Technical Appendix C9

Intertidal Habitats

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GORGON DEVELOPMENT ON BARROW ISLAND

TECHNICAL REPORT

INTERTIDAL HABITATS

Prepared for:
ChevronTexaco Australia Pty Ltd
250 St Georges Terrace
PERTH WA 6000

Prepared by:

RPS Bowman Bishaw Gorham
290 Churchill Avenue
SUBIACO WA 6008
Telephone: (08) 9382 4744
Facsimile: (08) 9382 1177

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1 Introduction

ChevronTexaco Australia Pty Ltd (ChevronTexaco), on behalf of the Gorgon Venture participants, proposes to develop the Gorgon gas fields utilising a processing, storage and offloading facility on Barrow Island. Marine infrastructure for the proposed development includes elements in intertidal habitats on the east and west coasts of Barrow Island, comprising:

- a shore crossing at North White's Beach or Flacourt Bay on the west coast of Barrow Island
- a causeway at Town Point on the east coast incorporating shore crossings for export pipelines
- a shore crossing near Robe River on the mainland for the domestic gas pipeline.

RPS Bowman Bishaw Gorham has conducted a number of studies of intertidal habitats around Barrow Island prior to the present proposal. Le Provost Environmental Consultants (1991) surveyed intertidal habitats around the Island in 1990. Further studies of the areas expected to be affected by the proposed development have been undertaken to assist formal environmental assessment of the proposal (Bowman Bishaw Gorham 2003). This report describes the results of the current field surveys and relates the findings to existing information for similar areas within the region.

2 Methods

Intertidal habitats in the vicinity of the proposed causeway at Town Point and the mainland shore crossing of the domestic gas pipeline were surveyed during 26 to 28 January 2004. The surveys also covered adjacent intertidal habitats.

Intertidal areas were surveyed as close as possible to spring low tide to maximise the time for survey and the area of exposed habitat. Marine biologists with experience in intertidal surveys around Barrow Island and nearby mainland sites examined the area extending from the very low intertidal to supra-tidal zones.

3 Regional Intertidal Environment

3.1 Introduction

The Montebello/Lowendal/Barrow Islands region is characterised by limestone islands, running along the western edge of the Rowley Shelf, exposed to open ocean swells on their west coasts and sheltered on their east coasts.

The Leeuwin Current connects the Montebello/Lowendal/Barrow Island regions with areas further north and provides the area with an ongoing source of recruits for re-establishment of new biotic habitats or recovery of disturbed ones.

Wave energy plays a major role in the physical structure of intertidal habitats, and exposure to salinity and the desiccating effects of the sun play major roles in shaping biotic intertidal habitats. The local distribution of intertidal habitats is affected by the regular passage of tropical cyclones that shape sandy beaches, redistribute boulders and sand sheets over intertidal platforms and, in extreme cases, cause widespread destruction of biotic habitats.

The ongoing effects of exposure to wave energy have led to the development of different intertidal habitats on the west and east coasts of the region's islands. The predominant habitats on the exposed west coasts of islands in the Montebello/Lowendal/Barrow Island region are sandy beaches, rocky shores and cliffs. The predominant physical habitats on the sheltered east coasts and the adjacent mainland coast are sand flats, mud flats, rocky pavements and platforms. Mangroves have developed on sheltered coasts of the islands and along the mainland coast.

Tidal inundation plays a major role in shaping the distribution of the essentially marine assemblages of intertidal habitats. Biotic habitats in the intertidal zone are generally represented by stunted and resilient ecomorphs of marine macrophytes, due to the physiological stress imposed by the environment.

3.2 Intertidal Habitats of Barrow Island Region

There are six main intertidal habitats around Barrow Island and along the mainland coast that characterise the region's intertidal environment, as described in the following:

- limestone platform reefs
- rocky shores
- sandy beaches
- sand/mud flats
- coral reefs
- mangals

These are described in more detail in the following sections.

3.2.1 Limestone Platform Reefs

Geomorphology

Coastal limestone is often eroded into gently sloping wave-cut benches in the intertidal zone, known as rock platforms or rock flats. Extensive intertidal rock platforms occur on both the west and east coasts of Barrow Island. These are backed in the higher intertidal zone by either beach slopes or notched rocky headlands.

There are distinct differences between the west coast and east coast rock platforms of Barrow Island. On the west coast, the intertidal platforms tend to be narrower than those on the east coast. The west coast platforms range from a few metres to two hundred metres wide, whereas the east coast platforms are generally several hundreds of metres wide. The west coast is highly energetic, particularly over the winter period when swell generated in the Southern Ocean reaches Barrow Island. West coast rock platforms usually have a discrete outer edge that bears the brunt of wave action at low tide (Plate 3-1 and 3-5). Typically, the outer edge is at or very close to the 0 m LAT datum (low spring tide).

Plate 3-1 – High Wave Energy on the West Coast near White's Beach

The east coast is much less energetic, with large waves restricted to the irregular passage of cyclones. East coast rock platforms typically grade imperceptibly into the subtidal zone without a distinct edge (Plate 3-2). These can be very wide, in places exceeding 1 km.

