area.

Trading tankers will be loading condensate from the condensate export mooring about every three months throughout the year and will be temporarily visible from the shore as they travel to and from the area. Due to the infrequent visits, trading tankers may cause at most a slight inconvenience to any local users. However, shipping in the Joseph Bonaparte Gulf is generally limited to fishing vessels and local operators using Wyndham Point for transport of cargo, live cattle export and supply for the Ord River agricultural industries. The condensate loading area is located well inshore of Timor Sea shipping routes.

Subsea structures will include wellheads, flowlines and 107.5 km of export pipeline. The main obstacle posed by such structures would be potential snagging of trawling nets or other bottom fishing gear. Several State and Commonwealth fishing zones are located within the Joseph Bonaparte Gulf including the Northern Prawn Fishery. However, fishing activity near the Blacktip reservoirs and export pipeline route has been shown to be negligible and due to the relatively small size of the platform exclusion zone (500 m) and trenching of the pipeline, the effect on fishing activity is likely to be minimal. Due to the depth of water in the vicinity of the wellhead platform (approximately 52 m), subsea installations will not physically present any navigational hazard to shipping or fishing vessels.

Not withstanding the prevailing legislation at the time, it is likely that decommissioning of the export pipeline at the end of field life will result in the pipeline being flushed and left in situ. The physical presence of the export pipeline in the nearshore and landfall area will result in a visual impact during installation. No other impacts will occur under normal operations.

Preventative and Management Measures

A gazetted safety exclusion zone of 500 m radius from the outer edge of the Blacktip wells and associated structures or equipment will be requested from the regulatory authority under the PSLA to protect the facilities and to reduce the risk of marine collisions. This safety zone will appear on Australian navigation charts. No environmental impact is expected due to the exclusion of shipping and fisheries from such a small area.

The position of the wellhead platform, condensate export mooring and export pipeline will be shown on admiralty charts.

Safety equipment such as markers, navigation aids, fog horns and illumination lighting will be installed on the wellhead platform and condensate export mooring. Lights and markers will adhere to the internationally recognised International Association for Lighthouse Authorities (IALA) standards. The wellhead platform will not visually impact upon the Australian coastline due to its distance from the shore.

Management Summary

In summary, preventative and management measures will include:

- A gazetted safety exclusion zone of 500 m radius to protect the facilities and pipeline.
- Navigational equipment on the wellhead platform and condensate export mooring.
- Admiralty charts will be updated showing wellhead platform, condensate mooring and export pipeline.

11.3 Seabed Disturbance

Impacts

Disturbance to the seabed will occur during both the drilling and installation stages of the development due to the following:

- installation of legs of Jack-up;
- discharge of drill cuttings and muds (**Section 11.8**);
- installation of temporary anchors for the pipeline laybarge and shore pull;
- installation of subsea facilities and reservoir fluid export pipeline, including at the beach crossing;
- installation of the wellhead platform and condensate export mooring;
- installation of the condensate export pipeline and PW pipeline.

The drilling rig will most likely be a Jack-up, which will be supported by legs, under which the seabed will be disturbed. Drilling of wells and installation of wellheads will also result in physical disturbance to the seabed due to deposition of drill cuttings and muds and installation of well heads and other sub sea equipment. However, only a localised area, directly adjacent to the wells, will be impacted upon, and the impact will be slight, especially given the large area of similar habitat surrounding the platform.

The pipeline laybarge will employ anchors to maintain its position. As it moves along the pipeline route during pipe laying, the laybarge's anchors are positioned by a support vessel. However, once the anchors are in position, movement and seabed damage will only be caused by the prevailing sea-state and is expected to be minimal. It will be necessary for the laybarge to anchor in several different locations in the nearshore area. As illustrated on **Figure 4-8** this will require anchoring within the boundary of a site identified as being culturally sensitive site. Impacts on this site are discussed in **Section 13.9**.

Installation of the pipeline will occur during the dry season, outside of the main prawn migration periods which occurs from February to April and October to December.

The effect of anchoring on the soft sediment in the development area is considered to be slight as the anchor and anchor chain scars are expected to fill in relatively quickly after the anchor has been removed. Similarly the biological communities associated with these soft sediments are expected to recover quickly from the physical disturbance. There are no known coral reefs, seagrass beds or other areas of sensitive bottom habitat along the pipeline route (Fugro 2004). It is therefore expected that there will be no impact on sensitive habitats.

The gas export pipeline will most likely be trenched into the seabed using a plough or jetting sled along the route and an excavator over the 1.7 km section adjacent to HWM (**Section 4.5.6**). Due to the soft nature of the sediment and large tides, the pipeline should become covered within a short period. Impacts due to trenching will be localised along the pipeline route and resulting sedimentation will not reach sensitive environments, as there are no known coral reefs, seagrass beds or other areas of sensitive bottom habitat along the pipeline route. The area affected will be a maximum of approximately 10 to 15 m each side of the pipeline, except near shore where strong currents may spread stockpiled spoil, dredged using an excavator, further than 30 m from the pipeline route and outside the 60 m working corridor. The affected area represents a very small percentage of the similar habitat present in the region and the soft sediment infauna community will re-establish disturbed areas rapidly. Potential environmental impacts associated with trenching are considered slight.

The wellhead platform installation will disturb a small fraction of the total seabed habitat area in the Joseph Bonaparte Gulf, resulting in loss of benthic community directly beneath the platform legs. However, the loss of this minute area would not cause any significant impacts to the surrounding environment because of the areal extent of this habitat in the Gulf. Therefore, the environmental consequences of seabed disturbance resulting from wellhead platform installation are predicted to be negligible. As the life of the field is expected to be in the order of approximately 30 years, the duration of impacts are likely to be long-term.

The PW pipeline will be located 3 km offshore. Construction of the PW pipeline will take place at the same time as the other pipelines and will utilise the same corridor as the condensate export pipeline. Although installation activities will result in minor seabed disturbance, once fixed in place the PW and condensate pipelines should not present any further disruption. Discharge of the PW from the pipeline is not expected to scour the seabed, as the plume is buoyant and the ocean pipeline will be fitted with a diffuser to ensure sufficient PW dispersal.

The condensate export pipeline will be laid in the same trench as the main export pipeline for 1.7 km, but will extend 3 km from the export pipeline in a south-westerly direction to a condensate export mooring. Six permanent anchors and two ship anchors will be used to position the tanker at the export mooring facility. The installation of the anchors, and movement of anchor chains with tides throughout the life of the condensate export mooring, may disturb the seabed. The anchor chains may also cause some scouring as they drop to and rise from the seabed with changing tides. However, the seabed at the condensate export mooring is covered in a layer of gravel sized particles which should help minimise scouring. Buoys will be attached to the anchors to mark their position. During operation, trading tankers will be secured by attaching moorings to all six anchor buoys as well as using two of their ship anchors. A flexible hose will then be attached to the condensate pipeline to load the condensate. Movement of this flexible hose may cause scouring and disturbance to the area of seabed surrounding the end of the condensate pipeline. It is envisaged that two tugs will be required per tanker to provide support and assist with positioning.

The area selected for the condensate export mooring is naturally prone to seabed disturbance and resultant turbidity due to large tidal movement and high turbidity. Sampling of the seabed confirms that the condensate export mooring area does not support any significant epibenthic communities such as coral or seagrass. The impact of physical disturbance is restricted to a small area of soft sediment habitat that is widespread and inhabited by communities that are likely to have a low sensitivity to physical disturbance. Installation of the condensate pipeline and condensate export mooring will result in minor impacts and localised seabed disturbance.

The *Walpinhthi* Reef, located roughly 1.5 km west of Yulow Point, is a sensitive Aboriginal cultural site (**Section 9.10**), which may potentially be disturbed by nearshore pipelaying and shore pull activities. This is discussed in detail in **Section 13.9** and not considered further in this Section.

Preventative and Management Measures

Management of seabed impacts will mainly involve adherence to appropriate procedures for anchoring and installation of the wellhead platform, condensate export mooring, gas export pipeline and any support or installation vessels to ensure seabed disturbance is minimised. It is anticipated that support vessels will not anchor unless in an emergency situation.

It may be necessary to drill or blast the seabed in some areas due to the presence of bedrock near the shore crossing. Any drilling or blasting would be undertaken to fragment rocks to a manageable size, therefore making it possible for equipment to trench the route for the main export, PW and condensate pipelines. Drill and blast impacts, if they were to occur, will be localised and would not affect large areas. Studies will be performed during the detailed design phase to assess the erosion potential close to the beach, which may determine the final trench depth in this area.

In summary preventative and management measures for seabed impacts will include:

- Adherence to appropriate anchoring and pipeline procedures for wellhead platform, pipelay, condensate export mooring and any support or installation vessels.
- Where possible, support vessels will not anchor unless in an emergency situation.

Management Summary

- Studies will be undertaken during the detailed design phase to assess the erosion potential close to the beach.
- Small area will be affected compared to area of similar habitat in the region.
- Benthic infauna is known to recovery rapidly following disturbance.
- Pipeline installation will occur outside of the prawn migration season.
- Installation vessels will adhere to appropriate anchoring and pipelay procedures to minimise area of disturbance.

- Pipelines will be trenched and will naturally backfill, so there will be no interference with geomorphic processes.

11.4 Beach Disturbance

Impacts

Over the designated shore crossing length (between HWM and LWM) the construction corridor will be 60 m wide (from a beach which is approximately 700 m long) and all works at the landfall will take approximately 20 weeks. The 60 m corridor will incorporate the shore pull for all three pipelines, which will require 24 hour operations over an estimated seven days within a period of 2–3 weeks.

Construction will involve nearshore and beach/dune trench excavation and the potential installation of a temporary groyne, which will be removed at the completion of the shore crossing. Following the pipeline installation, backfilling and rehabilitation of the beach profile will occur to minimise potential future impacts on turtle nesting and to minimise unnatural beach erosion. Subtidal and beach infaunal communities will re-establish rapidly and any impact is expected to be localised and slight.

Due to the logistical difficulties and safety issues of working at this remote location in the wet season, construction activities, including installation of the pipeline, will occur during the dry season. This coincides with the period in which flatback turtle nesting occurs. Aside from the loss of habitat, construction lighting and vibrations may affect turtle nesting and hatching (Guinea 2004). It is estimated that 20 turtles would nest on the pipeline crossing beach, which represents 1% of the nests laid in the Anson Beagle Bioregion, which extends from Pearce Point to Cape Hotham, including the Beagle Gulf and the southern shores of Melville and Bathurst Islands (Guinea 2004).

Sea turtles are sensitive to lights in the visible spectrum. Adult female sea turtles are photonegative as they approach the beach to nest. Having finished nesting female turtles become photopositive and will move towards a lighted area that is at the lowest horizon. Similarly, hatchlings are photopositive once they leave the nest. The combination of light and low horizon usually lead the hatchlings to the open ocean. Light of sufficient intensity can attract hatchlings away from the water and entice them to climb the beach towards the light and a greater risk of predation (Guinea 2004).

Sea turtle embryos are particularly sensitive to vibrations, which may dislodge the embryo from the egg membranes leading to its death during the early phase of development. In the later phases of development, vibrations may cause the hatchlings to hatch prematurely leading to non-synchronous emergence from the nest and an increase in late development mortality (Guinea 2004). A range of measures designed to minimise the impact of construction activities on turtle nesting and hatchlings' activity are outlined below. Given the low level of nesting activity on the proposed pipeline crossing beach (**Section 7.3.9**) and limited duration of construction activity, any impact is expected to be localised and minor.

With the very low level of turtle nesting activity on the beach and the fact that only a very small number of hatchlings tend to survive the hatchling process and migration to the sea, due to death from natural causes, the presence of the laybarge should not present a significant impact because of the broad dispersal pattern of a very small number of hatchlings; the limited time the laybarge will be at this location; and the limited effect of lighting from the laybarge or other vessels located 1,500–1,700 m from shore.

In the event that a temporary groyne is installed, this is likely to result in short term changes to the sediment transport regime in the immediate vicinity of the landfall site. Currents in the immediate waters adjacent to the proposed landfall site are understood to be nearshore currents. The corresponding hydrodynamic regime of nearshore currents, means that the waves hit the shoreline almost totally perpendicular to the coast. As a consequence, the groyne is unlikely to affect sediment transfer along the beach or interrupt beach nourishment in the coastal waters. Potential impacts are subsequently considered low.

The shell midden, a registered archaeological site located in the dunes at the back of the pipeline crossing beach (**Section 9.9**), will be disturbed by pipeline installation activities. Impacts are discussed in detail in **Section 13.8** and not considered further in this section.

Preventative and Management Measures

Particular attention will be paid to minimising the impact of construction activities on turtle nesting activities and hatchling success, and to the restoration of the beach profile following the completion of the pipeline shore crossing. Management measures will include:

- A Turtle Management Plan will be developed and implemented during construction activities.
- A Lighting Management Plan will be developed and implemented during construction activities.
- Restricting shore crossing construction activities and personnel to the designated approved construction corridor (beach is approximately 700 m wide).
- Fencing the construction corridor prior to nesting activity commencing to prevent turtles entering, and direct turtles back to water after nesting.
- Where possible (shore pull operations excepted) night time construction activities will be minimised over the 20 week construction period.
- Minimising construction lighting on the beach, including using orange, yellow and red lights where ever possible, and provided safety of personnel is not compromised.
- Limiting the height of lighting as much as possible, directing lights inward and downward to reduce light spill and placing shades to further reduce light spill provided safety of personnel is not compromised.
- Monitoring of nesting activity at the proposed pipeline crossing beach and beaches to the north and south by dedicated, trained personnel which includes:
  - Assisting or coaxing disorientated turtles back to the water after nesting, as required.

  - Removal and translocation of nests to Yelcherr Beach to the south.
  - Enclosing transplanted nests so hatchlings can be collected and returned to the proposed pipeline crossing beach for imprinting of natal cues.
  - Restoration of the proposed pipeline crossing beach profile to the pre-construction shape.
- A Rehabilitation Management Plan will be developed and implemented prior to construction activities.
- A Sediment and Erosion Control Management Plan will be developed and implemented prior to construction activities.

Management Summary

- A Turtle Management Plan will be developed and implemented during construction activities.
- A Lighting Management Plan will be developed and implemented during construction activities.
- Construction corridor and duration of shore crossing construction reduced to minimum required.
- Construction corridor will be fenced off to exclude turtles from entering the pipeline trench.
- Artificial lighting will be minimised and positioned to reduce light spill.
- The beach will be regularly monitored for turtles during construction. Turtle nests will be removed from the beach each morning during construction and placed in a hatchery to the south. Hatchlings will be returned to Yelcherr Beach to enter the sea.
- A Sediment and Erosion Control Management Plan will be developed and implemented prior to construction activities.
- A Rehabilitation Management Plan will be developed and implemented prior to construction activities.

11.5 Artificial Habitat

Impacts

The presence of hard substrate will provide a foundation for the colonisation of encrusting organisms in an area generally devoid of hard substrate. Planktonic organisms attach to structures and remain attached in adulthood, leading to the development of an often diverse community (fouling community) that is likely to include attached filter-feeding organisms such as sponges, ascidians, corals and barnacles as well as a variety of mobile invertebrates.

Structures proposed for the Blacktip Project that may provide an artificial habitat for colonisation by marine organisms include:

- the wellhead platform jacket, mud mats and moorings;
- wellheads;
- main subsea export pipeline (where not trenched or subsequently exposed);

- condensate pipeline (where not trenched or subsequently exposed) and condensate export mooring;
- the PW pipeline (where not trenched or subsequently exposed).

The presence of a fouling community is detrimental to ship hulls and slows passage, therefore anti-fouling will be used on support vessels and trading tankers in order to prevent growth of organisms (**Section 11.7**). However, the fixed subsurface and intertidal structures of the proposed Blacktip Project, including the wellhead platform, pipelines and condensate export mooring, will not be treated with anti-fouling paints but other mechanical cleaning devices will be considered.

The majority of the pipeline to shore will be trenched and naturally covered over by sediment and is expected to provide minimal exposed artificial substrate.

Once established, the structures and associated colonies will attract a variety of fish and other organisms that may utilise the newly formed habitat for aggregation, food and/or refuge. The colonisation of new habitat generally stabilises over time and any ecological effects are localised. The potential exists for a community different to that originally found in the area to become established. However, it is expected that the fouling community will most likely consist of endemic or regional species, because most vessels will be travelling to the site from Darwin (although some may come from international waters). Introduced species or marine pest species may colonise structures; however, the likelihood is minimal and is further discussed in **Section 11.6**.

The reef effect of submerged structures is believed by some to promote or increase the dominance of predatory species; however, this has not been adequately demonstrated. A biological monitoring study of the artificial reef, HMAS Swan, in Western Australia (Morrison 2001) found that a very large fish and encrusting invertebrate community had established over a four year period on a scuttled vessel in 30 m of water. During the first year the initial colonisation was dominated by prey species and subsequently the presence of predatory species has stabilised the community structure approximating that of local natural reefs. Predatory species have not been promoted above that of natural reefs and prey species appear not to be any more vulnerable. The effect of the artificial reef was localised and the surrounding habitat was not affected.

The localised increase in the diversity and abundance of marine life due to artificial habitat cannot be assigned either a positive or negative overall effect. Should submerged structures be removed during decommissioning, thereby removing the artificial habitat and associated communities, the overall environmental impact will be negligible and removal would lead to a return to original biota levels. Should structures be left in place, the habitat associated with these structures would remain intact. Options to decommission facilities and associated impacts will be thoroughly investigated well in advance of actual decommissioning.

Preventative and Management Measures

No specific measures are proposed to prevent or minimise the artificial habitat created by presence of the wellhead platform, export pipeline and associated subsea infrastructure. Measures to reduce the likelihood of introduction of exotic species are discussed in the next section. No antifouling will be used on these facilities. A decommissioning plan will be developed, and approval sought from the regulatory authority, to undertake decommissioning of the facilities.

Management Summary

In summary, preventative and management measures will include:

- No antifouling will be used on the wellhead platform, export pipeline and associated subsea infrastructure.
- A decommissioning plan will be developed, and approval sought from the regulatory authority.

11.6 Marine Pest Species

Impacts

Introduced or exotic species are those that have been introduced to an area outside of their natural range and have survived. To date more than 250 introduced marine species have been identified in Australian coastal waters (AQIS 2000 in Woodside 2002b).

Marine introduced species may potentially be transported to the proposed development area as a component of ballast water (and associated sediments) or as marine fouling. The successful establishment of an exotic species depends primarily on two factors; the frequency of immigrant arrivals (introduction) and their post-arrival mortality (survival). The focus of Woodside's management actions is to prevent the translocation of organisms as post-arrival survival is largely determined by the intrinsic suitability of the receiving environment.

