

Appendix B

Blacktip Project Offshore and Intertidal Environmental Surveys prepared by Sinclair Knight Merz



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Blacktip Project Offshore and Intertidal Environmental Surveys



- Rev 0
- 15/10/2004

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Document history and status

Revision	Date issued	Reviewed by	Approved by	Date approved	Revision type
A	10/8/04	U Phelan	U Phelan		
B	08/09/04	U Phelan	U Phelan		
C	11/10/04	B Brown	B Brown	11/10/04	Editorials

Distribution of copies

Revision	Copy no	Quantity	Issued to
A			
B			
C	Electronic	1	Ceri Morgan

Printed:	18 October 2004
Last saved:	11 October 2004 06:22 PM
File name:	I:\WVES\Projects\WV02540\Technical\Environmental Survey\Report\R11BFC_EnvSur_Rev C_review.doc
Author:	Brian Cohen
Project manager:	Una Phelan
Name of organisation:	Woodside Energy Ltd
Name of project:	Blacktip Project
Name of document:	Offshore and Intertidal Environmental Surveys
Document version:	Draft C
Project number:	WVO2540

1. Executive Summary

An intertidal and offshore environmental survey of the proposed Blacktip Project area was conducted to provide information on the existing marine environment for the Blacktip Project Environmental Impact Statement (EIS).

Sediment hydrocarbon and metal concentrations indicate that the Blacktip Project area is mostly free of significant sediment contamination, even at the proposed platform location despite it being near the previous drilling activity associated with the Blacktip-1 well. This result is not surprising, as there are only low levels of anthropogenic activity in the Joseph Bonaparte Gulf. Low concentrations of long chained hydrocarbons were found in some mangrove sediment samples, which were probably associated with hydrocarbon seeps from the Petrel and Tern Fields. This result suggests that the measurement of hydrocarbon concentrations in mangrove sediments may be an effective tool for monitoring hydrocarbon discharges associated with the proposed Blacktip Project, particularly hydrocarbons associated with the produced water (PW) discharge.

Preliminary water quality data indicates that during the dry season the water column is well mixed and therefore will not limit dilution of the PW discharge plume. Additional data is required for the wet season to determine if stratification of the water column occurs, particularly at the proposed produced water discharge location. Waters near the coast are very turbid which appears limits the occurrence of seagrass, macroalgae and coral. There were no indications to suggest that seagrass beds, macroalgal beds or coral reefs occur within the Blacktip Project area. The data collected suggests that turtle activity in the project area is low. No cetacean activity was recorded during any of the offshore surveys. Woodside should continue to monitor cetacean activity whenever they conduct activities in the proposed project area to determine if any seasonal cetacean activity occurs in the Joseph Bonaparte Gulf.

Intertidal and subtidal infauna is species rich. A number of intertidal species have been identified which would be suitable for monitoring of shore crossing construction activities including the littorinid gastropod *Echinolittorinia trochoides*, which occurs on rocky substrates, and *Littoraria filosa*, which occurs in the mangroves, and the bivalve, *Donax faba*, which occurs on sandy beaches. The data collected is suitable for power analysis, which should be undertaken to design a construction-monitoring program if the proposed project is approved.

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2. Introduction

The primary objective of the intertidal and offshore environmental surveys was to provide information to assist with the description of the existing marine environment for the Blacktip Project Environmental Impact Statement (EIS).

The information gathered during these surveys will also:

- assist with the development of future monitoring programmes;
- allow differences between predicted and actual impacts to be quantified and the need for additional environmental management identified;
- enable reporting to regulators and stakeholders on environmental performance and determination of whether environmental performance targets are met;
- determine rehabilitation success eg at the beach crossing;
- ultimately ensure that no adverse environmental impacts are occurring.

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3. Methods

3.1 Survey Locations

3.1.1 Offshore

The offshore environmental survey covered the:

- platform location
- pipeline route including shore approach
- PW discharge area and the condensate export mooring, located approximately 3 km and 4 km offshore from the proposed pipeline beach crossing, respectively.

Sampling sites along the pipeline route were stratified using the results of the geophysical survey (**Table 1**), to ensure coverage of all the identified seabed habitats. Most of the seabed along the pipeline route was categorised as either:

- flat and featureless seabed containing soft to firm silty clay
- area of hummocky seabed containing megaripples/sand waves.

The offshore sampling regime is presented in **Table 2** and **Figure 1**. Sampling was conducted from the MV *Island Explorer* between the 19th and 22nd of May 2004.