Plate 3-2 - East Coast Limestone Platform near Town Point

Rock platforms may slope gradually from the upper intertidal level down to the low tide level, or there may be distinct steps or changes of slope that create microclimates and allow the formation of biotic zones. Rock platforms on the west coast are typically dissected by deep and irregular gutters caused by erosion. There are often sand and rubble-filled drainage gutters in the upper intertidal zone.

The different energy regimes that prevail on the east and west coasts also maintain different covers of sediments on the platforms present around the Island. West coast platforms are generally bare of sediments, except for coarse deposits in drainage channels and fronting sandy beaches. In contrast, east coast platforms typically have a thin layer of fine sand over most of the low profile limestone reef. The sand is deeper in basins and rock pools, but absent on upstanding ridges and boulders.

Macroalgal Assemblages

Benthic communities are very different on rock platforms in various areas of Barrow Island.

The outer platforms on the west coast are generally moderately to densely vegetated with macroalgae (*Sargassum*, *Caulerpa* and *Halimeda*). The middle flats in the wave zone usually support a dense, but low algal turf (Plate 3-3).

Plate 3-3 - Dense Macroalgae Bed on West Coast Rock Platform

Exposure to solar radiation, desiccation and sand deposition appear to restrict the formation of macroalgae meadows to the lower intertidal, rock pools and subtidal pavements. The highly exposed mid and upper intertidal pavements support little macroalgal cover.

Intertidal Faunal Assemblages

Intertidal pavement reefs support a diverse assemblage of vertebrates and invertebrates, particularly in vegetated areas and areas of increased structural diversity, such as rock pools, boulders and upstanding rocks.

Some species exhibit horizontal zonation on the reef flat. Generally, the species richness is higher in the lower intertidal zone. For example, scleractinian and soft corals are generally common and diverse in the lower intertidal on both east and west Barrow Island coasts, but few species live at higher levels. Some coral genera are particularly

resistant to exposure and these are generally the representatives found in areas where sparse corals occur. These genera include *Goniastrea, Plesiastrea, Porites, Platygyra, Acropora* and *Euphyllia*. The exception occurs at Biggada Reef, where a very diverse and abundant coral reef community extends from the base of the reef, in approximately eight metres water depth, up into the lower intertidal.

Where there are high rocks in the mid-to-lower intertidal zone, barnacles and molluscs may occur that are otherwise restricted to the upper intertidal zone. For example, the mussel *Brachidontes ustulatus* and the rock oyster *Saccostrea*, which normally live in a band in the upper intertidal zone, occur on high rocks in the mid-to-lower intertidal zones.

Beach sand may be eroded to expose the beach rock at the base of the beach slope. When beach rock is exposed for extended periods, it is colonised by some of the suite of molluscs and barnacles that generally live in intertidal notch habitats. However, the vertical zonation patterns that are characteristic of the notch habitats are often poorly defined in exposed beach rock habitats.

East coast rock platforms often have a relatively wide zone of sediments on the inner flat with associated infaunal and epifaunal communities (Plate 3-4). The surface layer of oxygenated sediment is generally less than 5-10 cm deep (inset Plate 3-4). These flats are uncommon on the west coast.

Plate 3-4 - Wide Sediment Zone on the Limestone Pavement South of Town Point. The inset shows the shallow oxygenated layer (pale) with anoxic sediment underneath (grey)

Related to these physical differences in habitat, there are significant differences in species assemblages occupying the west and east coast rock platforms. Although the majority of species found on Barrow Island limestone pavements occur around the Island, some species are restricted to one coast. An example is the molluscan genera *Conus*, *Modiolus* and *Rhinoclavis,* all of which have species restricted to the habitats specific to each coast (Table 3-1).

Table 3-1 - Species of Three Intertidal Molluscan Genera Restricted to Either the East Coast or the West Coast of Barrow Island

West Coast	East Coast
Conus textile	*Conus victoriae*
Conus geographus	*Conus novaehollandiae*
Conus vexillum	*Conus monachus*
Conus miles	
Conus lividus	
Modiolus auriculatus	*Modiolus sp. nov.*
Rhinoclavis bituberculatum	*Rhinoclavis vertagus*

This pattern occurs throughout the West Pilbara region and is the basis of the distinction between the *Offshore Pilbara Region* and the *Nearshore Pilbara Region* made in the Marine Parks and Reserves Working Group Report (Wilson et al. 1994) and in the ecosystem-based classification of IMCRA (1998). The differences between intertidal communities on the west and east coasts of Barrow Island are a localised example of the differences between offshore and nearshore regional sub-province communities.

3.2.2 Rocky Shores

Intertidal limestone cliffs in the West Pilbara region are typically double-notched in the upper intertidal zone (Plate 3-5). The double notches are created by erosion of the cliff face above and below the protective or accretionary band of oysters in the central zone. The depth of the eroded lower notch in some areas is increased by burrowing invertebrates. The most important of these are the barnacle *Lithotrya* and the bivalves *Petricola* and *Lithophaga.*

Plate 3-5 - Notched Upper Intertidal Zone on the West Coast of Barrow Island

Two species of littorinid gastropod are ever-present in the upper notch at Barrow Island. *Nodilittorina pyramidalis* extends up into the supralittoral zone and *N. millegrana* extends down to the upper edge of the oyster zone. At most west coast sites there may also be one or more of *N. australis, N. nodosa* and *Littoraria undulata* in the upper notch. These latter species are rare at east coast sites.