The location of the offshore component of the development (wellhead platform and wells) is greater than 12 nm from the coast and therefore considered an acceptable area for international shipping to conduct ballast water exchange under the AQIS Ballast Water Management Requirements. Nonetheless, as an added risk reduction method, the Jack-up, laybarge and support vessels will exchange ballast water prior to arrival at the Blacktip Project area where it is safe and feasible for vessels to do so en-route.

The nearshore component of the development, the condensate loading facility (condensate export mooring), is located less than 12 nm from the coast and therefore is not considered an acceptable area for international shipping to conduct ballast water exchange. Trading tankers approaching the site to undertake condensate loading, and support vessels for installation activities, will exchange ballast water prior to arrival as required by Australian quarantine laws.

The second factor in the successful establishment of an exotic species, post-arrival mortality, relates to the suitability of the environment at the destination. The majority of marine organisms contained within ballast water taken on in port or from hull fouling are likely to have habitat requirements and their distributions restricted to sheltered habitats (Carlton 1985). The proposed wellhead platform is located in relatively deep oceanic water, approximately 90 km from the nearest coastline. Environmental conditions at the proposed wellhead platform are not likely to be suitable for coastal species. Additionally, the wellhead platform is in an isolated location, with low levels of shipping activity and should the establishment of an exotic species occur, it is highly unlikely that the species could spread to the coast.

Exotic organisms may also find suitable habitat on the chains and floats of the condensate export mooring, where trading tankers will moor to load condensate. However, given the strong tidal currents and a low frequency of visitation (tankers will only visit the mooring for one day at a time, on a three monthly basis), the frequency of potential introduction is low.

Woodside will require that shipping companies comply with AQIS standards. Support vessels are likely to come from within Australian waters, therefore it is unlikely that exotic species could be transported from outside Australia either on the hull or in ballast water of support vessels. The use of a jack-up rig also reduces the likelihood of introductions via hull fouling as jack-up rigs and their supports (legs) spend considerable periods out of the water at different stages of operations, ensuring regular mortality of any fouling communities.

It is unlikely that there will be an environmental impact from the unintentional introduction of marine pest species to the surrounding marine waters of the proposed development area. The management of ballast water through ballast water exchange in open ocean areas would mean the potential environmental consequence would be slight.

Preventative and Management Measures

Limiting the probability of introducing species to an area is the main controllable factor to reduce the impact of introduced species. Therefore, the focus of Woodside's management actions will be to prevent the introduction of organisms into Australian waters. Application of the Commonwealth *Quarantine Act 2000* and the AQIS ballast water management requirements for international shipping (July 2001) will be compulsory for all vessels entering or leaving Australian waters. This further reduces the risk of introducing species to the Joseph Bonaparte Gulf. Where the potential risk is considered to be high, one or more of the following options for management of ballast water, as approved by AQIS (AQIS 2000 and 2001), will be implemented:

- no discharge of 'high risk' ballast tanks in Australian waters;
- tank-to-tank transfers;
- full ballast water exchange at sea (ie beyond 12 nm from the coastline).

Management Summary

In summary, preventative and management measures will include:

- Application of the Commonwealth *Quarantine Act 2000* and the AQIS ballast water management requirements for international shipping (July 2001) will be compulsory for all vessels entering or leaving Australian waters.
- Jack-up, laybarge and support vessels will exchange ballast water prior to arrival at the Blacktip Project area where it is safe and feasible for vessels to do so en-route.

11.7 Anti-fouling

Impacts

In November 1999, the International Maritime Organisation (IMO) directed the Marine Environment Protection Committee to develop an instrument, legally binding throughout the world, to address the harmful effects of antifouling systems used on ships. The objective was to institute a global ban on the application of Tri-n-butyltin (TBT) paints on ships by 1 January 2003 and a complete prohibition on the presence of TBT paints on ships by 1 January 2008. The 5 year gap allows for ships legally coated with TBT prior to 1 January 2003 to operate until their next dry-docking for maintenance.

These conditions will apply to all potential project vessels, including the laybarge, Jack-up, wellhead platform, trading tankers, support and supply boats.

The wellhead platform will be a newly constructed platform for use at the Blacktip Project after 1 January 2003 and consequently, in accordance with the IMO regulations mentioned above will not be coated with any TBT antifouling. Neither the wellhead platform, pipelines or associated subsea structures will have anti-fouling, nor will the condensate export mooring.

Support and supply vessels will not be coated with TBT antifouling. The Jack-up or laybarge may be coated with TBT antifouling if they were last dry docked prior to 1 January 2003. Any leached TBT from these vessels will be diluted quickly in this open ocean environment (US EPA 1997). TBT is quickly broken down in aerobic conditions (Short and Thrower 1986) and, given the strong currents in the Joseph Bonaparte Gulf, it is extremely unlikely that TBT could reach the sediment or accumulate to a level where there could be an effect on marine life in the area. In addition, there is little benthic marine life on the sea floor in the vicinity of the development area that could be affected by TBT (**Section 7.3.4**).

With the global ban on TBT in antifouling paints, safer alternative substances will be used as they become available. However, by nature, any antifouling substance is designed to be offensive to marine organisms that settle on painted surfaces. Given that marine organisms and benthic communities in the development area are common and widespread and that the water is deep, the potential impact of antifouling on the marine ecology of the area is considered to be localised and slight.

Preventative and Management Measures

Woodside has a chemical selection process that specifies chemical avoidance and/or selection of chemicals with the lowest health, safety and environmental risks. This policy is applicable to antifouling coatings.

Management Summary

- TBT will not be used as an anti-foulant on Blacktip facilities.
- The use of TBT will be phased out internationally between 2003–2008.

- Should TBT be present on any vessels employed, it should break down quickly in water column, minimising risks.
- Marine organisms and benthic communities are common and widespread, so no major impacts on ecological communities are likely.

11.8 Drilling Waste and Discharges

Impacts

The environmental impacts associated with the discharge of drill cuttings and muds relate primarily to:

- increases in localised turbidity;
- smothering and alteration of sediment characteristics;
- depletion of oxygen in surface sediments;
- toxicity of drill cuttings;
- toxicity of drilling muds and mud additives.

Increases in Localised Turbidity: Turbidity is mainly caused by the concentration of suspended solids in the water column. Following discharge from the Jack-up to sea, drill cuttings and adhered muds are subject to initial turbulent mixing. The discharge plume, in the form of a turbid patch of water, firstly grows due to horizontal transport, then gradually dilutes as it disperses down current and through the water column. Field observation on the North West Shelf of Western Australia has found that the plume from drilling mud discharge is visible for up to one kilometre from the discharge point (Swan *et al.,* 1994).

The proposed Blacktip drilling location is over 90 km from the nearest shore in a water depth of approximately 52 m. There are no known seagrass beds, coral reefs, shallow algae covered reefs or other habitats sensitive to the effects of turbidity within the vicinity of the drilling location. The Joseph Bonaparte Gulf is known for its high sediment load and levels of turbidity (**Section 7.2.4**), therefore, most marine communities in the vicinity are probably well adapted to high turbidity levels.

The drilling location is outside the main fishing area of the Northern Prawn Fishery and is unlikely to have any effect on the fishery. As the adult and juvenile prawns are well adapted to the high sediment and turbidity levels in the inner part of Joseph Bonaparte Gulf where they breed, turbidity from drilling is also unlikely to impact prawns migrating through the area to fishing grounds. The area affected by discharge from drilling is very small relative to the broad scale migration of prawns across the Gulf.

Although significant turbidity can result in impacts on the photosynthetic activity of organisms, no major impact is anticipated in the area due to the temporary nature of the discharge, the small area affected and absence of sensitive benthic communities directly reliant on photosynthesis for survival. The environmental effect of localised short-term increase in turbidity from drilling is considered to be slight.

Smothering and Alteration of Sediment Characteristics: There is a high likelihood that some localised smothering of the benthic invertebrate communities will occur during well drilling. Drill cuttings and WBMs discharged from the Jack-up after processing or at completion of well drilling will be dispersed as the particles sink through the water column, and will also be transported horizontally with the ambient currents. The distance that particles are transported before settlement will be a vector of both the horizontal (currents) and vertical (sinking) transport forces. The extent of smothering will be influenced by the size and length of the well, strength of tidal movement and the predominant direction of currents. Based on observations of cuttings piles from other drilling campaigns, cuttings generally form a roughly elliptical pile of 40 to 60 m, elongated in the direction of the prevailing currents. Given the large tides and strong currents in the Joseph Bonaparte Gulf, the areal extent of the cuttings pile at Blacktip may be slightly greater. Field studies suggest that infauna community composition may be altered within approximately 100 m of the cuttings discharge point during drilling (Swan *et al.,* 1994) as infauna suited to the new sediment characteristics replace those unsuited.

Finer particles may be spread over a much greater distance to form a thin layer with less likelihood of smothering benthic fauna. The concentration of particles on the seabed at any one point further than 100 m from the drill area will be too low to cause any significant alteration of sediment characteristics or smothering to the extent that it would affect biota diversity or community characteristics.

The severity of smothering and alteration of sediment characteristics by drill cuttings and muds will be slight, due to:

- the low toxicity of the discharged seawater and drilling mud mixture;
- the short time period during which discharge will occur;
- the small area potentially affected;
- the action of water currents in dispersing this material.

Depletion of Oxygen in Surface Sediments: Smothering of the seabed by drill cuttings near the wells may result in the covered area becoming anoxic, or without oxygen, over time. Organic material encapsulated in the surface sediments at the time of smothering, or introduced with the cuttings, will initially be biodegraded by organisms using oxygen in the surrounding sediments and deposited cuttings. Once this oxygen is depleted, biodegradation occurs more slowly by micro-organisms using electron acceptors other than oxygen (Brock & Madigan 1991 in Woodside 2002b). In circumstances where the drill cuttings have associated oil, either as coating from NWBM or from oily sands removed from the reservoir, field studies have shown that this oil persists for a long time before it is fully biodegraded (Schaaning *et al.*, 1995 in Woodside 2002b). The persistence is considered to be primarily due to reduced rates of biodegradation that occurs in anoxic conditions of cutting piles below the first few centimetres (Neff *et al.,* 2000 in Woodside 2002b).

Repeated field studies have demonstrated oxygen depletion in the surface sediments is associated with changes in the composition and/or abundance of benthic biota in, or adjacent to, cuttings piles (Neff *et al.,* 2000 in Woodside 2002b). The observed effects usually include a decrease in the number of taxa and biological diversity; however, the total number of individuals and biomass may remain constant, or even increase in some instances. Depletion of oxygen is expected to occur where cuttings are discharged directly adjacent to the drill holes within 20 to 52 m, but is not expected to cause an impact over larger areas.

Toxicity of Drill Cuttings: During drilling of the final section of the wells, during which the reservoir is being intersected, reservoir fluid will be adsorbed within the cuttings. Small concentrations of condensate will remain adhered to the cuttings when they are subsequently discharged from the Jack-up. A portion of the hydrocarbons associated with drilling cuttings that are discharged to sea will remain adsorbed to particles and settle to the seabed. Another portion will be dissociated in the water column.

As the Blacktip reservoir consist mainly of gas, absorption of hydrocarbons onto cuttings is expected to be low. Most heavy metals present are unlikely to be in a bioavailable or soluble form, with the exception of very minor quantities in reservoir fluids that may be circulated. Barite and bentonite, used in the drilling muds, from natural clays, may also contain some heavy metal but not in a readily bioavailable form (Neff 1987).

Toxicity of Water-Based Muds (WBMs): WBMs have low toxicity and low bioaccumulation potential. The Western Australian Department of Industry and Resources (DoIR), the Northern Territory DBIRD and other regulatory authorities routinely accept the discharge of WBMs in open waters.

Recovery of the affected seabed community following contact with discharged WBMs occurs rapidly. Evidence for this is provided by a field experiment conducted by Bakke *et al.,* (1985) in Woodside (2002b), which found that seabed covered with a 10 mm layer of WBM slurry was immediately recolonised by algae (principally diatoms), meiofauna and macrofauna. Peak meiofauna densities were reached within two weeks and macrofauna diversity was found to be comparable to mature sediment communities within one year. A survey to evaluate the environmental effects of drilling on the North-West Shelf undertaken by Woodside (Hanley 1993 in Woodside 2002b) demonstrated that little environmental effect remained after three years.

Toxicity of Non Water-Based Muds (NWBMs): NWBMs will be used if drilling conditions require the use of mud with a higher performance than can be achieved using WBMs. NWBMs, if used, will only be applied in the lower sections of holes after drilling systems have been closed in and cuttings and fluids can be brought back to the rig. Bulk NWBMs will not be discharged to sea but will be returned to shore for reprocessing. Cuttings generated while drilling with NWBMs will be separated from the drill fluids to meet statutory requirements.

If a NWBM is used to drill the lower section of holes, it is most likely to be the Synthetic Based Mud (SBM) Syntec™. SBMs, including the Olefin-based Syntec, are manufactured to contain minimal (< 0.001% w/w), if any, aromatic hydrocarbons. Olefin based drilling fluids are generally rated as non-toxic (96 hr LC50 >100,000 ppm) to almost non-toxic (96 hr LC50 10,000–100,000 ppm) (ERM 1997). Depending upon the location of the drilling activity, and nature and sensitivity of the receiving environment, the DoIR consider the range of non-toxic to slightly toxic is acceptable for drilling fluid toxicity (DoIR 2004). Approval of drilling fluids by regulatory authorities is also based on, amongst other factors, the biodegradation and bioaccumulation of the drilling fluid. Only regulator-approved NWBMs will be used.

Toxicity of Drilling Mud Additives: Drilling muds contain a variety of special purpose additives, as described in **Section 4.4.3**. Acute toxicity from drilling mud additive contamination is highly unlikely given the limited volumes used and can only occur where the drilling mud is present in concentrations far greater than that which would occur in field situations.

Whilst not specifically added to drilling muds, pipe dope (or thread anti-seize) becomes mixed with the mud and cuttings as they travel through the pipe string. Pipe dope is considered potentially toxic as it contains heavy metals, but its impact is not considered significant based on the very small amounts discharged, and the fact that the metals are usually present as insoluble sulphides or metal granules that have limited bioavailability.

Preventative and Management Measures

Drilling muds are generally re-used several times and all attempts are made on board the Jack-up to separate the muds from the cuttings as much as possible prior to discharge of cuttings overboard. However, not all of the mud can be separated from the cuttings and inevitably drill cuttings are discharged with some mud still attached.

Once drilling muds have been reprocessed several times, they can no longer be used and are usually discharged to sea or shipped back to shore. Muds transported back to shore are either returned to the manufacturer for recycling or disposed of in an approved method such as at a landfill or by incineration.

The primary measure for mitigating the potential environmental impacts of drilling muds is to select muds with the least toxicity and persistence. This will be done in accordance with Woodside’s Engineering Drilling Fluid Selection Procedure, whereby:

- WBMs will be used wherever possible and technically practicable, as these low-toxicity muds have minimal impact on the environment.
- NWBMs (low toxicity Ester Based Muds (EBMs) or SBMs) will only be used where WBMs cannot provide the required lubricity, bore stability or other properties.
- Whole NWBMs will not be discharged to the marine environment.
- Woodside will design and operate equipment to prevent loss of containment.

WBMs discharged to sea will be released from the Jack-up close to or above the sea surface to assist dispersion through the water column.

The major preventative measure for pipe dope is to select pipe dope that has the least potential to cause any adverse effects on the environment while meeting technical requirements. This will be done in accordance with Woodside's chemical selection process, which targets chemical avoidance and/or selection of chemicals with the lowest health, safety and environmental risks. The main operational management measure is to apply the minimum amount of material while still ensuring appropriate coverage.

Environmental Risk of Drill Cuttings, Drilling Muds and Additives: The environmental impacts associated with drill discharges to the marine environment are likely to comprise localised short to medium term effects. These impacts are likely to be caused mainly by smothering and oxygen depletion, as well as some temporary impacts over a wider area caused by small alteration to the sediment characteristics.

Benthic organisms are widely distributed in the area of the proposed development and the environmental impact associated with drill cutting disposal is predicted to be minor due to the relatively small area effected and the wide distribution of similar community types throughout the region.

Management Summary

In summary, preventative and management measures will include:

- A regulator approved Production Drilling Environment Plan that meets the requirements of PSLMER.
- Drilling muds will be separated from the cuttings as much as possible prior to discharge of cuttings overboard. If NWBM are used, separation will meet statutory requirements.
- NWBMs will be shipped back to shore for recycling or disposal in an approved method.
- Muds will be selected which offer the least toxicity and persistence in accordance with Woodside's Engineering Drilling Fluid Selection Procedure.
- WBMs discharged to sea will be released from the Jack-up close to or above the sea surface to assist dispersion through the water column.
- Select pipe dope that has the least potential to cause an adverse effects on the environment while meeting technical requirements in accordance with Woodside's chemical selection process.
- Apply the minimum amount of pipe dope while still ensuring appropriate coverage.

11.9 Drilling Mud Spills

Impacts

Drilling mud will be shipped to the Jack-up in bulk containers or cargo tanks containing the basic components in dry or liquid form depending on the nature of the component. The mud components will be mixed on board with water or other base liquid to make up the mud to the desired formula.

Transfer of drilling mud components between the support vessel and Jack-up in bulk containers has a very low potential for material to be spilled overboard. For a spill to occur there would first have to be an accident involving loss of the container overboard and the container would have to rupture to release the contents. The volume of a spill will be limited by the size of the container being transferred, usually in the order of 200 L drums to 1500 L bulk containers.

Liquid transfers by hose also has a very low potential for material to be spilled overboard as hoses and couplings will be inspected for faults prior to use, hoses will be fitted with dry couplings and transfers will be visually monitored at all times.

Materials from a spill will either disperse in the water or sink to the seabed, and are extremely unlikely to reach any sensitive resource at a concentration where an impact could be caused. The impacts associated with a spill will be similar to the impacts of disposal of the used mud at the completion of drilling as previously described in **Section 11.8**.

Preventative and Management Measures

Procedures will be in place to minimise risks from the transfer of drilling muds between the support vessel and Jack-up. The main preventative measures to avoid spills, or prevent them from reaching the environment, are the pit transfer system and the drainage systems on board the Jack-up, and dry couplings on transfer hoses. Transfer and handling procedures will be in place to ensure that there is a very low potential for concentrated mud components being spilled on the rig or during transfer to enter the sea. In the event of a spill on board the rig, liquid material will be diverted to a drainage sump or slops tank. Dry material will be contained on deck until it can be cleaned up.

Management Summary

In summary, preventative and management measures will include:

- Non toxic or low toxicity drilling muds will be used wherever possible. The benthic habitat that might be affected occurs widespread in the region, so impacts in the local area are not considered critical.
- Procedures will be in place to minimise risks from the transfer of drilling muds between the support vessel and Jack-up.
- The main management measures to avoid spills, or prevent them from reaching the environment, are the pit transfer system and the drainage systems on board the Jack-up, and dry couplings on transfer hoses.