3.1.2 Intertidal

The proposed gas export subsea pipeline is planned to come onshore at northern Yelcher Beach, a small beach approximately 700 m long, located 12 km from Wadeye (formerly Port Keats). Three main intertidal habitats occur near the pipeline crossing location. They are:

- sandy beach
- rock platform
- mangroves.

Three areas (approximately 50 – 100 m apart) representing the high, mid and low intertidal zone were sampled on the sandy beach. At northern Yelcher Beach, three transects running perpendicular to the shore (ie from landward to seaward) were sampled, one on the pipeline alignment near the centre of the beach and the others approximately 200 m to the north and south of the pipeline corridor (**Table 3** and **Figure 2**). Sampling was also undertaken at Yelcher Beach to the south, selected due to its similar intertidal width, aspect and wave. Two transects were established using the same strategy implemented at northern Yelcher Beach.

At each end of northern Yelcher Beach are rock platforms and mangroves. Yulow Point, to the south, separates northern Yelcher and Yelcher Beach and Maninh Point, to the north, separates Yelcher Beach from Injin Beach (**Figure 2**). The mangroves at Maninh Point are of significance to the traditional owners due to the presence of the Cheesefruit Tree (*Morinda citrifolia*) and

sampling at this location was not possible. The survey of the adjacent mangroves of Maninh Point was conducted in association with the traditional owners. All intertidal sampling was conducted by Kristin Metcalfe between the 2nd and 4th June 2004. **Table 3** summarises the intertidal sampling regime.