The alga, *Bostychia tenella*, is usually present in both the oyster zone and the lower part of the upper notch. One of two species of the pulmonate snail genus *Ophiocardula* are often present in the algae zone.

The oyster zone is composed of clusters of the rock oyster *Saccostrea cucullata*, sometimes in association with a second *Saccostrea* species in more sheltered sites. The oyster zone provides habitat for the gastropod *Planaxis sulcatus* and a variety of other invertebrates, most of which are nestlers rather than borers. These animals are not generally restricted to the oyster zone and also extend onto the rock surfaces above and below it.

The lower notch is habitat for several species confined to that zone, for example the grazing gastropods *Cellana radiata*, *Monodonta labio* and *Turbo cinerea,* the boring bivalves *Lithophaga malaccana* and *Petricola lapicida* and the boring barnacle *Lithotyra valentiana.*

A variety of species inhabit both the lower notch and the inner part of the rock platform. For example, the molluscs *Nerita chamaeleon*, *N. albicilla*, *Siphonaria* sp. and *Onchidium* sp. and the two large chitons, *Acanthopleura spinosa* and *A. gemmata* are conspicuous in these habitats. *Acanthopleura spinosa* sometimes extends up into the lower part of the upper notch and *A.gemmata* sometimes extends out onto the inner rock platform. Cemented barnacles are also an important element of intertidal notch communities. Three or four species of barnacles are usually present in the Barrow - Montebello Complex intertidal notch habitats.

The composition of the species assemblage in intertidal notch sites varies among sites and not all of the typical species are always present. Sand scouring is an obvious cause of absence of some species in the lower notch. In general, intertidal notches on the wave-exposed west coast shores of Barrow Island tend to be more species-rich than comparable habitats of the more sheltered east coast shores.

3.2.3 Sandy Beaches

Sandy beaches around Barrow Island are typical of those found on Rowley Shelf islands. They are generally wide with steep intertidal zones on wave-exposed shores and relatively narrow and gently sloping along sheltered shores. The beaches are generally depauperate of invertebrates other than ghost crabs and burrowing bivalves. The ghost crab *Ocypode* sp. commonly burrows on the middle and upper beach slope. The bivalves *Donax cuneata* and *Paphies striata* burrow in the sand of the lower slope, with the latter confined to less wave-exposed beaches.

The importance of sandy beaches in the region is primarily related to their significance for turtle nesting (Plate 3-6), seabird nesting, roosting and foraging (Plate 3-7), and as foraging areas for terrestrial species, such the perentie (*Varanus giganteus*), brushtail possum (*Trichosurus vulpecula*), golden bandicoot (*Isodon auratus*) and water rat (*Hydromys chrysogaster*).

Plate 3-6 - Turtle Tracks at White's Beach

Plate 3-7 - Shorebirds Roosting in the Upper Intertidal Zone

Turtles nest in beach sands above the high tide mark and only use the beach slopes as a conduit between the ocean and nest sites. The beaches in the region are important nesting sites for most of the locally occurring species. Sandy beaches on the west coast of Barrow Island are heavily utilised by green turtles, while beaches in the Montebello and Lowendal Islands groups are important hawksbill turtle nesting sites. Flatback turtles nest on various beaches in the area, including those on the east coast of Barrow Island.

Shorebirds, such as terns and oyster catchers, nest on sandy beaches on islands in the Montebello and Lowendal Islands groups and on Barrow Island.

3.2.4 Sand and Mud Flats

Large intertidal sand flats are relatively uncommon on the offshore Rowley Shelf. There are sand sheets and bars on the northern end of Thevenard Island and at Barrow Island. Intertidal sand flats are much more extensive along the mainland coastline, including areas where the domestic gas pipeline is proposed to come ashore.

Extensive intertidal sand flats occur at southern Barrow Island, while limited areas occur around Surf Point at the northern extent of the Island. Observations of the northern sand sheets suggest they support a very limited faunal community. These are energetic areas comprised of well sorted sediments. Some of the more protected northern sand flats support seagrasses, particularly members of the genera *Halophila*, *Halodule* and *Thalassodendron*. Areas with seagrass contain increased invertebrate fauna, usually dominated by gastropods, particularly of the genera *Pseudovertagus, Rhinoclavis* and *Turbo*.

The intertidal sand flats in Bandicoot Bay support a diverse benthic and burrowing fauna (LeProvost 1991). At high tide, the intertidal sand flats provide foraging habitat for many larger carnivores such as shovelnose rays and sharks (Plate 3-8).

Plate 3-8 - Sharks Foraging over Intertidal Sand Flats in Bandicoot Bay

The natural sand flats support extensive areas of seagrasses and macroalgae. Seagrass of the genus *Halophila* are the most prevalent, with lesser amounts of *Syringodium* and *Thalassodendron*. The gastropods *Pseudovertagus* and *Rhinoclavis* are very common, particularly within the seagrass-dominated areas. The brown octopus (*Octopus cyanea)*, commonly found on limestone pavements on both the east and west coasts, is also common on the Bandicoot Bay sand flats. Compound ascidians are widespread, in places occurring as discrete, mono-specific mats.