- Transfer and handling procedures will be in place to ensure that there is a very low potential for concentrated mud components being spilled on the rig or during transfer to enter the sea.
- In the event of a spill on board the rig, liquid material will be diverted to a drainage sump or slops tank. Dry material will be contained on deck until it can be cleaned up.

11.10 Well Completion Fluids

Impacts

Once a well has been drilled to the required depth, well completion is conducted by installing suitable casing, cementing this casing and perforating the lower section of casing to access the gas producing zones. Well completion fluid is used during drilling of the final stage to ensure the well surface is clean and to prevent blocking of the reservoir.

Where a WBM is used, the completion fluids would be diesel, an effective oil-based solvent, and a fluid such as potassium chloride solution (brine). During well clean up, the two fluids will be separated, and diesel will be flared on the Jack-up. The discharge of brine overboard is further discussed in **Section 11.11**. If NWBM is used, then a base drilling fluid mixed with various additives is used in conjunction with the diesel. Should this be the case, none of the fluid would be discharged overboard, rather it would all be burnt.

The emission of greenhouse gases associated with well clean up represents only a small contribution to the total emissions (**Section 11.21**).

Preventative and Management Measures

The fluid will be recovered and separated as described above. Once separated, the low toxicity brine component will be discharged and the diesel or base fluid will be burnt off.

Management Summary

In summary, preventative and management measures will include:

- The fluid will be recovered and separated. Once separated, the low toxicity brine component will be discharged and the diesel or base fluid will be burnt off.

11.11 Brine

Impacts from Brine

The Jack-up will require brine for use in the well completion fluid for well clean up and completion. As WBMs will most likely be used to drill the wells, the brine will be in the form of potassium chloride brine. The Jack-up will receive the brine from the supply vessels.

Following well completion, the brine is brought back up to the Jack-up, where it is separated from other well completion fluids (including diesel) and the brine is discharged overboard. Brine is denser than seawater, therefore it will sink and disperse in the currents upon discharge. Both potassium and chloride are common constituents of seawater, therefore the discharge of brine will not result in the introduction of new substances. It may however, result in an increase of salinity near the point of discharge and oxygen depletion, which is discussed in **Section 11.13**.

Overall, salinity in the open ocean remains relatively constant despite significant variation of the concentrations of individual dissolved salt species. Most oceanic species are able to tolerate short-term salinity fluctuations in the order of 20–30% (Walker and McComb 1990 in Woodside 2002b). It is expected that most pelagic species inhabiting the proposed development area would be able to tolerate short-term exposure to the slight increase in salinity caused by the discharge of brine. The effect of brine on the marine environment is considered slight.

Preventative and Management Measures

Discharge of brine from well completion fluid will meet legislative standards for oil-in-water before being discharged overboard.

Management Summary

- The discharge of brine from well completion fluid will meet legislative standards for oil-in-water before being discharged overboard.
- Only small volumes of brine will be discharged to the sea.
- The brine will rapidly diluted and dispersed.

11.12 Sludges and Sand

Impacts

Sludges and sand containing hydrocarbons may be brought up to the Jack-up periodically during well clean up. If this is the case, the impacts are expected to be similar to that for the discharge of drill cuttings, although on a much reduced scale and the discharge is likely to effect the area already covered by cuttings. Disposal directly overboard will only occur if hydrocarbons are at an acceptably low level and approval is gained from the regulatory authority. In circumstances where the sludges or sands cannot be discharged at sea, for example if they are contaminated by a chemical spill, they will be stored in suitable containers in the Jack-up and ultimately disposed of onshore.

Preventative and Management Measures

Where practicable, sludges and sand will be minimised at source, such as by using sand consolidation resins and completion stacks. If disposal overboard is not acceptable, sludges and sand will be stored in suitable containers offshore until the materials are transported onshore for disposal at an approved facility. A regulator approved Production Drilling Environment Plan will be implemented for drilling operations.

Management Summary

In summary, preventative and management measures will include:

- Where practicable, sludges and sand will be minimised at source, such as by using sand consolidation resins and completion stacks.
- Disposal overboard will occur if approval is gained from the regulatory authority, unless sands or sludges are contaminated or otherwise unacceptable for discharge.
- If disposal overboard is not acceptable, sludges and sand will be stored offshore and then transported onshore for disposal at an approved facility.
- A regulator approved Production Drilling Environment Plan will be implemented for drilling operations.

11.13 Hydrotest Waters

Impacts

The gas export pipeline and the condensate export pipeline will be flooded using seawater containing a number of additives to allow hydrostatic testing to be undertaken. The onshore condensate storage tanks will also be hydrotested though this will be undertaken separately from the hydrotesting of the pipelines. The volume of hydrotest water required for the export pipeline is 17,000 m^3, and 6,000 m^3 for the condensate storage tanks. At the conclusion of hydrostatic testing, the facilities will be dewatered, with potential impacts resulting from the toxicity of chemicals added to the hydrotest waters. Chemicals used as inputs into the hydrotest water will be chosen to ensure that the best environmental and technical solutions are achieved for the project.

The concentrations of the chemical additives in hydrotest water will be carefully determined. For example, the typical approach regarding oxygen scavenger is to only add sufficient additives to remove the oxygen normally present in the volume of seawater needed, adjusting for the temperature of the seawater (which determines oxygen content). Sufficient biocide is generally added to kill the bacteria in the filtered seawater without overdosing. Normally, the biocides selected degrade quickly upon discharge, which will result in minimal environmental impact upon discharge of any residual biocide from the line. The additives will be in a diluted form in hydrotest water and when discharged to sea will be rapidly diluted to extremely low concentrations that are harmless to marine communities in the area.

The main potential impact from the discharge of hydrotest water is oxygen deprivation on biota exposed to the de–oxygenated plume of water until it has mixed sufficiently with seawater. The test water has a high chemical oxygen demand.

A number of approaches to the pipeline flooding and dewatering for hydrotesting have been considered, including discharge from either the wellhead platform or the condensate export mooring. Discharge from the condensate export mooring was ultimately chosen as it offered the best technical solution and offered the same environmental performance as the other option considered.

Preventative and Management Measures

Pre-commissioning systems offsite with appropriate hydrotest water treatment or recycling facilities will reduce the amount of hydrostatic testing required on site. However, it is not possible to pre-commission all systems offsite; all pipelines will require hydrostatic testing to ensure safe operation.

The primary technique employed to lessen the impacts of hydrotest water is to select chemicals with low potential for environmental harm and carefully determine the quantities and concentrations required. A Pipeline Flooding and Hydrotesting Procedure and a Pipeline Pre-commissioning Procedure will be developed to provide details on the chemicals and quantities to be used, as well as minimisation options, the discharge point and discharge rates of hydrotest water during dewatering. Prior to its implementation, an EP covering flooding, hydrotesting and pre-commissioning activities will be submitted to the regulatory authority for review and approval.

Management Summary

In summary, preventative and management measures will include:

- Pre-commissioning systems offsite to reduce the amount of hydrostatic testing required on site.
- Selection of hydrotest chemicals with low potential for environmental harm and carefully determine the levels or concentrations required.
- A Pipeline Flooding and Hydrotesting Procedure, and a Pipeline Pre-commissioning Procedure will be developed.
- Dewatering discharge will be at the seabed level from the condensate pipeline and the hydrotest water will be re-oxygenated with minimal effects on marine habitats.

11.14 Scale

Impacts

Natural radiation within the environment occurs in a number of sources, with one of the principal sources being natural radioactive atoms (such as uranium, thorium, radium, and to a lesser extent potassium) present in rocks. These materials are known as Naturally Occurring Radioactive Materials (NORMS). As the water in a hydrocarbon reservoir has been in contact with the rock structures over geological timeframes, the water contains various concentrations of NORMS in solution. Formation waters will also contain various concentrations of sulphates or carbonates. The exact chemical make-up of the water depends greatly on the reservoir rock structures and so differs greatly from reservoir to reservoir. When gas reservoirs are developed and produced to surface, it is not possible to exclude the water, so the formation water (PW) is also generated.

Under certain conditions (high salinity, together with the presence of sulphates and/or carbonates plus calcium, barium and strontium) scales can form from the PW. The most common scales consist of barium sulphate ($BaSO_4$), strontium sulphate ($SrSO_4$) or calcium carbonate ($CaCO_3$). The most common places for scales to form are where there is a significant pressure drop, temperature change or where two PW streams of different chemistry mix (for example one high in barium and the other high in sulphates). These minerals can precipitate to form a solid mineral scale within a production well, in associated subsea flowlines, surface pipework and processing facilities. The scale itself comprising these materials is not a significant environmental issue; rather the material that can be deposited within the scale is the main issue, as highlighted in the following extract.

'When scale precipitates from a large volume of formation/produced water, radium is concentrated within a small amount of solid scale such that the radium concentration in scale exceeds the radium concentration in the formation/produced water by several orders of magnitude. As uranium and thorium radionuclides are substantially less soluble in the formation water than radium, NORM scale contains practically no uranium and/or thorium' (APPEA 2002b).

As part of the field development planning for the proposed development, the potential for scale formation was assessed, including the potential for individual wells to scale. The results indicated that there is very little possibility of scale deposition down-hole or in the processing. However, if scale formation does prove to be an issue, it will be managed by the injection of scale inhibitor. The Blacktip facilities will be designed into the system to allow scale inhibitor to be injected at the wellheads.

Maintenance of vessels during production phase, and clean-up tasks during decommissioning may require the disposal of scale should it have built up as a solid in the flowlines and pipework over the life of the project. In the unlikely event that the scale has a specific radioactivity above the NORMs threshold, it would be classified as a hazardous waste and dealt with appropriately (**Section 11.20.3**). A detailed plan will be prepared for regulatory approval if disposal is required during maintenance or decommissioning.

Owing to the low volumes expected and the assessment outlined above, low specific activity scale is predicted to have either no environmental impact or a slight environmental impact and the associated environmental risk is considered to be low.

Preventative and Management Measures

The primary measure for mitigating the potential effect of scale on the environment is to prevent the formation of scale in the process equipment. This will be achieved firstly by designing to restrict the potential for scale formation, and secondly by using scale inhibitor chemicals which are selected using the standard Woodside chemical selection process.

Should scale containing NORMs be recovered from the production process, appropriate disposal methods will be used for hazardous waste. Disposal options will minimise the potential for environmental harm.

Management Summary

In summary, preventative and management measures will include:

- Design to restrict the potential for scale formation, and secondly by using scale inhibitor chemicals which are selected using the standard Woodside chemical selection process.
- Should scale containing NORMs be recovered from the production process, appropriate disposal methods will be implemented in accordance with Northern Territory or Western Australian Government guidelines.

11.15 Cooling Water

Impacts

Whilst on site for drilling and installation activities, the Jack-up will require cooling water to prevent over-heating of machinery. Seawater drawn from the ocean will be circulated through heat exchangers and then discharged back into the ocean. As the seawater cooling system is segregated from other systems, the risk of cooling water contamination is very low. Potential impacts from the discharge of cooling water may result from temperature differences or biocides, added to prevent marine growths in the cooling water systems.

Mixing and dispersion of the discharged cooling water will reduce the temperature of the water and the concentration of biocides added. Typical biocides include sodium hypochlorite (chlorine), most of which reacts within the cooling system. Dosing rates are controlled to minimise the available chlorine in the discharge, and in the marine environment the biocide rapidly degrades to salt. As pelagic species in the development area are mobile, any exposure to the discharged cooling water would be temporary, with the exception of the fouling species located near the discharge point.

Ecological impacts of cooling water discharge are therefore expected to be negligible.

Preventative and Management Measures

The use and dosage of biocide in cooling water will be kept to the minimum required to ensure the cooling water system is in suitable condition for operational purposes. Rapid dispersion of the biocide by the surrounding ocean at the discharge point will also assist in minimising impacts.

Management Summary

In summary, preventative and management measures will include:

- Cooling water will be mixed by turbulence in the ocean causing dilution and dispersion. The effect of the cooling water will be negligible.
- The use and dosage of biocide in cooling water will be kept to the minimum required to ensure the cooling water system is in suitable condition for operational purposes.

11.16 Deck Drainage

Impacts

The Jack-up, laybarge, support vessels and wellhead platform will have deck drainage systems. Deck drainage will consist mainly of clean rainwater, which will generally be directed overboard. During drilling, well intervention or maintenance work oily or dirty equipment may lead to the generation of contaminated drainage water. Drip trays will be used to capture oily material. The unintentional release of contaminated drainage water from the decks of the wellhead platform, laybarge or support vessels could lead to a reduction in water quality leading to an adverse impact on marine fauna in the immediate vicinity of the release.

Preventative and Management Measures

No contaminated waste will be intentionally discharged via the vessels' deck drainage systems. The primary measure will be to avoid the possibility of spills in the first place through the initial integrity design built into process and utility equipment. Furthermore, the chemical selection process will favour the use of non-hazardous materials.

Areas on vessels, the laybarge and the Jack-up where hazardous materials will be stored including fuels, oils and lubricants will be bunded. The drainage system will segregate potentially contaminated drainage from clean run-off, ensuring clean run-off remains uncontaminated and is discharged overboard separately.

Spills on the Jack-up deck will be contained and diverted to the slops tank, sump or mopped up to prevent overboard discharge. To achieve this, the Jack-up will have scupper plugs available to block overboard drains, as well as absorbent booms and clean-up materials at the ready so that any spill on deck can be rapidly contained.

On board all vessels contaminated drainage will be directed to a sump (or similar), which is connected to an oily-water separator where it will be treated prior to discharge. The unit will be designed in accordance with IMO administration and will be capable of detecting oil content at 15 ppm. Drainage water from machinery space, with hydrocarbon concentration <15 ppm, will be discharged to sea as per MARPOL regulations; however, this may not be allowed within relevant port limits. The vessel contractor will consult with the relevant Port Authority for clarity on allowable discharges (if any) within port limits. Discharge to sea in accordance with MARPOL regulations will not occur during any diving-related activities. Drainage water with hydrocarbon concentration >15 ppm will be stored in suitable containers and transported to shore for treatment. The holding tank contents will be disposed of onshore by a certified waste oil disposal contractor, most likely in Darwin.

The wellhead platform will most likely have decks of open steel grating; however, oily or dirty run-off is not expected to be generated during normal operations. There will be no fuel storage on the platform or diesel generators.

Deck drainage on the condensate trading tankers will be managed to the Oil Companies International Marine Forum guidelines and the International Safety Guide for Oil Tankers and Terminals guidelines to prevent any discharge of oily water.

Materials handling, 'dropped object' studies, and operating and maintenance procedures will also be implemented. Routine maintenance and visual monitoring will allow for the early detection of leaks, ensuring a quick response to repair leaks and clean up spills.

Management Summary

In summary, preventative and management measures will include:

- The avoidance of spills through the initial design integrity built into process and utility equipment, materials handling and operating and maintenance procedures.
- The chemical selection process will favour the use of non-hazardous materials.
- No contaminated waste will be intentionally discharged via deck washdown.
- The drainage system will segregate potentially contaminated drainage from clean run-off.
- Areas on the Jack-up, laybarge and support vessels which are more likely to have small oil spills will be bunded so that the oil can be cleaned up or directed to a sump, or similar.
- Deck drainage water on all vessels will be either directed overboard if it is clean or directed to a sump (or similar) which is connected to an oily-water separator. Once separated, the oil and grease will be stored in suitable containers ahead of transfer ashore for recycling, and the treated water will be discharged to sea. This discharge will be monitored for oil-in-water content.
- Spills on the Jack-up deck will be contained and diverted to the slops tank, sump or mopped up to prevent overboard discharge.
- Deck drainage on the condensate trading tankers will be managed to the Oil Companies International Marine Forum guidelines and the International Safety Guide for Oil Tankers and Terminals guidelines to prevent any discharge of oily water.
- Routine maintenance and visual monitoring will allow for early detection of leaks, ensuring a quick response to repair leaks and clean up spills.

11.17 Ballast Water

Impacts

Ballast water is seawater that is taken on to maintain vessel weight and stability in the ocean. Ballast water will be discharged from the Jack-up and laybarge only once, on arrival or prior to arrival at site. Trading tankers will exchange ballast water at sea before arrival at the nearshore condensate export mooring and will then discharge the exchanged ballast water on site to load condensate. Ballast water tanks on all vessels will be segregated from the fuel and condensate tanks and the ballast water will not contain oily residue or contaminants.

Support vessels, work boats and tugs generally do not have ballast tanks. However, if they are large enough vessels to have ballast tanks then the same regulations will apply as for tankers.

There are no environmental impacts predicted to occur as a result of the discharge of seawater from ballast water tanks in the open ocean at the proposed wellhead platform location, or from exchanging ballast water outside 12 nm from the coast . The potential for the introduction of exotic marine species in ballast water is separately assessed in **Section 11.6**.

Preventative and Management Measures

Woodside has in place a tanker vetting system that will be applied throughout the Blacktip Project to ensure that tankers taking on condensate from Woodside facilities are of an acceptable standard. The use of fully segregated ballast water tanks is a requirement of the vetting process; vessels that do not satisfy this requirement are not permitted. The same standard will be applied to all vessels including the pipeline laybarge.

All vessels will comply with MARPOL regulations, Northern Territory Marine Pollution Act, Australian Quarantine Act and the AQIS guidelines for ballast water management where such are applicable.

Management Summary

In summary, preventative and management measures will include:

- Vetting procedures for the Jack-up, laybarge, condensate trading tankers, installation and support vessels will be used throughout the various phases of the Blacktip Project. These vetting procedures will require all vessels to have segregated ballast water tanks to minimise the potential for contaminated ballast water to be discharged.
- All vessels will comply with MARPOL regulations, Northern Territory Marine Pollution Act, Australian Quarantine Act and the AQIS guidelines for ballast water management where such are applicable.
- A Ballast Water Management Plan will be prepared and implemented **(Section 15**).

11.18 Produced Water

A comprehensive analysis of the potential impacts and environmental risks posed by PW was undertaken for the Blacktip Project by IRC Environment. The findings of this study are summarised below, and the complete study is presented in **Appendix J, Volume 2** of this Draft EIS.