The main macroalgal genus on the flats is *Sargassum*, with lesser *Padina*, *Caulerpa*, *Halimeda* and *Penicillus*. The macroalgae community is more prolific in the deeper intertidal and sub-tidal zones. This area also supports species with lower exposure tolerance, such as soft corals, particularly from the genera *Sarcophyton* and *Lobophyton.*

Mainland sand flats are generally muddier than those associated with the offshore islands. These support seagrasses in the very low intertidal, particularly *Halophila* and *Halodule.* Macroalgae is usually very poorly represented on the mainland sand flats, generally being restricted to *Halimeda*, *Caulerpa* and *Penicillus* in the low intertidal.

Mainland sand flat faunal communities range from diverse to depauperate. The diversity of invertebrates in the intertidal zones around Cape Preston formed the basis of the recommendation of the Marine Parks and Reserves Working Group (Wilson et al. 1994) for consideration of the area for reserve status. Other areas have very low species diversity with limited attached or burrowing fauna above the low intertidal level.

3.2.5 Coral Reefs

Coral communities are generally sub-tidal, however, many coral species are very tolerant to exposure and, in places, form reefs which extend into the lower intertidal. Many of the intertidal platforms which surround the islands of the Rowley Shelf contain small emergent reefs, and there are at least two large intertidal coral reefs in the region:

- unnamed reef on the southwest side of Thevenard Island
- Biggada Reef on the west coast of Barrow Island.

The intertidal coral reef at Biggada Reef in Turtle Bay on the west coast of Barrow Island extends approximately 1.5 km northward and 0.5 km offshore from Biggada Creek. This area has been proposed as a Marine Park (CALM 2004). The reef crest and lagoon areas support extensive expanses of corals that are exposed on very low tides. Surveys of the intertidal component of this coral community in 1995 revealed a diverse fauna, including at least 64 species of scleractinian (hard) coral, 32 species of echinoderm and 75 species of shelled mollusc (Bowman Bishaw Gorham 1996).

Another example of an emergent coral community occurs at Dugong Reef of the east coast of Barrow Island on the Barrow Island Shoals. The majority of corals on this reef occur in the shallow sub-tidal zone, but some of the larger colonies are intertidal on spring tides. Corals from the genera *Porites* and *Goniastrea* are the most common large colonies exposed on low tides (Plate 3-9).

Plate 3-9 - Small Coral Colony on the East Coast of Barrow Island Exposed – During the Low Tide

3.2.6 Mangals

The large mangrove forests (mangals) growing along the Pilbara coastline are composed of up to six different mangrove species. Mangals on the offshore islands tend to be small stands of the white mangrove *(Avicennia marina*) together with the red mangrove *Rhizophora stylosa*. White mangroves grow at several localities on the protected south and east coasts of Barrow Island, but generally only occurs as a narrow zone of stunted trees.

Although the faunal assemblage associated with Barrow Island mangals is usually species poor, consistent with the mangals limited size and floral diversity, the mangals are not

unimportant because of the additional diversity, albeit relatively minor, of species and habitats they add. Ospreys (*Pandion haliaetus*), brahminy kites (*Haliastur indus*) and white-bellied sea eagles (*Haliaeetus leucogaster*) use the trees as roosting sites. The small mangal in Square Bay has an associated population of red fiddler crabs (*Uca* sp.).

On the mainland, well developed mangals extend from the Dampier Archipelago south-west to Exmouth Gulf. Six mangrove species are known from the region; the most common being *Avicennia marina* and *Rhizophora stylosa*. Less common species are *Ceriops tagal, Aegialitis annulata, Bruguiera exaristata, Aegiceris corniculatum* and *Osbornia octodonta*.

Mainland mangals support a range of associated faunal species, many of which are restricted to that environment. Common mangal fauna include burrowing infauna such as peanut worms (sipunculids), crabs and mud lobsters (*Thallasina*) and epifauna such as gastropods, mud skippers and crabs. Some littorine whelks and barnacles are limited to mangrove trees.

4 Local Intertidal Habitats

4.1 West Coast Development Areas

4.1.1 Shore Crossing at North White's Beach or Flacourt Bay

The proposed pipeline route to North White's Beach crosses an intertidal limestone reef platform and a sandy beach with an exposed beach rock bench. The upper surface of the eroded reef platform is essentially bare, presumably due to exposure to the sun at low tide. The holes and fissures in the reef support brown macroalgae such as *Sargassum* with larger thalli than the turfing algae at Flacourt Bay. The exposed beach rock appears to experience cycles of sand burial and exposure and does not support an abundant assemblage of intertidal fauna. The faunal assemblage is expected to be temporally variable, dominated by littorine gastropods that settle on exposed intertidal rock surfaces opportunistically (Plate 4-1).

The southern end of North White's Beach is sheltered from sea and swell energy by the low cliffs of a headland and the intertidal and supratidal areas include boulders and vertical rock faces. The intertidal assemblages in this area are dominated by rock oyster (*Saccostrea*) zones with the associated mollusc and cirripede (barnacle) fauna characteristic of this habitat.

Plate 4-1 - Intertidal Zone at North White's Beach

Green turtles cross the intertidal zones of the sandy beaches at Flacourt Bay and, to a lesser, extent North White's Beach as described in Appendix C7. Migratory waterbirds are expected to roost on the sandy beach occasionally, but these are not an important areas for avifauna (Appendix C3).

The proposed alternative feed gas pipeline to Flacourt Bay would cross the broad sandy beach running between two high rocky headlands. The beach is exposed to high wave energy and changes shape as sand is eroded or deposited. The limestone pavement underlying the beach is, at times, exposed in both the intertidal and supratidal zones.

The sandy beach slopes into the surf zone and has a narrow (<10 m) intertidal component. The remainder of the intertidal zone is a wave washed rock platform with deep fissures and holes (Plate 4-2).

Plate 4-2 - Intertidal Pavement Reef and Sandy Beach at Flacourt Bay

This high energy section of the coastline does not support well developed intertidal assemblages. Wave action on the intertidal areas of the nearshore pavement reef precluded survey and is also expected to restrict the diversity of flora and fauna that can persist there. Intertidal areas of the steep sandy beaches are very narrow and support limited assemblages of bivalves and crustaceans.

The intertidal habitats in these two areas are typical of intertidal areas along the west coast of Barrow Island and are of low conservation significance.

4.2 East Coast Development Areas

4.2.1 Town Point Causeway and Landing

Physical Setting

The proposed causeway extends from the rocky headland at Town Point, through the boulder-strewn upper intertidal zone and across the intertidal part of the platform reef fringing the east coast of the Island (Plate 4-3). The development at Town Point would bury or subsume the rocky shoreline at the point and approximately 400 m of the shoreline extending south. The landing area would occupy approximately 200 m of the width of the causeway. Intertidal habitats in the area of the proposed development are described below.

Plate 4-3 - Town Point Intertidal Zone

The limestone pavement reef slopes gently into the lower intertidal and subtidal zones approximately 200 m seaward from the boulder zone at Town Point and up to 500 m from the adjacent beaches. There is a large shallow lagoon surrounding Town Point with a narrow break in the platform reef open to the sea. This channel appears to have been blasted for barge access during construction of the previous landing.

There are extensive intertidal platform reefs with large rock pools and channels, often with sandy bottoms, to the north and south of Town Point. These platforms are backed by sandy beaches.

The headland was previously developed as a landing with concrete armour across the seaward area of the headland. The landing was demolished in the early 1990s, however, remains of the concrete armour and associated debris are still evident in the upper intertidal boulder zone. There is a pile of boulders immediately offshore from the point.

The intertidal areas north of Town Point and Terminal Beach were previously disturbed during construction of the large oil storage facility (Terminal Tanks). Tank modules were brought in across the intertidal platform to a channel cut through the beach dunes and hinterland.

Intertidal Biota

The invertebrate assemblage of the upper intertidal boulder zone is relatively poorly developed. It is dominated by barnacles, small limpets and occasional oysters (*Saccostrea*). Small corals (*Pleasiastrea, Porites*, Mussidae) and juvenile fish were observed in small permanent rock pools.

The limestone pavements support a relatively low diversity biotic assemblage. Boring bivalves (*Lithophaga*) were the most broadly distributed mollusc. Large rock oysters (*Chalma*) and bastard oysters (*Pinctada alba*) were present in low numbers over most of the pavements. Strap shells were present under most of the rocks investigated and along the edges of rock pools. Orange sea cucumbers (*Holothuria hilla*) were abundant, being found under most of the rocks investigated. The common octopus (*Octopus cyanea*) was abundant in rock pools and crevices across the platform. Sand filled pools contained large numbers of gastropods *Pseudovertagus* and *Rhinoclavis.*

The lower component of the platform had less sediment cover and supports a more abundant and diverse epibiota, including macroalgae, sponges, scleractinian corals, octocorals, zooanthids, hydroids and ascidians. Common macroalgae include *Sargassum*, *Halimeda, Padina, Caulerpa* and *Turbinaria*. Sponge morphologies included large encrusting lithophagid sponge, ball, digitate and other encrusting species.

The coral assemblage is dominated by various species of *Goniastrea*, with some colonies of *G. favulus* exceeding 80 cm in diameter and extending at least 60 cm above the low tide level. Less common corals include *Porites, Euphyllia*, *Lobophyllia, Plesiastrea, Favia, Favites, Turbinaria, Platygyra* and *Acanthastrea*. Octocorals (soft corals) observed include *Sarcophyton, Lobophytum, Sinularia, Nepthea* and *Dendronephthya.*

Macrophyte assemblages vary from almost bare exposed rock to low turf to luxuriant thalli in rock pools and the lower intertidal. The surface of the upper intertidal pavement was essentially bare of macrophytes. The surface of the platform that is regularly exposed supports a low turf with entrained sediment. The rock pools supported the most well developed macrophyte assemblage.