Impacts

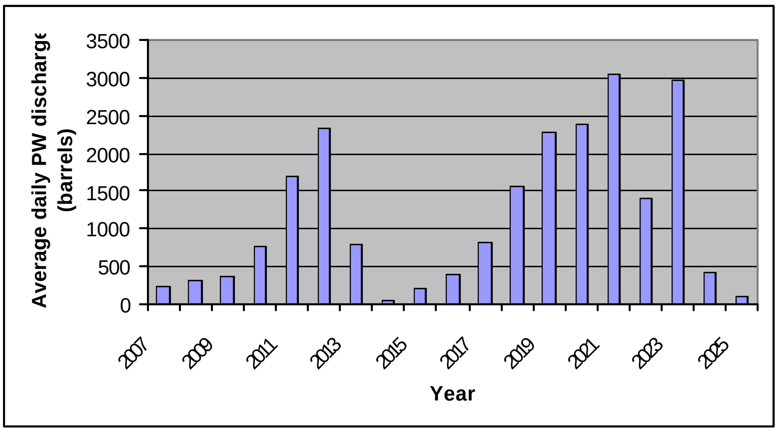
Produced Water (PW), also referred to as produced formation water or formation water, is the water that is separated from the production stream during oil and gas production. In gas and condensate wells, PW is generally associated with saturation water that condenses due to the pressure drop between the reservoir and surface.

PW is of environmental concern due to contaminants, which are typically present in small quantities, including:

- dispersed oil;
- dissolved organic compounds (aliphatic and aromatic hydrocarbons including polyaromatic hydrocarbons or PAHs, organic acids and phenols);
- inorganic compounds;
- residual process chemicals;
- carboxylic acids;
- heavy metals.

The composition of PW varies according to the attributes of the reservoir geology and hydrocarbon properties. PW from gas/condensate fields such as Blacktip usually contains higher concentrations of hydrocarbons than PW from oil fields due to the technical difficulties in separating condensate from water. This is offset by the low volumes of water produced from gas fields. At this stage it is not possible to precisely quantify the constituents of Blacktip condensate or PW.

The Blacktip Project's PW discharge rate will vary over the life of the field, increasing from 200 bpd (32 m^3) at start-up to a maximum of 7800 bpd (1119 m^3) in 2012. Rates will fluctuate throughout the project life as the reservoirs mature and new wells are brought online (**Figure 11-1**).



- **Figure 11-1 Annual Average Daily PW Discharge Rate (barrel = 0.159m^3)**

The Blacktip PW treatment process is discussed in detail in **Section 4.7.5**. The treated PW will be discharged approximately 3 km offshore. Preliminary design indicate that at least 700 dilutions can be achieved within 20 m of release for the maximum discharge rate, reducing the PW concentration from 100% to 0.14% (**Figure 11-2**).

PW may cause an oily sheen which has a visual impact. Sheen associated with PW discharge occurs when free oil within the PW rises to the sea surface and forms a visible micro-layer. The sheen persists until such time as the oil has dispersed. It is likely that sheen formation will occur whenever the oil-in-water concentration exceeds approximately 15 ppm (Woodside 2002b). The

Blacktip PW treatment facilities have been designed to achieve very low concentrations of free oil and very high dilution rates upon discharge, which will minimise any sheening.

Once discharged to sea, PW is subject to a number of physical, chemical and biological changes. Although the individual processes causing these changes act simultaneously, their relative importance varies with time. In the short term, evaporation and dilution are the most effective processes for reducing contaminant concentrations and mitigating acute toxic effects. Other processes including biodegradation, oxidation and sedimentation act over longer time scales.

Due to the processes above, and the careful selection of process chemicals to minimise acute toxicity, the majority of components are not expected to have any acute effects. The concerns raised by the discharge of PW relate to chronic effects and constituents that may accumulate in the tissues of marine organisms (bioaccumulate).

Polycyclic Aromatic Hydrocarbons (PAH) are the PW contaminants of greatest environmental concern as they have a wide range of solubilities and bioaccumulation potential (Neff and Sauer 1996, Neff 2002). However, the most common PAHs (naphthalene, alkylnaphthalenes, fluorene and phenanthrene) are soluble and tend to evaporate readily. As the Blacktip Project discharge area will be strongly mixed by tides and discharged PW dilution will be high, concentrations of PAHs are unlikely to become high enough to lead to bioaccumulation.

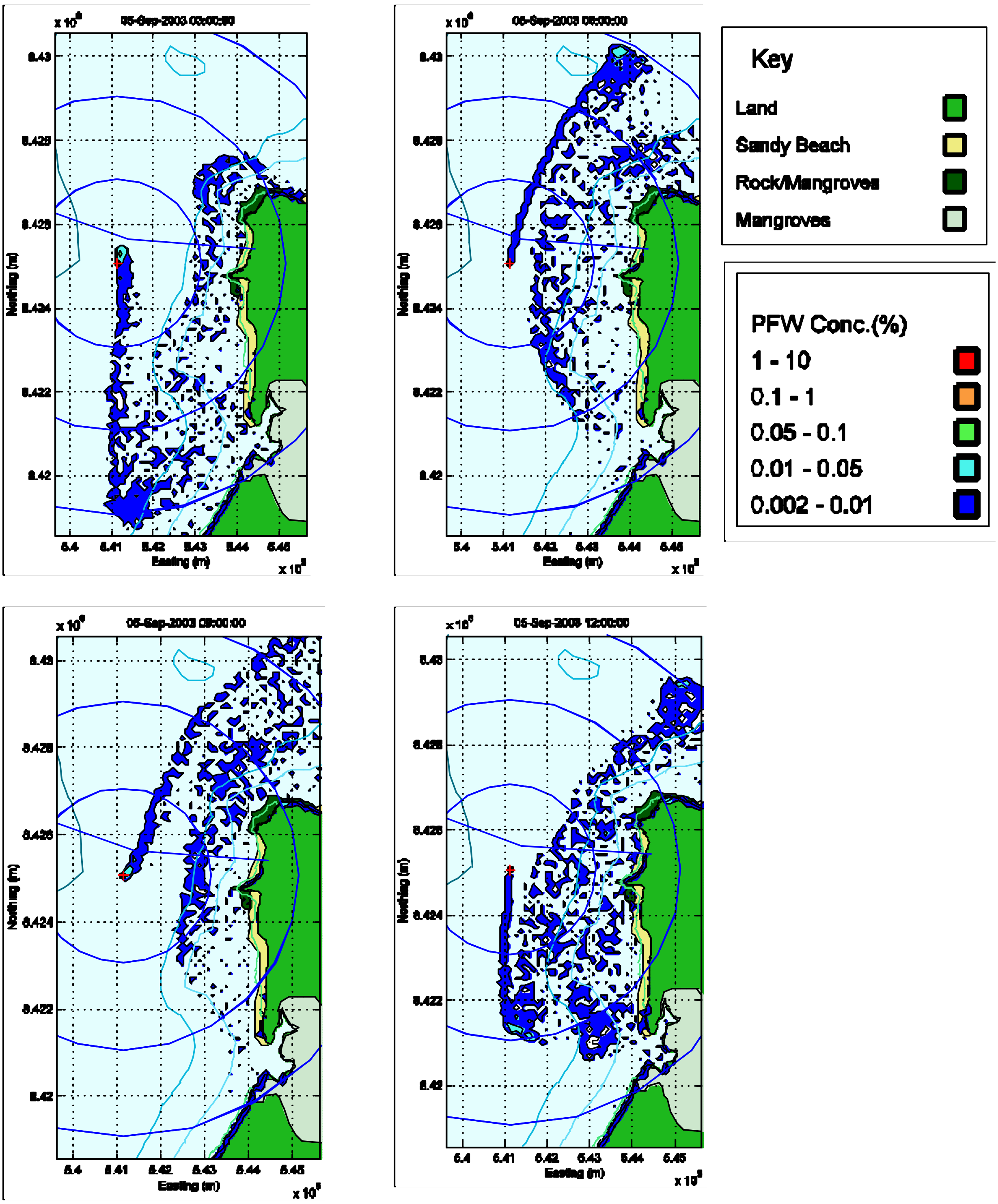
The environmental effect of produced water has been subjected to numerous studies, mostly focussing on acute toxicity. The results have generally concluded that PW is not acutely toxic (Neff 2002). Field studies over the past 15 years addressing the impacts of PW have found measured environmental concentrations of targeted contaminants generally below No Observed Effect Concentrations (NOEC) (Neff 2002).

Woodside has undertaken extensive studies into the fate and toxicity of PW discharges from its five facilities located off the coast of North West Australia and in the Timor Sea (IRC 2003a-e). In these studies, toxicity of the whole effluent, which includes residual process chemicals, was measured on five organisms; bacteria, algae, rock oyster larvae, juvenile tiger prawns and sea urchins.

The relevant toxicity thresholds were identified for each of these organisms, defining the ‘Predicted No Effect Concentration’ (PNEC) for each organism. The PNEC values were then combined with modelling results for the Blacktip Project to determine likely “zones of effect” in the Joseph Bonaparte Gulf receiving waters, using the following approach:

- Identification of the major circulation patterns and hydrodynamic influences in the project area.
- Modelling the dilution and dispersion of the plume and obtaining the Predicted Environmental Concentration (PEC).
- Determining the impact of the PW discharge using the PEC:PNEC method, whereby if the PEC:PNEC ratio is larger than one, there is the potential for an environmental effect and if the

PEC:PNEC ratio is less than one, no toxic effect is expected. Toxicity threshold of the most sensitive taxa in the IRC (2003a-e) studies used.



▪ **Figure 11-2 Predicted PW Concentration for the Maximum PW Discharge Rate (7,000 bpd) in Surface Layer (0–2 M) over a Neap Tide. Range Rings (2 km) Indicate Distance from Discharge Location**

The modelling considered the maximum predicted PW discharge in combination with neap tides (weakest tidal currents and minimal dilution) to provide the worst case results for the lifetime of the facility. Under this scenario the PEC:PNEC ratio exceeded one within the surface waters, from the pipeline discharge point and out to 400 m beyond. This build up of PW appeared to occur as the tide turned at slack waters. The peaks were intermittent and occurred for only short periods during a tidal cycle. At all other times, modelled PEC:PNEC ratios were below one due to:

- low rates of discharge;
- low contaminant concentration in PW;
- high rates of dilution at the point of discharge due to strong tidal currents and diffuser design.

Full modelling results are provided in **Technical Appendix J, Volume 2** of this **Draft EIS**.

The PEC:PNEC approach is generally considered to be highly conservative, as it assumes an ecological response immediately on contact with PW that exceeds the PNEC. In reality the PNECs are derived from ecotoxicology studies in which organisms are exposed for durations of at least one hour. The PW plume moves with the currents and tides and individual organisms are unlikely to be exposed for anything like these durations.

Biological communities are unlikely to experience prolonged exposure to the PW plume. Plankton are at most risk, as they are freely floating organisms which may pass directly through or be entrained in the discharge plume. However, as the PEC:PNEC ratio is generally likely to be less than one, this exposure is unlikely to have a noticeable impact on the planktonic community. Benthic organisms are unlikely to be exposed to the buoyant PW plume at all, as the plume is unlikely to contact the seabed. Fish are likely to swim through the plume occasionally, leading only to sporadic exposure. Seabirds are harmed mainly by the physical properties of floating oil and not the toxicity (Furness and Camphuysen 1997) and insufficient floating oil is likely to be produced from PW discharge to have an impact.

Higher trophic level species may be affected by accumulation of toxins in the food chain, however as bioaccumulation is unlikely to be significant, impacts on marine mammals, seabirds and other top predators are likely to be negligible.

When present in foods, petroleum hydrocarbons stimulate an olfactory response that can cause a tainting of taste. Fish tainting can occur when fish are exposed to ambient concentrations of 4–330 ppm (Connell and Miller 1981) and filter feeders, such as oysters, can be tainted at concentrations as low as 10 ppb (O'Sullivan and Jacques 2001), though this is dependent on exposure periods. These results indicate that the PW is highly unlikely to cause tainting of fish, except possibly those residing directly in the discharge plume at the point of discharge. Coastal fauna, including oysters and mud crabs, are also highly unlikely to be affected by tainting as the modelling results indicate that the exposure times are minimal and that the concentrations of PW hydrocarbons contacting the coast is very low. Under maximum discharge rates with an onshore wind (worst case conditions) modelling indicates hydrocarbon concentration will be below 5 ppb.

The removal of hydrocarbons from PW followed by disposal to the ocean is common practice throughout the offshore industry. The separation process is usually only partly successful, and the constituents described above typically remain in the PW. Accordingly, most of the world's regulatory authorities set limits on the concentration of petroleum hydrocarbons (or total oil and grease) that can remain in PW for ocean disposal.

For the Blacktip Project, regulations will be set under the PSLA, and Northern Territory and Commonwealth Guidelines. PSLA specifies that the oil concentration must be below 50 mg/L oil, with the 24 hour average below 30 mg/L. The standards with regard to final effluent characteristics will be agreed with and set by the relevant agencies.

Preventative and Management Measures

The primary preventative and management measures employed to minimise the impact of PW disposal will include:

- The results of a modelling study have allowed a variety of discharge scenarios to be tested (**Appendix J, Volume 2**). These results have been used to select the location and design of the discharge to maximise the dilution and dispersion of the produced water.
- Regulatory agreement will be obtained on final effluent characteristics.
- The treatment system which was chosen for its ability to achieve very low oil-in-water concentrations whilst also being robust to variations in water flowrates (**Section 4.7.5**).
- Process chemical selection, which will select only environmentally acceptable chemicals.
- Monitoring to continually measure the oil-in-water concentration using an in-line analyser, to ensure compliance with all regulations, and includes a system to divert or hold the discharge stream for re-treatment should it exceed the maximum acceptable concentration.

Management Summary

- Produced water will be treated to meet legislative requirements for oil and grease content, so hydrocarbon loads will be low. The discharge location has been selected to maximise the dilution and dispersion of the produced water.

11.19 Hydrocarbon Spills

Impacts

Large liquid hydrocarbon spills, whilst highly unlikely, potentially pose significant impact to the environment from the Blacktip Project. The severity of the impacts from spills is directly related to the size of the spill, the chemical characteristics of the spilt hydrocarbon, the weather conditions (wind, tide etc) and the sensitivity of the receiving environment. The following section presents the findings of hydrocarbon spill modelling undertaken for the Blacktip Project.

The main liquid hydrocarbon inventories associated with the Blacktip Project will include:

- condensate being produced from the reservoir and exported to the onshore gas plant (maximum of 80 m^3 per day);
- loading of condensate on to trading tankers (10,000 m^3 per tanker);
- condensate stored on and transported by the trading tankers (a fully laden tanker holds 100,000 m^3);
- heavy fuel oil stored on the trading tankers (a fully laden tanker holds 2,500 m^3);
- diesel stored on construction and support vessels and the drill rig (typically about 100 m^3 for support vessels).

Any spilt hydrocarbon at the wellhead platform, including large spills such as that caused by a blowout, will evaporate before reaching sensitive coastal resources. Additionally, the wellhead platform will be unmanned except during maintenance, largely removing the potential for accidental spills caused by human error.

Sources of large-scale spills near shore could possibly be from accidents involving condensate tanker operations resulting in the full or part loss of cargo and or fuel oil. A series of stringent safeguard measures, detailed below, would all need to fail for this type of spill to occur. According to industry averages for well-managed operations, large spills of the magnitude of 100 m^3 or more are extremely unlikely, have a frequency of one in 100–1000 years or greater. Woodside undertook a Quantitative Risk Assessment study for the WA-271-P development (Woodside 2002b) to estimate the highest potential frequency of occurrence for different spill sizes. The results from this study are applicable to the proposed development and are summarised in **Table 11-2**.

- **Table 11-2 Potential Sources and Frequency of Hydrocarbon Release (from**

Volume	Maximum Potential Frequency	Example Potential Sources
<1 m3	One in 1 – 2 years	Small leaks and spills
1 – 10 m3	One in 2 – 3 years	Small offloading spills
10 – 50 m3	One in 50 years	Spill of diesel day tank contents
50 – 100 m3	One in 100 – 1,000 years	Large offloading spill
1000 m3	One in 10,000 years	Large trading tanker failure
>1000 m3	As low as one in 1,000,000 years	Major trading tanker failure

Source: Woodside 2002b

More likely spill scenarios include small scale spills, such as spills during cargo loading operations. For the Blacktip Project a condensate spill during cargo loading of 8 m^3 has been selected as the most likely spill scenario. Spills of this magnitude from all sources, not just condensate loading, have a frequency of one in 2–3 years (**Table 11-2**). However, the frequency of spills during the operation phase of the Blacktip Project should be less than industry averages as only a small volume of condensate is produced, there will be minimal tanker vessel movements and loadings, and offshore activity will be far less than for manned operations.

The likelihood of this type of spill provides a key focus for spill contingency measures to be prepared and implemented for the project. Contingency planning will be developed with the ability to mitigate as much as possible the impacts of all spills, regardless of size. Contingency planning will also concentrate on the protection of the most sensitive habitats along the coasts, including mangroves and the inlets to the two swamps located to the north and south of the condensate export facility. Oil spill preventive and management measures are detailed at the end of this section.

It is worth noting that over the last 20 or more years, the largest spill to have been recorded from Australian offshore oil and gas production activities is 60 m^3. The total volume of accidental oil spills from all Australian facilities over this time is estimated at less than 1,000 m^3 (Woodside 2002b).

Fate: Following an accidental loss to the marine environment, oil generally spreads out over the sea surface to form a slick. The slick is then transported horizontally away from the spill location by wind and currents. The rate of spread of the slick is largely dependent upon the nature of the oil and the sea state, proceeding most quickly with light oils and in the presence of breaking waves.

A range of weathering processes also act on the slick that change the physical and chemical properties in the short term and eventually cause the complete break down of the slick in the longer term. These processes are detailed in **Technical Appendix K, Volume 2**. The relative importance of the weathering processes will depend on the type of oil spilt. For Blacktip, the prevailing wind and surface currents will be the most important factors transporting the oil away from the spill location as tidal currents are strong and winds are typically onshore during the wet season.

Properties of Blacktip Condensate: The properties of Blacktip condensate are summarised in **Table 11-3**. It is a light oil with an API of 49°. Should the condensate be spilt to the sea, it would spread rapidly on the sea surface due to its low density, and would be readily lost through evaporation and dispersion into the water column. Modelling of weathering behaviour predicts that 60–85% of a spill would be removed within the first 24 hours due to evaporation. Any residual condensate not evaporated or dispersed would be removed by microbial degradation. Blacktip condensate therefore will not be persistent in the marine environment in the event of a spill.

- **Table 11-3 Characteristics of Blacktip Condensate in comparison to Fuel Oil & Diesel**

Parameter	Blacktip Condensate	Diesel	Heavy Oil
Specific Gravity (g/cc)	0.736	0.84 to 0.88	0.95
API (°)	49	30 to 32	17.5
Flash Point (°C)	< -5	40 to 46	98
Viscosity @20°C (cSt)	0.5	13	750

Spills*:* The likelihood of larger spills at the condensate export mooring, or anywhere else, is extremely remote as all preventative measures put in place would need to fail. For example, if the flexible loading hose failed and broke from the condensate export line, the pressure of seawater acting on the condensate in the pipeline would limit the spill to about 100 m3. However, correct design and a regular maintenance schedule will eliminate the likelihood of the loading riser failing due to mechanical problems.