Macroalgal turfs generally comprise red algae including *Laurencia*, *Chondria*, *Ceramium*, *Centroceras clavulatum*, *Gelidiopsis* and *Hypnea.*

Macrophytes in the rock pools included *Sargassum* and *Cystoseira* with thalli up to 30 cm long and seagrasses (*Halophila, Halodule* and *Thalassia*) in densities ranging from occasional plants to small meadows (Plate 4-4).

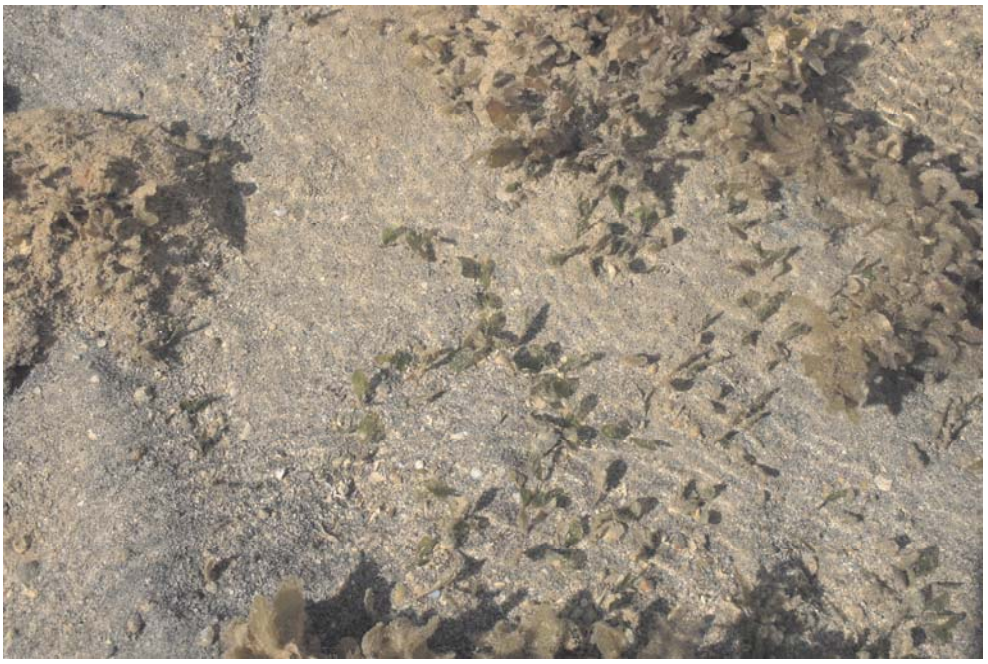

Plate 4-4 - *Halophila* and *Sargassum* in Shallow Intertidal Rock Pool at Town Point

Deeper rock pools support mobile marine faunal assemblages comprising juveniles and larger individuals trapped by the outgoing tide, such as squid, fish and large hermit crabs (*Dardanus* sp.).

The intertidal habitats and associated assemblages at Town Point are widespread along the east coast of Barrow Island and are of low conservation significance.

4.2.2 Mainland Shore Crossing

East of Passage Island

The proposed shore crossing for the domestic gas pipeline from Barrow Island is adjacent to the existing domestic gas pipeline from Varanus Island to Compressor Station 1 on the mainland. Intertidal habitats in the area east of Passage Island comprise broad intertidal sand/mud flats overlying pavement reef and mangals with tidal creeks. In adjacent areas of the coast there are exposed pavement reefs, with small boulders and silt veneer seaward of and within the mangroves.

The existing pipeline crosses an extensive intertidal sand and mud flat on the mainland shore that extends up to 3 km seaward from the mangrove zone (Plate 4-5).

Plate 4-5 - Extensive Sand Flat near Proposed Domestic Gas Shore Crossing on Mainland

The mangrove zone is regularly dissected by muddy tidal creeks, the longest of which extended some kilometres inland. The water in the creeks is very turbid. The mangrove communities are dominated by *A. marina* and *R. stylosa* (Plate 4-6).