A spill of up to 100 m^3 of diesel would only occur near shore if a support vessel ruptured a fuel tank as a result of a violent grounding or collision. Similarly, a spill of 500 m^3 of heavy fuel oil would only occur if a trading tanker ruptured one fuel tank. Aframax trading tankers carry up to 2,500 m^3 of heavy fuel oil in five separate tanks and 100,000 m^3 of condensate. A spill of 100,000 m^3 would only occur if a trading tanker lost its entire load of condensate. For a vessel to rupture a fuel or cargo tank, all safety measures would need to fail. The following would need to occur:

- the vessel would need to run aground or collide violently due to navigation error or engine failure;
- support vessels would fail to respond and provide assistance;
- the cargo or fuel tanks would need to rupture ('Aframax' trading tankers are double hulled) and spill their loads to the sea.

This will not be allowed to happen. Woodside will vet trading tankers and support vessels to ensure that no substandard vessels are allowed. They will provide detailed mooring instructions and support vessels (tugs) to enable safe mooring. Mooring will only occur if weather conditions are suitable (below a Beaufort 6 seastate) and all valves and the flexible transfer hoses will be checked for integrity prior to use. Additional preventative and management measures are discussed in detail at the end of **Section 11.19**.

The most realistic hydrocarbon spill scenario for the Blacktip Project is the spillage of a small volume (8 m^3) of condensate during loading on to tankers at the condensate export mooring. The modelling results are presented below.

The proposed Blacktip Project will be managed to avoid or minimise the potential for accidental releases of all hydrocarbons. However, whilst the probability of an accidental release of hydrocarbons is extremely remote, the consequences of a hydrocarbon spill could be potentially significant, particularly for larger spills.

11.19.1 Oil Spill Fate and Trajectory Modelling

Model Descriptions: An oil spill trajectory modelling system was developed for the Blacktip Project to predict the consequence of oil spills. The modelling system comprises an oil weathering model coupled with a three-dimensional oil spill trajectory model and a detailed hydrodynamic finite element model of the Bonaparte Gulf (IRC 2004b). The hydrodynamic model simulates the flow of ocean currents generated by astronomical tides and wind stress, the two most significant driving forces in the region. Given the proximity of the condensate export mooring to the shoreline, the large tides and wide intertidal zone in the Joseph Bonaparte Gulf, particular attention was given to the accurate simulation of the wetting and drying of intertidal zones and the resolution of the circulation in the vicinity of the coastline. The modelled current direction and phase were verified against measured data with the results confirming that the model is fit for purpose.

Wind forcing for the model was based on historic data measured at the Australian Bureau of Meteorology's Wadeye meteorological station. Three seasons are evident:

- the 'summer' wet season between September and February when winds are predominantly from the northwest;
- the 'winter' dry season between April and July when winds are predominantly from the southeast;
- the transitional seasons (March and August) when winds can blow from either direction.

Deterministic and Stochastic Simulations: The model was run in both deterministic and stochastic (statistical) modes. In deterministic mode, a single simulation was undertaken to determine the fate and likely consequence of an individual oil spill. This was modelled for worst-case conditions, which is the spill initiated on a neap tide resulting in minimal dilution, coinciding with a 5 ms^{-1} onshore wind to drive the spill onto the coastline. To demonstrate the worst case scenario, all modelled scenarios assume that no response measures are undertaken. However, in the unlikely event of a spill, Woodside would implement the management measures outlined at the end of this section to reduce possible impacts. Results of the modelling are presented as contour plots showing:

- hourly concentration of oil at sea;
- stranded masses of beached oil.

The model was also run in stochastic mode to take into consideration the frequency of occurrence of a range of different tide and wind conditions. In this mode, multiple spill simulations (100) were undertaken using randomly selected start dates for the wet and dry season. The results from each simulation were combined to generate contour plots showing the probability of hydrocarbons impacting a given location.

Modelled Scenario: The risk assessment modelling of a spill of Blacktip condensate during loading on to a trading tanker is based on losing 8 m^3 of condensate over a period of one hour. The frequency of a spill of this size has been conservatively estimated at one in 2–3 years. However, this is based on historic data and this frequency is likely to be less today given improvements in risk management and the limited number of tanker loadings scheduled for the Blacktip Project. Loading will be continually monitored and carried out under constant supervision. Any discrepancy between the volume being loaded and that received at the tanker, or any physical observations of oil being released to the ocean would be quickly noticed and the emergency shut-down procedures activated.

Figure 11-3 and **Figure 11-4** present the results from the 8 m^3 spill of Blacktip condensate under worst case conditions of a neap tide and a 5 ms^{-1} onshore wind. The condensate was released on the ebb tide. Three hours after the release commenced, the slick had travelled 4 km from the release point towards the north-east and was predicted to extend over approximately one kilometre. On the following flood tide, the slick returned towards the south. The northern part became entrained into the pipeline shore crossing bay where it impacted the shoreline about 6 hours after release.

Approximately 82% of the condensate evaporated before a total of 900 kg became stranded on shorelines. Less than one kilometre of the coastline was impacted with a maximum of 136 kg of spilt oil being beached within any 100 m stretch of coastline (model resolution is 100 by 100 m). Once beached, condensate would continue to evaporate and would be unlikely to result in long-term environmental damage unless it is incorporated into sediments. Condensate is expected to totally evaporate and disperse within three days on sandy beaches. It therefore would not pose a significant risk to the offshore marine environment.

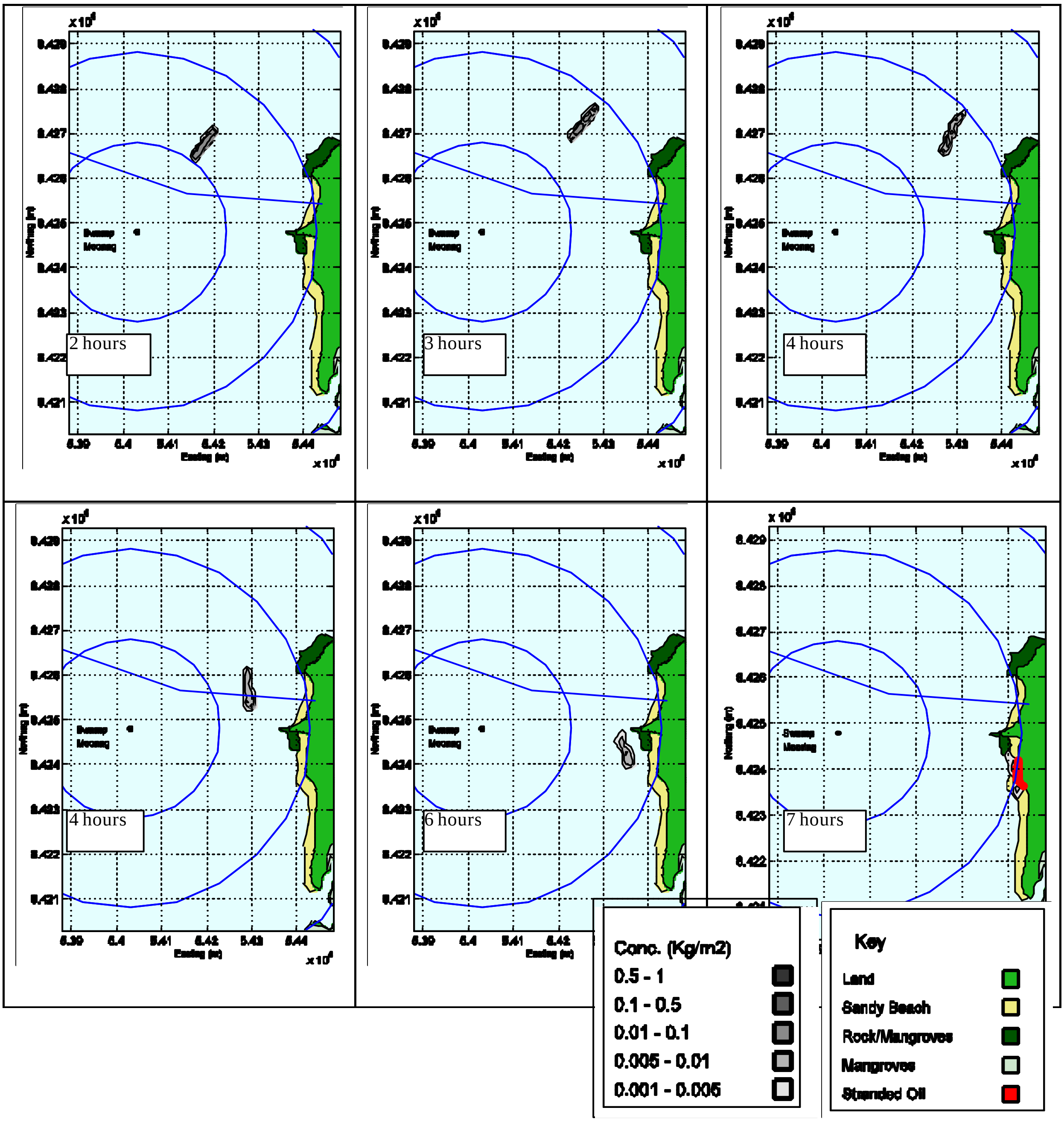
Figure 11-5 and **Figure 11-6** show the predicted probability of exposure to condensate for the wet and dry seasons, respectively. During the wet season prevailing winds are north-westerly and the condensate would be driven directly onshore. Results show that there would be a maximum of 0.05 probability of oil impacting the shoreline after one day and that less than 20 km of the coastline would be at risk. A similar result is shown after five days suggesting that most of the oil would be evaporated or driven onshore within the first 24 hours.

During the dry season prevailing winds are offshore and the probability of oil being washed ashore has reduced to 0.02. After five days the 2% probability contour envelopes extend over about 25 km, parallel to the coastline, and approximately 25 km offshore. Less than 5 km of coastline would be at risk.

The tanker mooring location has been re-positioned since the technical report was completed (**Appendix J**, **Volume 2**). The modelled scenario as presented in this EIS has been updated to reflect the change in location; however, the associated technical report has not been updated as initial comparisons indicated that the small change in tanker location would not affect the model outputs.

11.19.2 Effects on Biota

A vast number of laboratory studies have been published describing the toxicities of crude and refined oils. However, large scale mortalities of marine life resulting from hydrocarbon toxicity are relatively rare, localised and short lived and are only associated with oil spills in areas with poor water exchange. For example, actual field-based post-spill studies on plankton populations have shown either no effects or temporary minor effects (Kunhold 1978). Similarly, fish mortalities are rarely observed as it is thought that fish actively avoid waters underneath spills. Where fish mortalities have been recorded, the spills have occurred in sheltered bays in which the oil and fish could not readily disperse (resulting from the groundings of the tankers ‘Amoco Cadiz’ in 1978 and ‘Florida’ in 1969).

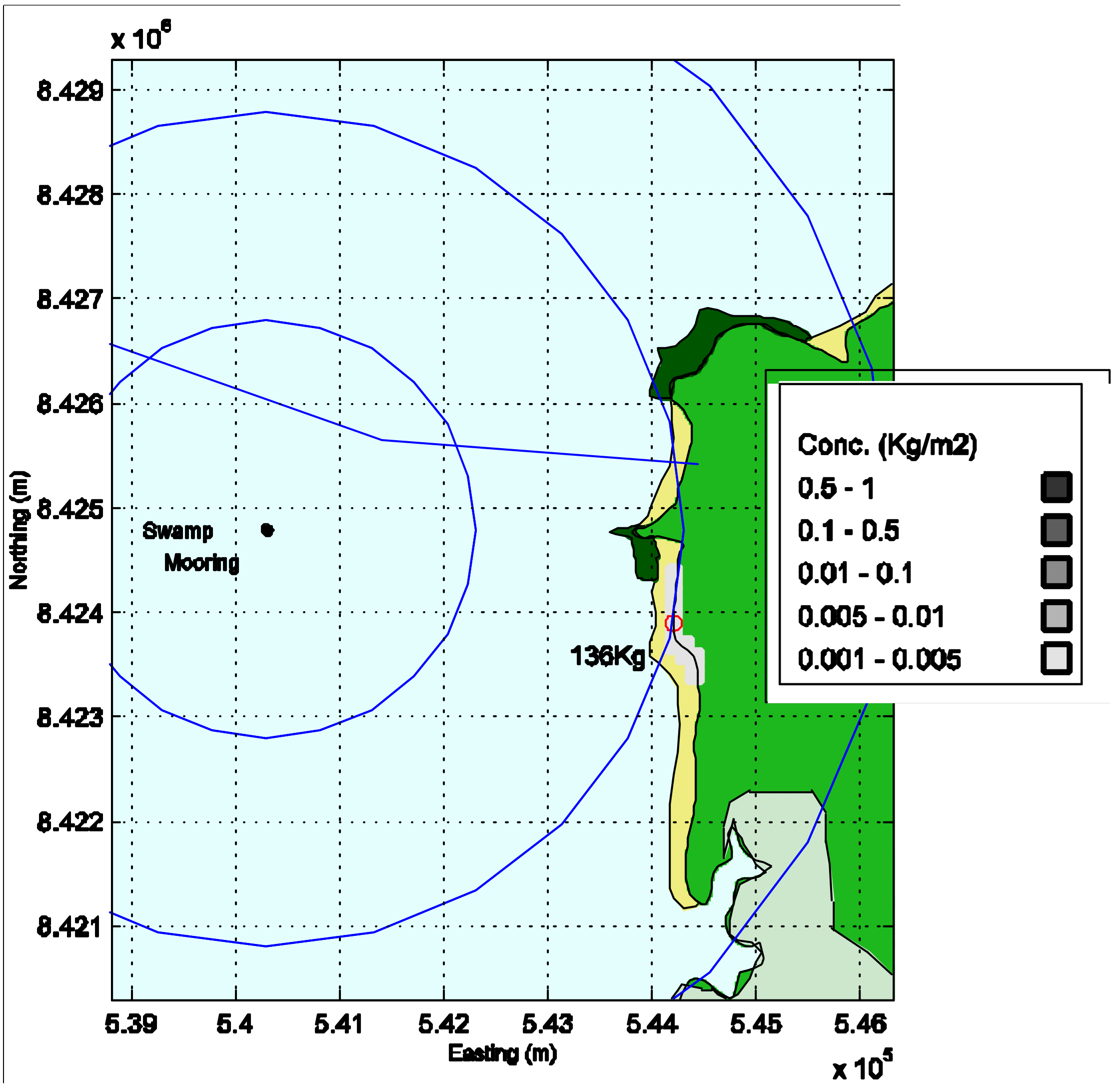


- **Figure 11-3 Predicted Surface Oil Concentration for a 8 m^3 Spill of Blacktip Condensate During a Neap Tide and an Onshore 5 s^{-1} Wind (Wet Season)**

(1) **Figure 11-3** shows the trajectory and predicted concentration of condensate at sea for an 8 m^3 spill under worst-case ambient conditions. The figure above shows the resulting mass washed up on the beach. The model does not allow outwashing of the condensate so this is the cumulative mass of oil that arrives on the beach with no further weathering processes applied. The maximum mass washed up, 136 kg, is indicated by the red circle.

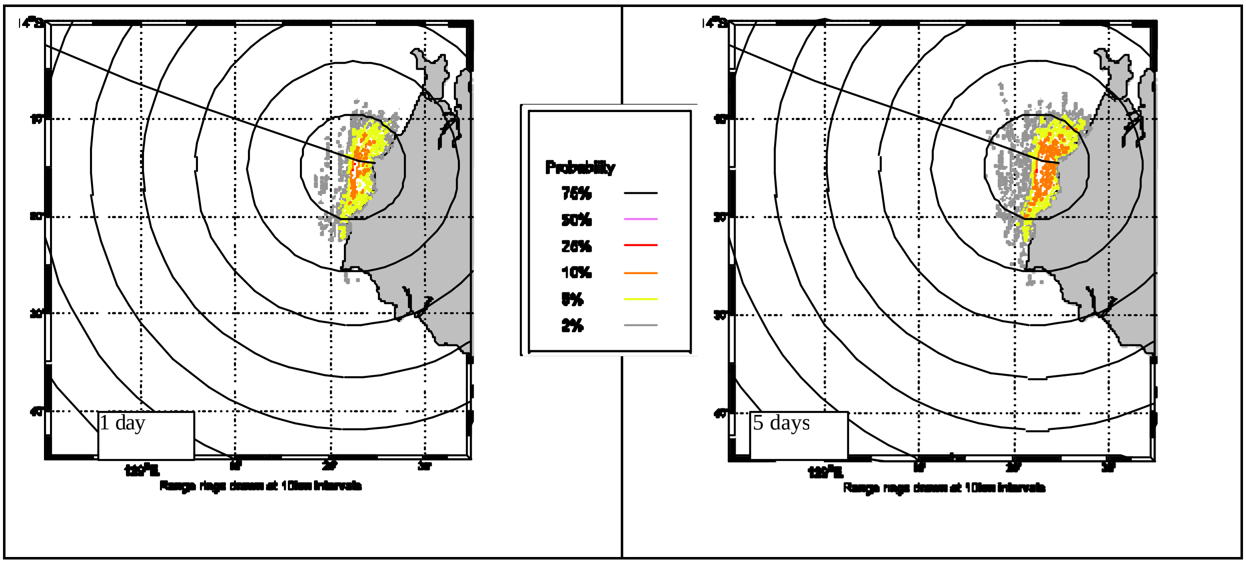
(2) Evaporation rates are high from condensate. Approximately 80% was evaporated whilst at sea. Once ashore this process would continue. Any residual, resistant to evaporation would be removed by biodegradation and photoxidation.

(3) The proposed pipeline and distance rings (2 km intervals) about the condensate export mooring are shown in blue.

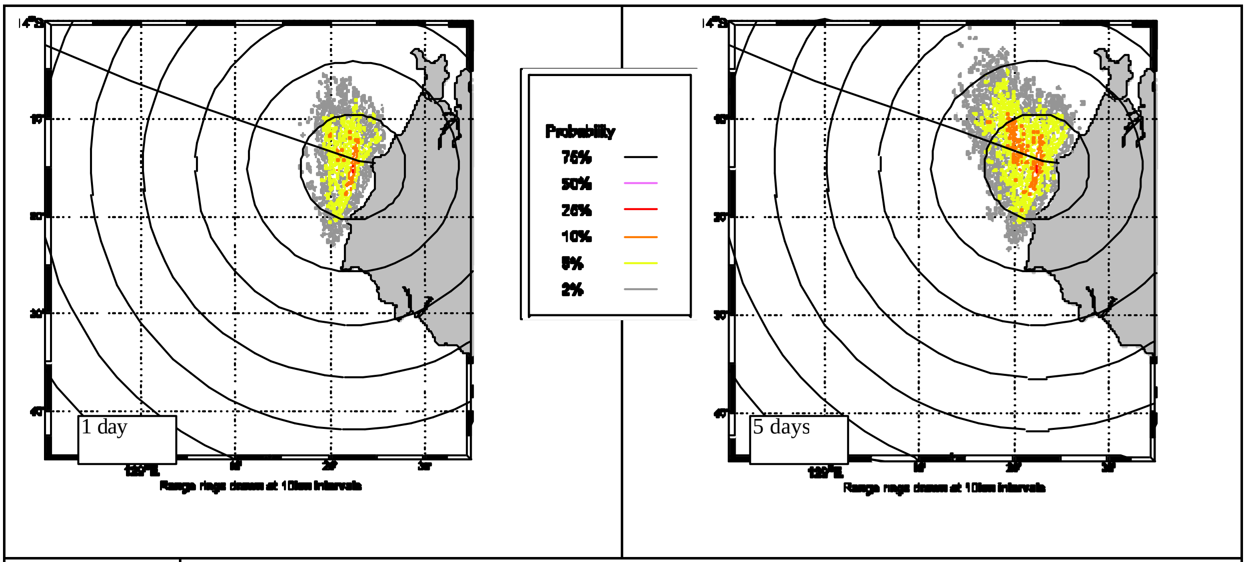


- **Figure 11-4 Predicted Mass of Stranded Oil for a 8m^3 Spill of Blacktip Condensate During a Neap Tide in the Wet Season**

- **Figure 11-5 Probability of Surface Exposure After One and Five Days Resulting From a 8 M^3 Condensate Spill Occurring Over One Hour for the Wet Season**



- **Figure 11-6 Probability of Surface Exposure after One and Five Days Resulting from a 8 m^3 Condensate Spill Occurring over One Hour for the Dry Season**



Risk	2%	5%	10%	25%	50%	75%

(1) The probability contours were calculated from 100 oil spill simulations using randomly selected wind and circulation data for the defined months of the specified seasons.

(2) The proposed pipeline and distance rings about the condensate export mooring are shown in blue. Distance rings are drawn at 10 km intervals. Coastline between Point Pearce and Cape Hay is shown.

Physical effects: Physical effects from hydrocarbons are of greater concern and include coating and/or smothering which, in cases of severe contamination, can lead to death through the prevention of normal functions such as feeding, insulation, respiration and movement. As damage is caused by physical contact, the animals and plants at most risk from physical effects are those that could come into contact with a contaminated sea surface.

Whales and Dolphins: Whales and dolphins surface to breathe air. They are therefore vulnerable to exposure to oil spill impacts caused by intersecting an area of oil slick on the sea surface (AMSA 1998). However, whales and dolphins are smooth-skinned, hairless mammals, so oil tends not to stick to their skin and since they do not rely on fur for insulation, they will not be particularly sensitive to the physical effects of oiling. Additionally, whales and dolphins are also known to actively avoid oil slicks. For example, studies of bottlenose dolphins found that this species was able to detect and actively avoid a surface slick after a few brief contacts and that there were no observed adverse effects Smith *et al.*, 1983).

Whales and dolphins are not abundant in the Joseph Bonaparte Gulf. There are no known whale and dolphin breeding, feeding or resting areas in the Joseph Bonaparte Gulf. Baleen whales, which are susceptible to suffering damage to their feeding apparatus, rarely occur in the Joseph Bonaparte Gulf and, if they occur, are unlikely to be actively feeding (**Section 7.3.7**).

Dugongs: No information is available regarding the susceptibility or sensitivity of dugongs to oil spills. Like whales and dolphins they are likely to be able to detect a surface slick but it is not known whether they will in fact do so or whether the brief contact may cause eye damage or other significant damage.

Dugongs may be secondarily affected by ingesting oiled seagrass leaves. Such oiling of seagrasses is generally restricted to intertidal seagrass communities, which are not common in the Blacktip Project area. In the absence of any data to the contrary, dugongs must be considered to be potentially sensitive to oil with the predicted environmental consequence the same as for whales and dolphins. Importantly, the oil spill modelling indicates that even for large spills (500 m^3), oil does not impact the area around Dorcherty Island where the main local population of dugongs is located.

Turtles: There is little documented evidence of the effect of oil on turtles. Should turtles make contact with a spill, the impact is likely to include oiling of the body as well as irritations caused by contact with eyes, nasal and other body cavities and possibly ingestion or inhalation of toxic vapours.

Turtles and hatchlings are also very vulnerable at nesting sites during the breeding season. Eggs may be contaminated with oil, which may inhibit their development, and newly hatched turtles may become oiled or the oil may act as a barrier preventing them from reaching the sea (AMSA 1998). Importantly, the oil spill modelling indicates that for even large spills, oil does not extend to the important turtle nesting areas around Cape Hay and Point Pearce.

Sea Snakes and Crocodiles: No information is available regarding the susceptibility or sensitivity of sea snakes and crocodiles to oil spills. Sea snakes and crocodiles surface to breathe air and may be vulnerable to oil spill impacts. Crocodiles reside in the intertidal zone and would be particularly susceptible to stranded oil, especially if this occurred in tidal mangrove inlets.

Birds: Birds which congregate in large numbers on the sea or shorelines to breed, feed or moult are particularly vulnerable to oil pollution. Although oil ingested by birds during preening may be lethal, the most common cause of death is from drowning, loss of body heat and starvation following damage to the plumage by oil. Mortalities among shoreline feeding/resting species are generally a less common, but a still frequent outcome of oil spill impact.

The potential exists for a large number of seabird mortalities in the event of a large to very large oil spill occurring. However, the Blacktip Project area is not a significant habitat for sea or shore birds (**Section 7.3.8**).

Intertidal Shorelines: The modelling showed that approximately 20 km of coastline is at risk from the most likely condensate spill scenario (8 m^3) during the wet season. This coastline is characterised by sandy beaches interspersed with rocky headlands and tidal inlets (**Figure 7-5**). It is extremely unlikely that in the event of a larger oil spill that any spilt oil would reach important wetlands to the north near Wadeye and to the south near the mouth of the Victoria River (**Section 9.3** & **Figure 9-2**).

The persistence of the oil and the time to recovery are a function of the energetic fluxes where oil is deposited. The beaches and rocky headlands along the Joseph Bonaparte Gulf are relatively high energy environments due to the strong tidal currents. As a result, oil should not persist long and recovery should be relatively quick, unless the oil enters the tidal inlets. However, these tidal inlets may be able to be boomed off in the event of an oil spill. This will be investigated further during the preparation of the Oil Spill Contingency Plan. Sandy beaches, which dominate the coastline between Cape Hay and Point Pearce, are relatively easy to remediate following an oil spill.

Mangroves: Mangroves are considered to be an important component of tropical ecosystems as they provide nursery areas for a wide range of marine species and a source of organic matter and nutrients. The stands of mangroves along the coastline between Point Pearce and Cape Hay, although relatively small, may be of high ecological importance. The sensitivity of mangroves to oil spills has been well recorded, with extensive defoliation and sometimes mortality, being noted at a number of spills. Importantly, most of the mangroves between Point Pearce and Cape Hay occur in tidal inlets, which may be able to be boomed off in the event of an oil spill (**Figure 7-4**).

Benthos: Benthic communities are found in and on the seabed (algae and seagrass are discussed later). Spilt oil can arrive in the subtidal by two mechanisms. Oil can sink as it weathers and loose buoyancy or become associated with particulate matter which sinks. A second route is the transport of oil or contaminated particles from nearby oiled beaches (National Academy of Sciences 2003). If oil becomes incorporated into the sediments, it can provide a long-term pathway for exposure to infauna and burrowing benthic organisms, increasing the long-term environmental consequences. However, Blacktip condensate is a very light oil and will evaporate completely within three days.

Algae and Seagrasses: A review of field studies conducted after spill events by Connell and Miller (1981) indicated a high degree of variability in the level of impact on algae, but in all instances the algae appeared to be able to recover rapidly from even very heavy oiling.

The susceptibility of seagrass to hydrocarbon spills, by contrast, depends largely on their distribution. Deeper communities will be protected from oiling under all but the most extreme weather conditions. Shallow seagrasses are more likely to be affected by dispersed oil droplets or, in the case of emergent seagrasses, direct oiling. Intertidal seagrass communities would theoretically be the most susceptible because the leaves and rhizomes may both be affected. Seagrass distribution between Point Pearce and Cape Hay is patchy and the seagrass is mostly restricted to subtidal waters.

Preventative and Management Measures

The likelihood of an oil spill occurring is remote, particularly given that four tanker loadings will occur each year. The primary preventative measure employed to minimise the impact of oil spills is the prevention of spills occurring in the first place:

- All facilities (platform, pipeline and export facility) will be designed and maintained to ensure compliance with legislative requirements (PSLA and Marpol 73/78), industry standards and extreme weather predictions.
- Woodside will develop a regular schedule of inspections and preventative maintenance to ensure the integrity of all facilities. This is likely to occur on a monthly basis during platform servicing. Due to the infrequency of use of the condensate tanker moorings, the moorings will also be inspected on a regular basis to ensure that they are in full working order. Additionally, this mooring will be checked at a minimum of 24 hours prior to the tanker berthing and continuously during loading operations.
- Facilities will be gazetted and marked on navigational charts and have appropriate navigation lighting and radar reflectors which will reduce the likelihood of an oil spill resulting from a vessel collision. All five spar buoys at the condensate tanker mooring will also be fitted with navigational lights. Local fisherman will also be provided with detailed information regarding the position of the facilities.
- Woodside will vet trading tankers to ensure that no substandard vessels are allowed and trading tankers will be provided with mooring instructions (Terminal Handbook) to enable safe mooring at the condensate export mooring. The Terminal Handbook will specify the enhanced requirements for tanker mooring wires and winches and will specify ship acceptance requirements required by Woodside for the Blacktip condensate mooring.
- An experienced pilot, with a nominated back up, both of whom will have extensive local knowledge and will be very experienced in the condensate loading operation will moor the trading tankers. The pilot will also take charge of condensate loading operations. Woodside

has considerable operational experience from similar North West Shelf terminals which will be available to the pilots.

- Loading of condensate will only occur if weather conditions are suitable (conditions below Beaufort 6 seastate). As an additional safety measure, the maximum acceptable weather condition has been set below the design maximum of the mooring. Additionally, this working limit is further reduced by the safety considerations of crew working on small line boats.
- All valves and the flexible transfer hoses will be checked for integrity prior to use and loading will be continuously monitored. Hoses and flanges are overrated for the requirements and location (Oil Companies International Marine Forum (OCIMF) rated at 275PSI with 300 American National Standards Institute (ANSI) flanges).
- Emergency shutdown valves can be triggered if a leak occurs and emergency response procedures will be implemented. Additionally, the condensate export line will also be fitted with a back suction pump located at the onshore gas plant, which will be activated when a leak is detected. This will return some of the condensate in the export pipeline back to the onshore gas plant and enables the end of the export pipeline to fill with seawater. This will minimise or eliminate any further escape of condensate to the environment. This back suction pump will be tested as part of the terminal preparation, prior to condensate loading.

In addition to the preventative measures outlined above, Woodside will develop detailed management measures in the unlikely event that a spill occurs. Woodside has an approved Emergency Response Plan and Oil Spill Contingency Plan for Northern Territory waters under which preliminary Blacktip operations are conducted. As the current Northern Territory Oil Spill Contingency Plan is focused on offshore activities, a Blacktip-specific Oil Spill Contingency Plan will be prepared prior to the commencement of production which will address specific oil spill risks from the project. This document will include:

- Oil spill trajectory modelling capability based on site specific metocean conditions and knowledge of oil weathering rates (**Technical Appendix K, Volume 2**). Oil spill trajectory modelling indicates that spills occurring during the dry season are directed offshore with only a small probability of impacting the coastline. The spills occurring during the wet season that are of primary concern.
- Identification of oil-sensitive marine and coastal resources and priority protection areas, including the identification of fauna that may be attracted to affected areas.
- Spill response and clean up strategies for offshore and shoreline, including the use of dispersants, booms, skimmers and sorbents and the restrictions of weather and oil type on the various response strategies. Vessels supporting the trading tankers during condensate loading will carry spill response equipment to combat spills immediately.
- Identification of internal and external emergency organisations, responsibilities and resources (human and equipment and materials) for oil spill response, and call out details.
- Identification of local capacity to maintain and implement rapid response equipment and assist with habitat and wildlife rehabilitation.

Management Summary

The likelihood of a spill is very low, as only four tankers will be loaded per year.

- Extensive preventative, management and emergency response measures will be in place to prevent spills.
- The likelihood of a major spill is remote, due to the extensive preventative management and emergency response measures that will be in place.
- A major spill is unlikely to impact marine mammals as there are no known migration paths or breeding areas in the region.

11.20 Waste

11.20.1 Non-Hazardous Solid Waste Stream

Impacts

Non-hazardous waste will mainly be generated offshore during the drilling, installation and commissioning phases of the project. The typical waste stream will include scrap materials, packaging, paper and empty containers. Very minimal amounts may be generated offshore during maintenance of the wellhead platform in the operation phase of the project. Suitable containers will be kept aboard the Jack-up, laybarge, supply and support vessels for the storage of all offshore non-hazardous waste materials. Depending on availability of end markets for recyclables and the economics of transportation to these markets, efforts will be made to segregate waste offshore before they are transported onshore for disposal or recycling in accordance with the project Waste Management Plan. The environmental impact of discarding non-hazardous general waste is expected to represent a small incremental addition to impacts associated with existing facilities. All waste is expected to be transported directly to Darwin for appropriate disposal or recycling.

Putrescible waste generated offshore during construction will be macerated to less than 25 mm and disposed of to sea with the liquid waste stream as described in **Section 11.20.2**. The impacts from macerated putrescible waste are expected to similar to those described for liquid waste.

During the operational phase of the Blacktip Project, the only offshore facility in place will be the unmanned wellhead platform. Therefore, the only waste that will be generated will be during platform maintenance, which will be returned to Darwin for appropriate disposal or recycling.

Preventative and Management Measures

Effective waste management practices will be implemented during all phases of the proposed development and by Woodside support services. These procedures will be in accordance with Woodside's Environmental Standards and Aspirations (Woodside 2003c). The targets for waste minimisation will be set to demonstrate continual improvement and waste minimisation will be included in contractor and supplier selection criteria (**Section 15**).

Key aspects of waste management procedures will include the following elements:

- preventing potential environmental impacts;

- protecting human health;
- preventing long term liabilities of waste disposal;
- suitable storage and handling procedures will be provided to ensure that risk to the environment is managed to be ALARP;
- onshore disposal contractors will be audited to ensure disposal is carried out appropriately.

The primary preventative measure is to avoid waste being generated in the first place. A particular area of focus will be in the tendering and contracting process where waste minimisation will be included in the criteria. A project specific Waste Management Plan will be developed and implemented for all stages of the proposed development.

Management Summary

In summary, preventative and management measures will include:

- Waste management practices will be in accordance with Woodside's Environmental Standards and Aspirations (Woodside 2003c) and applicable legislation, conventions and guidelines including the PSLA. MARPOL 73/78 and APPEA guidelines.
- Avoid waste being generated in the first place. A particular area of focus will be in the tendering and contracting process where waste minimisation will be included in the criteria a repeat of the text above.
- A project specific Waste Management Plan will be developed and implemented for all stages of the proposed development.

11.20.2 Liquid Waste Stream

Impacts

The inappropriate discharge of liquid waste can lead to:

- pollution and nutrient enrichment of the surrounding waters;
- saprogenic effects (causing or resulting from putrefaction);
- toxicity effects on marine flora and fauna.

Most sanitary wastewater and greywater will be produced during drilling and installation phases, due to the presence of the Jack-up, laybarge and various support vessels. The volumes of waste generated during the operational phase are much smaller. Liquid waste will be produced offshore during operation of the Blacktip Project when support vessels are on site for wellhead platform maintenance. Only very small quantities of liquid waste will be generated on the wellhead platform during maintenance visits only.

Trading tankers and support vessels will also generate waste whilst at the condensate export mooring. However, as per the requirements of MARPOL 73/78, this waste will not be discharged at the condensate export mooring or within 12 nm of the coast. Rather, this waste will be stored in holding tanks and discharged once beyond the 12 nm limit.

Algal blooms caused by the discharge of sewage into confined water bodies will not be an issue because vessels, including trading tankers loading condensate, will be restricted from discharging sewage or waste into the ocean within 3 nm of the coast as per Northern Territory Marine Pollution Act, or 12 nm from the coast if the vessels fall under the jurisdiction of MARPOL 73/78 or 'PSLA - Schedule Specific Requirements As To Offshore Petroleum Exploration And Production'. Therefore, no coastal effects are expected.

Liquid waste from the onshore gas plant will include domestic wastewater, stormwater and process water which are discussed in **Section 12.5.2**. Contaminated stormwater and process water will be treated and discharged via the PW export pipeline. This will result in rapid dilution and dispersion of these waste streams in the marine environment. Preventative and management measures for the PW discharge are discussed in **Section 11.18**.

Preventative and Management Measures

Disposal of sewage and drainage water from all vessels will be in keeping with Annex IV of the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 (referred to as MARPOL 73/78).

Disposal of sewage and putrescibles within coastal waters will be in accordance with the Northern Territory Marine Pollution Act, which states that no waste, including those treated to MARPOL specifications, must be discharged into waters less than 3 nm from shore. It is expected that sewage, drainage water, food scraps or putrescible waste will not be discharged within 12 nm of land.

A certified sewage treatment plant, capable of servicing the full complement of crew, will be in place on the laybarge. The installation, decommissioning and support vessels may have either a certified sewage treatment plant or sewage treatment facilities to Woodside's satisfaction.

Management Summary

In summary preventative and management measures will include:

- Sewage, greywater, drainage water and other putrescible waste such as food scraps will be disposed of in accordance with PSLA and MARPOL 73/78 Annex IV.
- A certified sewage treatment plant will be in place on the laybarge.
- The installation, decommissioning and support vessels may have either a certified sewage treatment plant or sewage treatment facilities to Woodside's satisfaction.
- A project specific Waste Management Plan will be developed and implemented for all stages of the proposed development.

11.20.3 Hazardous Waste Stream and Chemicals

Impacts

Oils and greases are necessary for the operation of machinery on vessels, and have the potential to cause adverse impacts on the environment if accidentally lost to the marine environment in large amounts. The wellhead platform will not have any oils or greases on board during operation; however, some will be present on board vessels during installation and commissioning activities. Typical oils and greases used for machinery includes engine oils, compressor oils, lubricating oils, seal oils, hydraulic oils, and other similar oils.

The Jack-up and laybarge will recover oils where possible, particularly from slops, for recycling in the crude oil process/oily water separator (**Section 11.16**). Sump oils from diesel engines used for cranes, generators, compressors and other machinery will be stored in containers for transport back to Darwin for recycling or disposal, in accordance with local regulations. Greases will also be stored in appropriate containers for disposal onshore.