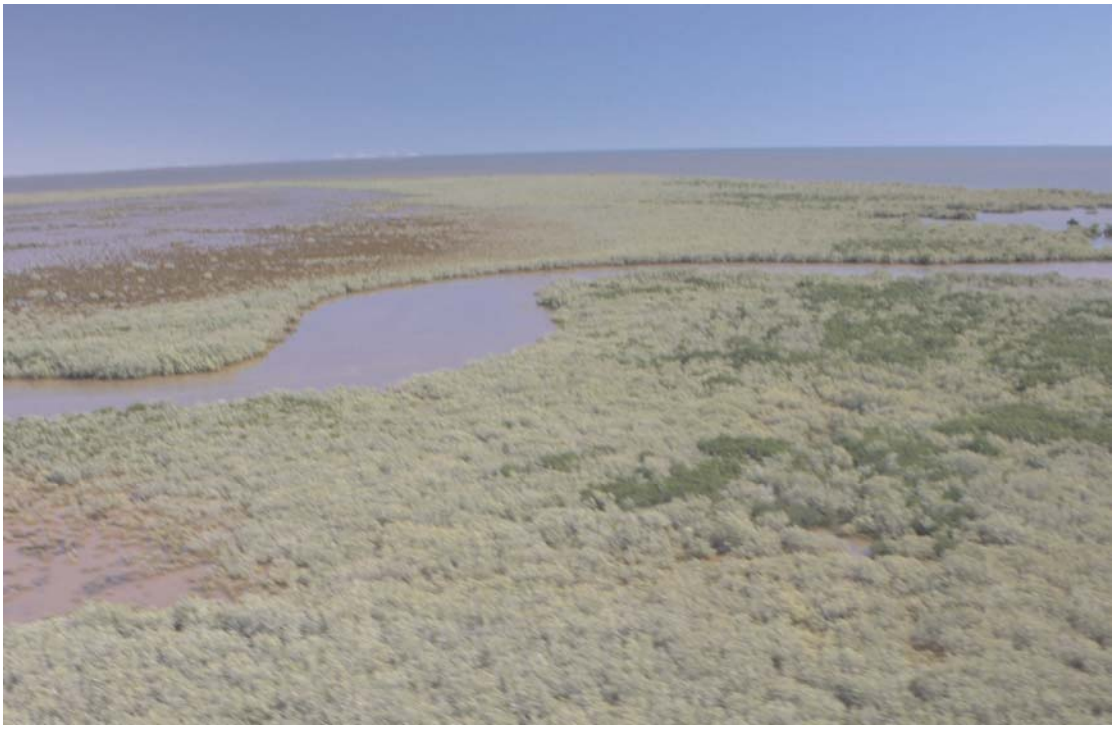

Plate 4-6 - A*vicennia marina/Rhizophora stylosa* Mangal and Samphire (brown) on Mainland Coast Near Proposed Domestic Gas Pipeline Shore Crossing

The existing gas pipeline easement through the mangroves has minor regrowth (Plate 4-7) and appears to be stable. There is no sign of ongoing edge effects such as would be expected from the exposure of acid-sulphate soils or major erosion.

Plate 4-7 - Existing Mainland Pipeline Crossing

The upper intertidal zone comprises salt-affected sand and mud substrates with samphire, but no exposed rock. The tidal influence extends 5-10 km inland from the mangrove zone and ends in a broad unvegetated salt pan.

Intertidal Biota

The upper intertidal zone is dominated by an extensive mangrove system. *Avicennia marina* is generally the dominant mangrove species along the seaward and landward edges of the mangal. *Rhizophora stylosa* forms a taller canopy in the midst of the mangal (darker green in Plate 4-6).

The fauna of the mangal includes abundant red fiddler crabs (*Uca*), occasional portunid crabs including mud crabs (*Scylla serrata*), mud skippers (*Periopthalmus vulgaris*), mud lobsters (*Thalassina anomala*), crawling gastropods and rock oysters (*Saccostrea*) attached to the pneumatophores and trunks of trees in the lowest part of the zone. A juvenile sea eagle was also observed roosting in the mangroves.

The broad intertidal sand flat seaward of the mangroves supports a sparse faunal assemblage of echinoderms, molluscs, crustaceans and other invertebrates. Common taxa include nemertean worms, gastropods (*Nassarius*, *Polinices*, *Syrinx*), digitate sponges and small sand dollars (*Echinodiscus* sp.).

Shallow drainage channels and the lower intertidal areas support soft corals (*Dendronephthya* sp.), macroalgae (*Caulerpa*, *Penicillus*) and razor mussels (*Pinna* sp.).

The intertidal sand and mud flats slope very gradually into the shallow subtidal zone. A broad area of this habitat is probably exposed on extreme low tides. This zone supports a much more abundant benthic assemblage dominated by seagrasses and crinoids.

The seagrass assemblage is dominated by *Halophila*, with lesser *Halodule* (Plate 4-8). The seagrass patches extend higher up the zone in shallow depressions that hold water longer than the surrounding sand flats. Macroalgae (*Halimeda, Caulerpa*, *Penicillus*) were less abundant and were restricted to small plants.

Plate 4-8 - Intertidal *Halophila* and *Halodule* Seagrass Meadow on Mainland Coast Near Proposed Domestic Gas Pipeline Shore Crossing

Small feather stars (crinoids) and large asteroids (*Protoreaster*) were abundant and appear to migrate with the incoming and outgoing tides, such that they occurred in large numbers in water less than 50 cm deep. They were observed swimming with the falling tide but were rarely observed beached.

Corals were restricted to very occasional *Trachyphyllia* and *Duncanopsammia* colonies sitting unattached on the sandy sediments. Soft corals are very poorly represented in the low intertidal, being limited to occasional *Dendronephthya* colonies. The rippled fine sands devoid of hard substrate do not favour a diversity of molluscs.

All of these habitats and assemblages are widespread along the mainland coast.

East of Cowle Island

The intertidal zone east of Cowle Island comprises a flat, limestone pavement extending approximately 400 m seaward of the mangrove zone (Plate 4-9). The uppermost extent of the intertidal zone was not examined, but the exposed limestone pavement extends at least 80 m into the mangrove forest.

Plate 4-9 - Intertidal Zone at Alternate Pipeline Crossing Location

A very thin laver of fine sediment coated the pavement across the mid intertidal level. Small and medium sized rock pools occurred across the intertidal zone below the mangroves. Undercut ledges occurred along the edges of some of the pools, while the floor of the pools was predominantly coarse sands.

Intertidal Biota

The dense mangrove forest appeared to be a mono-specific stand of medium sized *A. marina* trees with a narrow band of *Aegialitis* along the seaward edge. These were growing on rocky pavement with minimal sediments. The associated fauna was relatively depauperate, being limited to mangrove littorines (*Nodilittorina scabra*), small portunid crabs, hermit crabs, stunted rock oysters (*Saccostrea*), mud skippers and various small fish in the shallow perched waters.

The mid-tidal zone generally had a limited range of micro habitats, with sediment deposits on the pavements reducing the substrates suitable for many invertebrates. Small rock ledges supported xanthid and grapsid crabs and occasional gastropods (Turbinidae, Trochidae). One particularly large rock pool contained *Sargassum*, *Cystoseira*, stunted macroalgae, small fish, nemerteans and soft coral.

Rock pools and boulders in the lower intertidal zone supported a diverse and abundant biotic assemblage. Macrophytes were common, including stunted *Sargassum, Padina, Caulerpa*, *Halimeda* and other turfing macroalgae. Seagrasses (*Halophila, Halodule* and *Thalassia*) were moderately common in sandy rock pools.

The lower intertidal faunal assemblage was dominated by gastropods (*Cypraea stolida*, *C. gracilis*, *C. erones*, *Conus novaehollandiae*, *Astralium*, *Trochus hanleyanus*, *Melo amphora*, *Angaria*, muricids, *Trochus*, *Turbo*). Other molluscs included large dorid nudibranchs under loose rocks, *Octopus cyanea* and lithophagic mussels. Other abundant taxa in the lower intertidal zone included holothurians (*Holothuria hilla*, *H. atra*), asteroids (*Protoreaster*),

mantis shrimps (stomatopods), hermit crabs (anomurids), small portunid and xanthid crabs and a large mud crab (*Scylla serrata*).

Corals were common in the immediate sub-tidal zone, with a narrow band of moderate coral cover fringing the intertidal zone. Some corals extended into the intertidal zone, particularly members of the genus *Goniastrea.* Less common were other members of the family Faviidae, including *Platygyra, Favites* and *Plesiastrea.* Other corals observed in the low intertidal included small colonies of *Euphyllia*, *Porites* and *Goniopora.*

All of these habitats and taxa are very widespread along the mainland coast. They are all of low conservation significance, except the mangroves, which the EPA (2001) has identified throughout the Pilbara region as having high conservation significance and particular areas as having very high significance (regionally significant arid zone mangrove areas). The proposed shore crossing is approximately 6 km from the nearest mangal of very high conservation significance.

5 References

Bowman Bishaw Gorham. 1995. *Survey of the Intertidal Habitats of Thevenard Island.* Unpublished report RI3158 to WAPET by Bowman Bishaw Gorham, April 1995.

Bowman Bishaw Gorham. 1996. *Barrow Island Intertidal Survey:* 1995. Unpublished report RI5164 to WAPET by Bowman Bishaw Gorham, May 1996.

Bowman Bishaw Gorham. 1997. *Survey of the Intertidal Shores of the Eastern Side of Barrow Island.* Unpublished report RI6335 to WAPET by Bowman Bishaw Gorham and Murex Consultants, November 1997.

Bowman Bishaw Gorham. 2003. *Barrow Island Marine and Intertidal Environmental Survey Gorgon Gas Development.* Unpublished report R02119 to ChevronTexaco Australia Pty Ltd by Bowman Bishaw Gorham, January 2003.

CALM 2004. *Indicative Management Plan for the Proposed Montebello/Barrow Islands Marine Conservation Reserves.* Department of Conservation and Land Management 2004.

EPA 2001. *Guidance for the Assessment of Environmental Factors: Guidance Statement for Protection of Tropical Arid Zone Mangroves Along the Pilbara Coastline.* Environmental Protection Authority, Western Australia, Guidance Statement No. 1.

IMCRA. 1998. *Interim Marine and Coastal Regionalisation for Australia: An ecosystem Based Classification for Marine and Coastal Environments.* Interim Marine and Coastal Regionalisation for Australia Technical Group, Environment Australia, Commonwealth Department of the Environment, Canberra.

LeProvost Environmental Consultants 1991. *Shallow Marine Habitats and Biotic Assemblages of Barrow Island.* Unpublished report to West Australian Petroleum Pty. Limited.

Wilson B.R., Berry P.F., Carman-Brown A., Crossland C.J., Eliot I., Hatcher B., Jones H.E., Kirkman H., Lenanton R.C., Marsh L.M., Ottaway J.R., Poole M., Semeniuk V., Simpson C.J., Slack-Smith S.M., Walker D.I., Wilson B.R., Chevis H., May R.F., King S. 1994. *A Representative Marine Reserve System for Western Australia.* Report of the Marine Parks and Reserves Selection Working Group. Department of Conservation and Land Management, June 1994.