Waste oils and greases used on the wellhead platform will be transferred to the Jack-up or support vessel and treated as above. Smaller support vessels and trading tankers will also require oils and grease. These will be handled as per standard maritime procedures for smaller vessels.

It is highly unlikely that the transport of oils and greases to onshore disposal or recycling facilities will result in an impact on the marine or intertidal environment. The environmental impact of the disposal/recycling of the small volumes of hazardous waste at approved onshore facilities will be a negligible to slight incremental increase in the environmental impacts associated with these facilities. As no hazardous waste will be disposed to sea; no impact on the marine environment is anticipated.

In addition to the hazardous chemicals discussed above, various hazardous chemicals are discussed separately including: antifouling (**Section 11.7**), drilling waste (**Section 11.8**), well completion fluid (**Section 11.10**), hydrotest water (**Section 11.13**), scale (**Section 11.14**) and produced water (**Section 11.18**).

Preventative and Management Measures

In line with the objectives contained within Woodside's Environmental Policy, the exposure of personnel to, and/or environmental control of, hazardous materials will be evaluated and implemented in the following order of preference:

- elimination of the need for the hazardous substance;
- substitution with a less hazardous substance;
- engineering measures to prevent release of hazardous materials;
- administrative measures, such as specific systems and procedures, to prevent release of hazardous materials;
- equipment and procedures in place to respond to any releases of hazardous materials.

The primary measure to prevent the potential effects of hazardous waste on the environment is to avoid waste being generated in the first place. The tendering and contracting process will be used to reduce the potential for generation of hazardous waste wherever practicable. Non-hazardous chemicals that serve the same purpose and are as cost-effective will be given preference. Where hazardous chemicals are required, the substances will undergo Woodside's chemical selection process, which targets chemical avoidance and/or selection of chemicals with the lowest health, safety and environmental risks, for example through authorisation for use, regular review and Material Safety Data Sheet (MSDS) availability.

All hazardous waste materials generated offshore during the Blacktip Project will be documented and tracked. All chemical and hazardous waste will be segregated and stored in appropriate containers, in accordance with the Project Waste Management Plan. Used greases, used oils, oily rags or absorbent materials will also be collected and stored in suitable containers. The containers will be clearly marked and kept in areas capable of containing leakage or spillage, ahead of transfer ashore for recycling or disposal as appropriate.

Potentially recyclable hazardous waste, such as oils and batteries, will be stored separately from non-recyclable materials. Chemical storage areas will be provided with appropriate bunding and drainage systems to reduce the chance of a chemical spill to the environment.

Transfer of hazardous materials between the wellhead platform and support vessels (including transfer of drilling muds and fuels) will be conducted in accordance with defined procedures that will be identified to all personnel concerned with transfer operations.

All hazardous waste will be transported to shore for disposal or recycling at an approved facility in accordance with regulatory requirements. Onshore disposal or recycling will be undertaken at an approved facility in accordance with Woodside's Waste Minimisation and Disposal guidelines, Northern Territory requirements and a project specific Waste Management Plan (**Section 6-1**).

All chemicals will be stored according to Australian legislation and guidelines. The types and quantities of chemicals required for production, maintenance and operation are not yet known; however, potentially hazardous chemicals will be screened according to their technical requirements and environmental performance.

All storage facilities and handling equipment will be designed and constructed in such a way as to prevent and contain any spills, and will be maintained in good order. All waste and products will be stored, handled and transported with consideration for dangerous goods segregation, as per the *Dangerous Goods Act 1998*, and the *Dangerous Goods Regulations 1985*. Spill clean-up kits and MSDS will be stored in easily accessible areas.

Management Summary

In summary, preventative and management measures will include:

- The main preventative measure will be to avoid the use of chemicals through design where practicable.
- The primary measure to mitigate the potential effects of hazardous waste on the environment is to avoid waste being generated in the first place. The tendering and contracting process will be used to reduce the potential for generation of hazardous waste wherever practicable. Non-

hazardous chemicals that serve the same purpose and are as cost-effective will be given preference.

- Used greases and oils including oily rags or absorbent materials will be collected and stored in clearly marked containers in a bunded area, capable of containing leakage or spillage, ahead of transfer ashore for recycling or disposal as appropriate.
- All chemical and hazardous waste will be segregated into clearly marked containers/skips prior to onshore disposal, in accordance with a Waste Management Plan.
- All hazardous waste will be transported to shore for disposal or recycling at an approved facility in accordance with regulatory requirements.
- Hazardous waste storage facilities and handling equipment will be segregated, kept in good order and designed in such a way as to prevent and contain spills.
- Transfer of hazardous materials between the wellhead platform and support vessels (including transfer of drilling muds and fuels) will be conducted in accordance with the defined procedures that will be identified to all personnel concerned with transfer operations.
- Potentially hazardous chemicals will undergo a rigorous evaluation process.
- Chemical storage areas will be provided with appropriate bunding and drainage systems to reduce the chance of a chemical spill to the environment.
- Woodside's chemical selection process targets chemical avoidance and/or selection of chemicals with the lowest health, safety and environmental risks.
- A project specific Waste Management Plan will be developed and implemented for all stages of the proposed development.

11.21 Atmospheric Emissions

Impacts from Atmospheric Emissions

11.21.1 Greenhouse Gases

Offshore sources of greenhouse gases are expected to be minimal by comparison to the onshore sources, as detailed in **Section 6.3.1**. The most significant offshore greenhouse gas emissions occur during drilling due to the operation of the rig and support vessels. During commissioning, the wells are flushed with fluids including diesel, which is then flared off, forming another source of greenhouse gas emissions. During production, greenhouse gas emissions will be relatively small, associated with the operation of two closed circuit vapour turbines, which will be powered by fuel gas from the well stream.

As the amount of greenhouse gas that will be generated offshore compared to onshore at the gas plant during both construction and operation will be minimal.

11.21.2 Other Atmospheric Emissions and Pollutants

Other atmospheric emissions and pollutants are expected to be almost negligible. Minor releases of NMHCs are expected as detailed in **Section 6.3.3**, while some releases of additional combustion products such as NOx and SOx will be associated with power generation and fuelling support vessels and the drill. These emissions are expected to be insignificant by comparison to onshore emissions. Dust emissions are not expected to result from the offshore operations.

Preventative and Management Measures for Atmospheric Emissions

Atmospheric emissions will occur mainly during commissioning activities and as such represent a short-term source. There will be no processing of gas offshore and consequently there will be negligible offshore atmospheric impacts. No further management measures are recommended.

11.22 Noise and Vibration

Impacts from Noise and Vibration

Noise and vibration impacts on turtles during construction of the shore crossing are discussed in **Section 11.3**, as it is intrinsically linked with beach disturbance.

Noise emissions can affect marine fauna in the following ways:

- attraction;
- increased stress levels;
- disruption to underwater acoustic cue;
- behavioural avoidance;
- hearing impairment and pathological damage;
- secondary ecological effects (may occur as a result of one or more species influencing another species, for example by alteration of a predator/prey relationship).

Hearing impairment and pathological damage are unlikely for motile species as they are expected to practice avoidance before damaging noise thresholds are encountered.

Cetaceans are sensitive to sounds because they employ acoustic sensors. McCauley (1994) states that for some offshore developments there is the potential that severe sound waves created from drilling activities could induce stress, and any pulsating or modulating effects may cause abandonment of important habitats, such as calving and nursery sites by some cetaceans. However, as the nearest known whale calving ground to the development is that of the humpback whale located in Camden Sound, Western Australia, over 400 km away, any effect on important whale habitats, such as calving and nursery sites, is highly unlikely. Interestingly, the source levels of the highest components of humpback whale song are 192 dB re 1 Pa^2, above the levels generated by drilling and support vessels (McCauley 1994) indicating that noise generated by drilling will not have an impact on whales .

Electro-physical studies have indicated that the best hearing range for marine turtles is in the range of 100–700 Hz; however, no definitive thresholds are known for the sensitivity to underwater sounds or the levels required to cause pathological damage (McCauley 1994). Turtles are also expected to avoid areas before sounds reach levels where it can cause them any physical harm. Behaviour indicative of avoidance has been shown by turtles at a distance of 1 km from a seismic vessel discharging airguns (McCauley *et al.*, 2000). Impacts of noise and vibration on turtle nesting activity are discussed in **Section 11.4**. Furthermore, the frequency of whales, and other marine mammals, and turtle visitations to the Blacktip Project area is understood to be low.

There is a wide range of susceptibility among fish from noise; however, those with a swimbladder will be more susceptible than those without this organ. Many adult fishes, including sharks and rays do not possess a swimbladder and so are not susceptible to swimbladder-induced trauma. Disturbance to fish is likely to be minimal as fish are also expected to avoid acoustical emissions if levels are high enough to potentially cause pathological effects. However, noise generated during the proposed development may be capable of causing behavioural changes or a masking of other acoustic cues necessary for normal biological or ecological functioning. Various literature exists on the behavioural response of fish to noise from approaching vessels (for example Olsen 1990 in Woodside 2002b), and these studies have shown that fish avoid approaching vessels to some degree, usually by swimming down or horizontally away from the vessel path. Noise effects are temporary, with normal schooling patterns resuming shortly after the noise source has passed. Surface and mid-water dwelling fishes may theoretically be adversely affected by noise generated during vessel movements; however, the abundant presence of fish that accumulate adjacent to operating facilities around Australia indicates that fish can accustom to these noises without any apparent detrimental effect. Additionally, because of the sparse soft sediment habitat at the proposed wellhead platform location and along the main export pipeline route, fish numbers are likely to be relatively low at the drilling and installation locations.

Preventative and Management Measures

Most marine invertebrates have poorly developed mechano-sensory systems and would therefore be little affected by noise.

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

It is also unlikely that seabirds will be affected in any way from underwater noise generated by the proposed development. Helicopter flights to the development will avoid passing over any known seabird colonies or important nesting areas at low altitudes to minimise impacts and reduce the risk of collisions. Helicopter flights will be carried out during daylight hours only, except if required during emergencies (and training purposes).

Concerns regarding the indirect effects of underwater noise on seabirds caused by a reduction in prey availability are difficult to quantify. However, due to the fact that fish and other prey species will not be significantly impacted, most of the noise will be temporary, and the area is not a noted seabird feeding area it is highly unlikely that seabirds will be secondarily affected by underwater noise (Woodside 2002b). Due to the distance of the proposed development from any significant seabird nesting colonies, the potential for impacts due to airborne noises from the proposed development is extremely remote.

Offshore equipment will be designed to normal petroleum practice standards, which includes specifications for noise levels, and standard installation and drilling facilities will be used.

Management Summary

In summary, preventative and management measures will include:

- Equipment will be designed to normal petroleum practice, which includes specifications for noise levels, and standard installation and drilling facilities will be used.
- Helicopter flights will be carried out during daylight hours only, except if required during emergencies (and training purposes).

11.23 Lights

Impacts

Lighting will be used by the Jack-up, laybarge, wellhead platform, support and supply vessels for safe illumination during all phases of the proposed development. Light will be emitted from flaring activity on the Jack-up during well testing and commissioning. However, as the nearest coastline is approximately 90 km from the proposed surface facilities, wellhead platform lighting and Jack-up flaring will not be visible from any mainland or turtle nesting beaches. Lighting will also occur onshore from the onshore gas plant for illumination and near shore from navigational lighting on the condensate export mooring. The onshore gas plant will include a gas flare system for emergency depressurising of the processing facilities and prior to maintenance. However, during normal operations, only a small pilot will burn continuously.

In some locations, artificial lighting and flares have the potential to disorientate and confuse hatchling turtles and pregnant female turtles (Environment Australia 2003). During nesting and hatching, turtles can become disorientated as brightness is considered a significant cue by turtle hatchlings setting out to sea (Woodside 2002b). However, as the offshore facilities are located over 90 km from the nearest coast, any light emitted from the rig or vessels will not reach shore and hatching or nesting turtles will not be disrupted, even if drilling occurs during the hatching season. Therefore, it is highly unlikely that there will be any impact from lighting of the offshore facilities on breeding turtles, nesting areas or hatchlings.

The onshore gas plant will be located 2.5 km inland from the shore crossing. Flaring at the onshore facility will be the main potential source of impact from light reaching the shore. The flare will not operate continuously, but will be used during maintenance or when emergency pressure release is required. Maintenance flaring is expected to occur quarterly or annually and may last up to 24 hours. Emergency flaring may happen more frequently but the duration is typically less than 30 minutes. The flare will have a very small pilot light burning continuously for the ignition of flare gas. The pilot light will represent only a minor source of light and is not expected be visible at the coastline 2.5 km away, therefore it is highly unlikely that there will be any impact from lighting on breeding turtles, nesting areas or hatchlings.

As it will be a 24 hour operation, construction activities on the beach will require some lighting, potentially causing a temporary disturbance. Due to the need to avoid the wet season, construction of the pipeline crossing will occur during the dry season, which corresponds to the turtle nesting season. However, recorded turtle activity on the pipeline crossing beach is low. It is estimated that 20 turtles would nest on the pipeline crossing beach, which represents 1% of the nests laid in the Anson Beagle Bioregion, which extends from Pearce Point to Cape Hotham, including the Beagle Gulf and the southern shores of Melville and Bathurst Islands (Guinea 2004).

Turtles are very mobile and although they may pass through the area on their way between feeding grounds, they will only be in close proximity to the proposed development area for a short period and can easily avoid the facilities. Disturbance to turtles is expected to be negligible, particularly as lighting requirements during the operational phase will be minimal.

Lights on the Jack-up (during construction) and wellhead platform (during operation) are likely to attract marine life and seabirds in the immediate vicinity, however, the impacts are expected to be temporary and slight.

Preventative and Management Measures

Artificial light from the wellhead platform and installation vessels will not be visible from the coastline, as it will be located approximately 90 km from nearest shore. Despite this, lighting on the wellhead platform will be designed to take light spill into consideration, as well as navigational and safety requirements. Likewise, lighting for the onshore facilities will also be designed to minimise light spill and the likelihood of light reaching the beach.

Testing and commissioning of the production wells will involve flaring on the Jack-up for several hours to 2 days duration. During this time, measures will be taken to minimise the amount of light emitted, for example by using low intensity flare tips and enclosed flares, if flaring occurs during turtle nesting or hatching season. Studies will be conducted during the detailed design phase to identify further opportunities to restrict the amount of light from the flare system.

A Turtle Management Plan will be implemented to address the impact of lighting on the beaches including lighting during the construction phase. Consideration will be given in the plan to the use/installation of lights that emit at longer wavelengths and directing lights onto the construction activities to reduce light spill.

Management Summary

In summary, preventative and management measures will include:

- lighting on the wellhead platform will be designed to take light spill into consideration, as well as navigational and safety requirements;
- lighting for the onshore facilities will be designed to minimise light spill;

- environmental considerations included in flare design;
- low intensity flare tips and enclosed flares during well testing and commissioning;
- A Turtle Management Plan will be developed to provide management measures during construction and operations phases.
- A Lighting Management Plan will be developed and implemented during construction activities.

11.24 Summary of Marine Impacts

A summary of the potential marine impacts of the Blacktip Project is shown in **Table 11-4**. Column 1 specifies the environmental factor likely to be impacted by the project and Column 2 identifies the source of that hazard. Column 3 specifies the aspect of the development posing an environmental hazard. Column 4 describes the potential impact if the environmental hazard or event were to occur. Column 5 summarises the predicted impact after the specified preventative and management measures have been implemented to reduce the likelihood or the consequence of the impact.

To describe the type of change and duration of impacts, the terms already defined in **Table 10-2** have been used.

- **Table 11-4 Summary of Marine Impacts**

Hazard	Source	Potential Impact	Preventative & Management Measures	Risk
Physical Presence **Section 11.2**	Jack-up and laybarge. Support and supply vessels. Trading tankers. Subsea export, condensate and PW pipelines. Condensate export mooring. Unmanned wellhead platform.	Physical presence of Jackup, wellhead platform, trading tankers and mooring present a navigation hazard to shipping and fishing.	Gazetted safety zone (500 m) will be implemented to protect the facilities and reduce the risk of marine collisions. Navigation marks and fog and illumination lighting will be installed on the wellhead platform and condensate export mooring to reduce the risk of marine collisions. Admiralty charts will be updated identifying the location of the wellhead platform, condensate mooring and export pipeline. Predicted Impact: From obstacles at the surface **– Negative, Medium to Long term** Predicted Impact: From safety zone and seabed installations – **Neutral, Medium to Long term** Consequence: **Slight** Likelihood: **Likely**	**Low**
Seabed Disturbance **Section 11.3**	Temporary anchoring of Jack-up, laybarge and construction vessels. Anchoring/piling of wellhead platform and installation of subsea equipment. Subsea export, condensate (including flexible riser) and PW pipelines. Condensate export mooring. Propeller wash of trading tankers and installation vessels. Discharge of drill cuttings and muds (**Section 11.8**).	Short-term disturbance to benthic sediment habitats from Jack-up, anchor and chains, trenching of pipelines, propeller wash and pipeline installation. Permanent loss of seabed habitat beneath wellheads and platform, mooring and anchors. Altered geomorphic processes caused by exposed pipelines interfering with natural sediment transport. Disturbance to seabed in the event that drill and blasting are required during pipeline installation.	A relatively small area of seabed will be affected compared to the area of similar habitat, which is widespread in the region. Benthic infauna are known to recover rapidly following disturbance. Pipeline installation will be conducted outside of the prawn migration season. Pipelines will be trenched to avoid interference with geomorphic processes. Studies will be performed during detailed design to assess erosion potential close to the beach, which may determine the trench depth. Installation vessels will adhere to appropriate anchoring and pipelay procedures to minimise area of disturbance. Predicted Impact: **Negative, Temporary to Short term** Consequence: **Slight** Likelihood: **Likely**	**Low**
Beach Disturbance **Section 11.4**	Pipeline construction through beach including trenching and installation of a temporary groyne. Rock removal/blasting (if required).	Short term disturbance to turtles nesting and hatchlings success. Altered geomorphic processes caused by exposed pipelines and temporary groyne interfering with natural sediment transport.	A **Turtle Management Plan** will be developed and implemented during construction activities. A **Lighting Management Plan** will be developed and implemented during construction activities. The construction corridor, and duration of shore crossing construction will be reduced to the minimum required. The construction corridor will be fenced off to exclude turtles from entering the pipeline trench. Lighting will be minimised and positioned to reduce light spill provided the safety of personnel is not compromised. The beach will be regularly monitored for turtles during construction. Turtle nests will be removed from the beach each morning during construction and placed in a hatchery to the south. Hatchlings will be returned to Yelcherr Beach to enter the sea. A **Rehabilitation Management Plan** will be developed and implemented prior to construction activities. A **Sediment and Erosion Control Management Plan** will be developed and implemented prior to construction activities. Predicted Impact: **Negative, Temporary to Short term** Consequence: **Minor** Likelihood: **Likely**	**Medium**
Artificial Habitat **Section 11.5**	Wellhead platform and associated subsea equipment. Subsea export, condensate and PW pipelines.	Subsea structures provide a habitat for fouling communities in an area which is generally devoid of hard substrates.	Subsea structures provide habitat for fouling species. Decommissioning of subsea structures will be undertaken in accordance with a regulator approved plan. Predicted Impact: **Positive and Negative Impacts, Medium to Long term** Consequence: **Slight** Likelihood: **Likely**	**Low**
Marine Pest Species **Section 11.6**	Ballast water and hull fouling from Jack-up, laybarge, support vessels and trading tankers.	Introduction of pest species via ballast water discharge or from hull fouling. Displacement of native species by exotic species.	There is a very low likelihood of successful establishment of exotic species, especially as open ocean habitat are not suitable for exotic species that originate from sheltered port environments. Vessels will follow AQIS ballast water requirements and Commonwealth *Quarantine Act 2000*. The Jack-up, lay-barge and support vessels will exchange ballast water prior to arrival at the Blacktip project area, where it is safe to do so. Predicted Impact: **Negative, Medium term** Consequence: **Slight** Likelihood: **Unlikely**	**Low**

Hazard	Source	Potential Impact	Preventative & Management Measures	Risk
Anti-fouling **Section 11.7**	Tributyltin (TBT) used in some anti-fouling paints from Jack-up, laybarge, trading tankers and support/supply vessels.	Toxicity impacts to organisms in the water column and benthos.	Marine organisms and benthic communities are common and widespread, so no significant impacts on ecological communities are likely. TBT will not be used as an anti-foulant on any of the Blacktip facilities. The use of TBT on large vessels will be phased out internationally between 2003–2008 (TBT is not used on small vessels (<25m)). TBT breaks down quickly in the water column and aerobic sediments, minimising risks to the environment. Large tidal currents will also aid the dilution of leached TBT. Predicted Impact: **Negative, Medium term** Consequence: **Slight** Likelihood: **Highly Unlikely**	**Low**
Drilling Waste and Discharges **Section 11.8**	Drilling and drill cuttings. Drilling muds and additives for example barite. Pipe dope. Cement.	Increase in receiving water turbidity. Smothering and alteration of sediment characteristics.	There are no sensitive benthic habitats located near to the drilling locations. Marine organisms and benthic communities are common and widespread, so no significant impacts on ecological communities are likely. The discharge of drilling waste will be localised and of a short duration. As the area has naturally high turbidity, the introduction of additional suspended solids into the water column will have a minimal impact. A regulator-approved **Production Drilling Environment Plan** will be implemented prior to drilling operations commencing. Predicted Impact: **Negative, Temporary** Consequence: **Slight** Likelihood: **Likely**	**Low**
		Depletion of oxygen in sediments.	Strong tidal currents will aid rapid dispersion ensuring that oxygen depletion will only have an impact over a localised area. The local marine environment is not highly sensitive, and there is a wide distribution of similar habitat in the region. Impacts in the local area are therefore not critical. A regulator-approved **Production Drilling Environment Plan** will be implemented for drilling operations. Predicted Impact: **Negative, Short term** Consequence: **Slight** Likelihood: **Likely**	**Low**
		Toxicity of drill cuttings, drilling muds and additive to organisms in the water column and benthos.	Low toxicity water-based muds will be selected where practicable and in accordance with Woodside's Engineering Drilling Fluid Selection Procedure. Non water-based muds will not be discharged to sea (except for small amounts associated with drill cuttings) and will be shipped back to shore for recycling or disposal in an approved method. Discharged muds will rapidly disperse, be diluted or will biodegrade. Consequently only a small area will be affected. The toxic components of the drilling mud have low bioavailability. The local marine environment is not highly sensitive, and there is a wide distribution of similar habitat in the region. Impacts in the local area are therefore not critical. A regulator approved Production Drilling Environment Plan will be implemented for drilling operations. Predicted Impact: **Negative, Short term** Consequence: **Slight** Likelihood: **Likely**	**Low**
Drilling Mud Spills **Section 11.9**	Drilling.	Increase in receiving water turbidity. Alteration of sediment characteristics. Toxicity impacts to organisms in the water column and benthos.	Transfer and handling procedures will be in place to minimise risks from the transfer of drilling muds between the support vessel and Jack-up. Non-toxic or low toxicity drilling muds will be used wherever possible. The benthic habitat that might be affected is widespread in the region, and impacts in the local area are not considered critical. Predicted Impact: **Negative, Short term** Consequence: **Slight** Likelihood: **Likely**	**Low**
Well Completion Fluids **Section 11.10**	Drilling completion.	Toxicity impacts to organisms in the water column and benthos.	The well completion fluids will be recovered, separated and the diesel or base fluid component burnt off. Only the low toxicity brine component will be discharged. Predicted Impact: **Negative, Temporary** Consequence: **Slight** Likelihood: **Likely**	**Low**

Hazard	Source	Potential Impact	Preventative & Management Measures	Risk
Brine **Section 11.11**	Jack-up water supply.	Elevated salinity impacts.	Only small volumes of brine will be discharged to the sea. Any discharged brine will meet legislative requirements for oil in water. The brine will rapidly dilute and be dispersed. Predicted Impact: **Negative, Temporary** Consequence: **Slight** Likelihood: **Unlikely**	**Low**
Sludges and Sand **Section 11.12**	Well clean-up (Jack-up)	Incremental addition to impacts of existing onshore waste management facilities.	Volumes of sand and sludge produced during drilling will be minimised. Where practicable, sludges and sand will be minimised at source, such as by using sand consolidation resins and completion stacks. Disposal overboard will occur if approval is gained from the regulatory authority, unless sands or sludges are contaminated or otherwise unacceptable for discharge. If disposal overboard is not acceptable, sludges and sand will be stored offshore and then transported onshore for disposal at an approved facility. A regulator-approved **Production Drilling Environment Plan** will be implemented for drilling operations. Predicted Impact: **Negative, Temporary** Consequence: **Slight** Likelihood: **Unlikely**	**Low**
Hydrotest Waters **Section 11.13**	Testing of subsea export pipeline and condensate pipeline. Contains oxygen scavenger, biocides and other chemicals.	Toxicity impacts to marine flora and fauna. Oxygen depletion.	Pre-commissioning of systems offsite to reduce the amount of hydrotesting required. Selection of hydrotest chemicals with low potential for environmental harm. Hydrotest discharge from dewatering will be rapidly diluted and dispersed, so dewatering will have only localised effects. Dewatering discharge will be at the seabed level from the condensate export pipeline and will re-oxygenate the water with minimal effects on marine habitat. A Pipeline Flooding and Hydrotesting Procedure and a Pipeline Pre-commissioning Procedure will be implemented which will detail the chemicals and quantities to be used. Predicted Impact: **Negative, Temporary** Consequence: **Slight** Likelihood: **Likely**	**Low**
Scale (containing NORMS) **Section 11.14**	Subsea wells. Subsea export pipeline. Equipment in the gas plant, especially water systems. Maintenance and clean-up during decommissioning.	Potential accumulation of low level radioactive material NORMS.	There is a low potential for scale in Blacktip reservoir and expectation of NORMs in Blacktip facilities. Scale inhibitors will be selected using the standard Woodside chemical selection process. Scale inhibitors will be used to reduce formation of scale, if required. If required, scale will be disposed of in accordance with Northern Territory or Western Australian Government guidelines. Predicted Impact: **Negative, Long term** Consequence: **Slight** Likelihood: **Highly Unlikely**	**Low**
Cooling Water **Section 11.15**	Jack-up and laybarge. Vessels.	Thermal impacts to marine flora and fauna. Contamination impacts to marine flora and fauna.	The use of biocides will be kept to a minimum which ensures condition of heat exchange systems. Cooling water will be mixed by turbulence in the ocean causing rapid dilution and dispersion. The effects of the cooling water will therefore be negligible. Predicted Impact: **Negative, Temporary to Short term** Consequence: **Slight** Likelihood: **Likely**	**Low**
Deck Drainage **Section 11.16**	Washdown water. Contaminated rain run-off. Jack-up and laybarge. Supply and support vessels. Trading tankers. Wellhead platform.	Toxicity impacts to marine flora and fauna.	Jack-up procedures will be in place to prevent spills to the sea, including fitting of scupper plugs to block overboard drains, use of bunded areas and contaminated drainage directed to the sump and the oily water separator for treatment. Deck drainage will rapidly dilute and disperse. The effects will therefore be localised, and will be of short duration. Routine maintenance and visual monitoring will allow for early detection of leaks, ensuring a quick response to repair leaks and clean up spills. Predicted Impact: **Negative, Temporary to Short term** Consequence: **Slight** Likelihood: **Unlikely**	**Low**

Hazard	Source	Potential Impact	Preventative & Management Measures	Risk
Ballast Water (other than introduced marine pest species) **Section 11.17**	Jack-up and laybarge. Supply and support vessels. Trading tankers.	Pollution of marine environment by hydrocarbon contaminated ballast water. *Refer to Routine Physical Impacts section of this table for potential impacts of Exotic Marine Pest Species.*	A **Ballast Water Management Plan** will be prepared and implemented. Segregated ballast tanks will be used on the Jack-up, laybarge and support vessels to prevent hydrocarbon contamination of the ballast water. In the unlikely event that contaminated ballast water is released, it would involve a small volume of hydrocarbons which would be rapidly diluted and dispersed. All vessels will comply with MARPOL regulations, Northern Territory Marine Pollution Act, Australian Quarantine Act and the AQIS guidelines for ballast water management, where applicable. Predicted Impact: **Negative, Medium term** Consequence: **Slight** Likelihood: **Highly Unlikely**	**Low**
Produced Water **Section 11.18**	Reservoir water brought to surface during production (may contain various contaminants such as hydrocarbons, heavy metals, finely dispersed oil remaining after separation or production chemicals).	Potential toxicity impacts (chronic) to marine flora and fauna. Oil sheen on water surface.	Produced water will be treated to meet legislative requirements for oil and grease content, so hydrocarbon loads will be low. The discharge location and design has been selected to maximise the dilution and dispersion of the produced water. Discharged timed to coincide with daily maximum tidal flows. Only environmentally acceptable process chemicals will be used. Continual on-line monitoring of oil-in-water quality will be implemented to ensure regulatory compliance. The treatment system will be designed to reliably achieve low oil-in-water levels. System includes a capability to retreat PW if it does not meet legislative requirements. Modelling indicates environmental impacts are minimal. Predicted Impact: **Negative, Medium term** Consequence: **Slight** Likelihood: **Likely**	**Low**
Hydrocarbon Spills – Small Spills **Section 11.19**	Drilling, installation, commissioning, production and decommissioning (for example spill from tanker loading hose).	Marine flora and fauna effects through: ▪ increase in toxicity; ▪ physical coating; ▪ disruption of physiological processes; ▪ alteration of species interactions; ▪ oil sheen on water surface.	The likelihood of a spill during production is very low, as only four tankers will be loaded per year. Extensive preventative, management and emergency response measures will be in place to prevent spills, including the construction contract tender evaluation process (**Section 15**). A Blacktip specific **Oil Spill Contingency Plan** will be prepared addressing the project specific oils spill risks All facilities and vessels will meet legislative and Woodside requirements, including PSLA, MARPOL and Northern Territory legislative requirements. Woodside will develop a regular maintenance schedule to ensure integrity of facilities. Tankers will be moored and loaded by experienced pilots, under suitable weather conditions. Loading facilities will be fitted with emergency shutdown valves and back suction pumps to minimise any volumes spilt. Vessels supporting the trading tankers during condensate loading will carry spill response equipment to combat spills immediately. Predicted Impact: **Negative, Medium to Long term** Consequence: **Minor** Likelihood: **Quite Likely**	**Medium**
Hydrocarbon Spills – Large Spills **Section 11.19**	Drilling, installation, commissioning, production and decommissioning. (for example tanker rupture during loading).	Marine flora and fauna effects through: ▪ increase in toxicity; ▪ physical coating; ▪ disruption of physiological processes; ▪ disruption of behavioural activities; ▪ alteration of species interactions; ▪ change of habitat characteristics; ▪ asphyxiation.	The likelihood of a large spill is very low, as only four tankers will be loaded per year and due to the extensive preventative management and emergency response measures that will be in place. A major spill is unlikely to impact marine mammals as there are no known migration paths or breeding areas in the region, or reach important turtle and dugong areas around Point Hay and Cape Hay. All facilities and vessels will meet legislative and Woodside requirements, including PSLA, MARPOL and Northern Territory legislative requirements. Woodside will develop a regular maintenance schedule to ensure integrity of facilities. Tankers will be moored and loaded by experienced pilots, under suitable weather conditions. Loading facilities will be fitted with emergency shutdown valves and back suction pumps to minimise any volumes spilt. A Blacktip specific **Oil Spill Contingency Plan** will be prepared addressing the project specific oils spill risks. Vessels supporting the trading tankers during condensate loading will carry spill response equipment to combat spills immediately. Predicted Impact: **Negative, Medium to Long term** Consequence: **Moderate** Likelihood: **Remote**	**Low**

Hazard	Source	Potential Impact	Preventative & Management Measures	Risk
Non-Hazardous Solid Waste Stream **Section 11.20.1**	Drilling, installation, commissioning, production, decommissioning. Jack-up and laybarge. Supply and support vessels. Trading tankers. Wellhead platform.	Incremental addition to impacts of existing onshore waste management facilities.	Only low levels of waste will be generated from wellhead platform and support vessels. Waste will be segregated to ensure appropriate disposal, and recycling where receival facilities and markets are available. The primary management measure is to avoid waste generation where possible. Waste management practises will be in accordance with Woodside's Environmental Standards and Aspirations. A project specific **Waste Management Plan** will be developed and implemented for all stages of the Blacktip Project. Waste disposal will be at approved onshore waste management facilities, resulting in a relatively small increase in the volumes of waste handled by existing facilities. Predicted Impact: **Negative, Medium term** Consequence: **Slight** Likelihood: **Likely**	**Low**
Liquid Waste Stream **Section 11.20.2**	Sewage & greywater. Jack-up and laybarge. Supply and support vessels. Trading tankers.	Pollution and nutrient enrichment of the surrounding waters. Saprogenic effects (of, causing or resulting from putrefaction) Toxicity effects on marine flora and fauna.	Liquid waste will have small volumes and nutrient loads, and will disperse and be diluted rapidly. Laybarge and Jackup will have certified and operational sewage treatment plants in place. Solid components of the waste stream will be macerated to less than 25 mm (PSLA). Waste management practises will be in accordance with Woodside's Environmental Standards and Aspirations. A project specific **Waste Management Plan** will be developed and implemented for all stages of the Blacktip Project. Liquid waste will be treated and discharged according to legislative requirements (PSLA, MARPOL or NT legislation as applicable). Predicted Impact: **Negative, Medium term** Consequence: **Slight** Likelihood: **Unlikely**	**Low**
Hazardous Waste Stream & Chemicals **Section 11.20.3**	Used oils and grease, chemicals. Drilling, installation, commissioning, production, decommissioning. Jack-up and laybarge. Supply and support vessels. Trading tankers. Operations (wellhead platform).	Incremental addition to impacts on existing waste management facilities.	A project specific **Waste Management Plan** will be developed and implemented for all stages of the Blacktip Project Woodside's chemical selection process targets chemical avoidance and/or selection of chemicals with the lowest health, safety and environmental risks. The primary management measure is to avoid waste generation where possible. Hazardous waste will documented and tracked and will only be produced in small volumes. All storage facilities and handling equipment will be fit for purpose to reduce likelihood of a spill occurring or reaching the marine environment. Offshore, hydrocarbon recovery and recycling systems will be in place. Recovered hazardous waste will be transported to shore for disposal to appropriate waste management facilities or for recycling. Predicted Impact: **Negative, Medium term** Consequence: **Slight** Likelihood: **Likely**	**Low**
Atmospheric Emissions **Section 11.21**	Power generation required for drilling, installation, commissioning, production and decommissioning. Flaring from Jack-up during commissioning.	During production, greenhouse gas emissions will be relatively small. Wellhead platform will be powered by closed circuit vapour turbines from well stream fuel gas. Fugitive emissions will be small.	Offshore greenhouse gas emissions are expected to be extremely low, given the relatively short duration of construction activities and the very low fuel demand of the wellhead platform. There will be no processing of gas offshore and consequently there will be no offshore atmospheric impacts.	**N/A**
Noise & Vibration **Section 11.22**	Jack-up and laybarge. Blasting (if required) and trenching. Support and supply vessels. Trading tankers. Helicopters. Wellhead platform.. *Note: Shore crossing activities covered under **Section 11.4**.*	Interference with fauna, including turtles, fish and marine mammals. Interference with other users (for example beach users or fishing activities).	Noise and vibration activities such as shipping and drilling will be temporary, and largely confined to the initial installation period. Received noise levels for all activities should be below levels that impact upon marine fauna. Whale activity in the area is low and the site is situated over 500 km from humpback whale migration and breeding areas. Equipment will be designed to normal petroleum practice, which includes specifications for noise levels, and standard installation and drilling facilities will be used. Helicopter flights will be carried out during daylight hours only, except if required during emergencies (and for training purposes). Predicted Impact: **Negative, Medium term** Consequence: **Slight** Likelihood: **Unlikely**	**Low**

Hazard	Source	Potential Impact	Preventative & Management Measures	Risk
Lights **Section 11.23**	Lighting from Jack-up, wellhead platform, all vessels, condensate export mooring and onshore gas plant. Flaring at Jack-up and onshore facility during commissioning and production.	Attraction of seabirds and marine life. Disorientation of breeding / nesting turtles or hatchlings.	The offshore facilities are 90 km from nearest coast and turtle hatching grounds, and are not expected to impact upon them. Construction activities of relatively short duration. A **Lighting Management Plan** will be developed and implemented during construction activities. A **Turtle Management Plan** will be developed to provide management measures during construction and operation phases. Night time construction activities over the 20 week construction period will be minimised. Construction lighting on the beach, including using orange, yellow and red lights will be minimised where ever possible. Limiting the height of lighting as much as possible, directing lights inward and downward to reduce light spill and placing shades to further reduce light spill provided safety of personnel is not compromised. Flaring from the onshore gas plant will be limited to commissioning, maintenance and emergency situations and will be scheduled during daylight hours where possible. Flare pilot light will not be visible from the marine environment. Predicted Impact: **Negative, Long term** Consequence: **Slight** Likelihood of attracting marine life /seabirds in the immediate vicinity of the wellhead platform. **Likely** Likelihood of impact disorienting breeding turtles or hatchlings : **Unlikely**	**Low**