3.2 Parameters

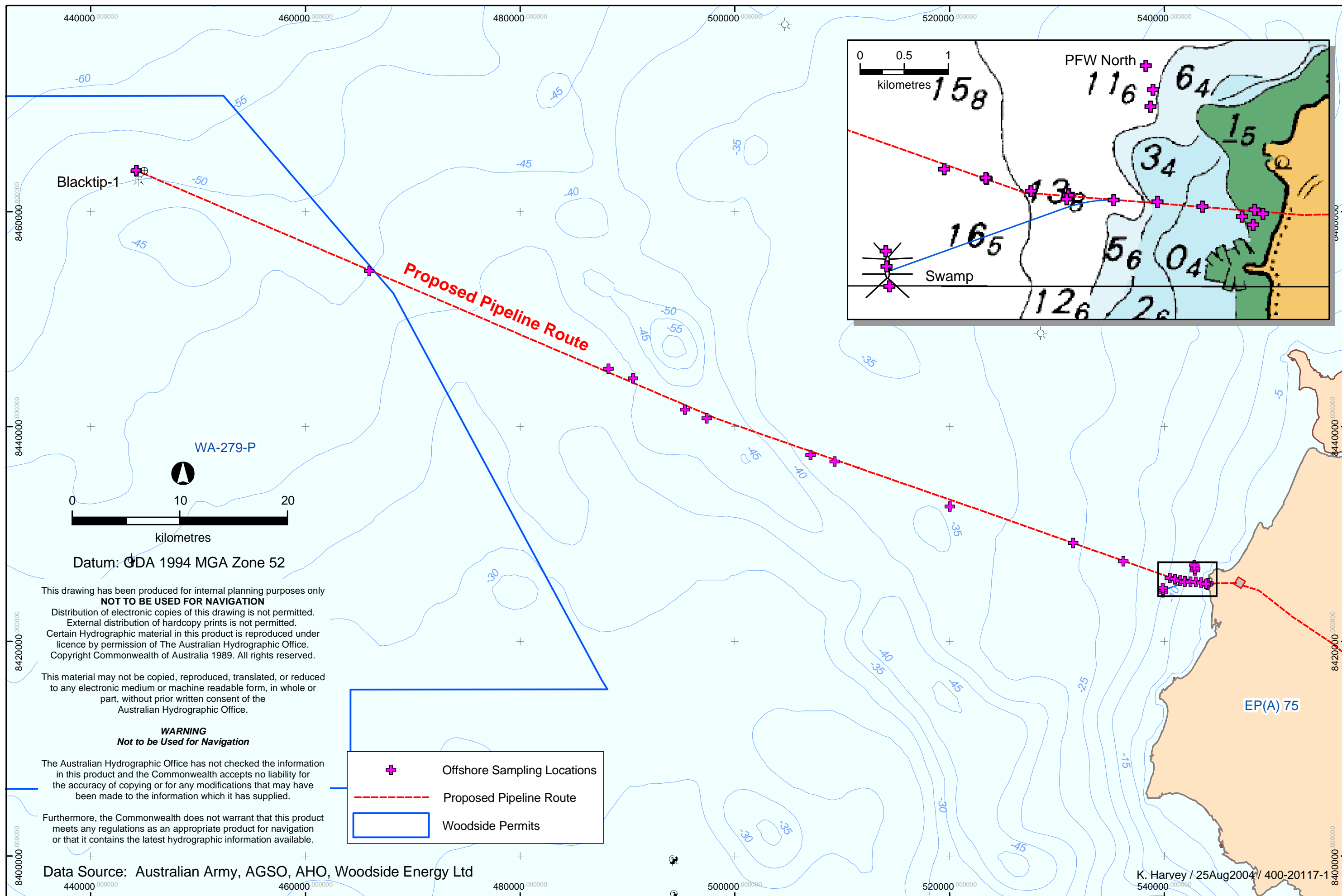
3.2.1 Sediments

Sediment samples were collected from all offshore sites and the intertidal beach and mangrove sites (not rock platform sites). Sediments were analysed for the following:

- Total Recoverable Hydrocarbons (TRH), speciated into
 - C₆-C₉
 - C₁₀-C₁₄
 - C₁₅-C₂₈
 - C₂₉-C₃₆.
- Sediment particle size distribution
- Metals as specified in **Table 1**.

Offshore sediment samples were collected using a Van Veen Grab. Intertidal sediments were collected directly during low tides. Samples for TRH analyses were collected directly into cleaned 300 ml glass jars (acid rinsed by the laboratory), samples for metals into 100 ml plastic containers and samples for sediment particle size distribution into 300 ml whirlpaks. All sample containers were labelled, recorded on the sample register sheet and placed into a freezer or fridge for storage and transport to the laboratories. Between all sample sites, sample collection buckets and ladles were washed with a dilute solution of Decon 90 cleaner and rinsed thoroughly with sea water.

The analyses were undertaken by SGS Australia Pty Ltd. (TRH and particle size distribution), the Marine And Freshwater Research Laboratory (sediment metals and offshore infauna) and Kristin Metcalfe and the Northern Territory Museum (intertidal biota). Both SGS and MAFRL are NATA accredited laboratories.



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■ **Table 1 Fugro's Geophysical Assessment of Seabed Habitats along the Proposed Pipeline Route**

From KP to KP	Seabed Type
0.000 to 47.445	Flat and featureless seabed containing very soft to firm silty clay.
47.445 to 47.942	Area of hummocky seabed containing megaripple/sand waves. Generally consisting of unconsolidated coarse sand, fine gravel. Occasionally sediments are consolidated/cemented and contain hard/soft coral and algae. Drop core recovered partially indurated gravel containing soft corals at KP47.847.
47.942 to 49.596	Flat and featureless seabed containing very soft to firm gravelly clay.
49.596 to 50.567	Area of hummocky seabed containing megaripple/sand waves. Generally consisting of unconsolidated coarse sand, fine gravel. Occasionally sediments are consolidated/cemented and contain hard/soft coral and algae.
50.567 to 52.789	Flat and featureless seabed containing very soft to firm gravelly clay.
52.789 to 53.542	Area of hummocky seabed containing megaripple/sand waves. Generally consisting of unconsolidated coarse sand, fine gravel. Occasionally sediments are consolidated/cemented and contain hard/soft coral and algae.
53.542 to 54.781	Flat and featureless seabed containing very soft to firm gravelly clay.
54.781 to 56.390	Area of hummocky seabed containing megaripple/sand waves. Generally consisting of unconsolidated coarse sand, fine gravel. Occasionally sediments are consolidated/cemented and contain hard/soft coral and algae.
56.390 to 59.341	Flat and featureless seabed containing very soft to firm gravelly clay.
59.341 to 59.945	Area of hummocky seabed containing megaripple/sand waves. Generally consisting of unconsolidated coarse sand, fine gravel. Occasionally sediments are consolidated/cemented and contain hard/soft coral and algae. Drop core recovered unconsolidated gravel containing shell and coral fragments at KP59.600.
59.945 to 64.751	Flat and featureless seabed containing very soft to firm gravelly clay.
64.751 to 66.656	Area of hummocky seabed containing megaripple/sand waves. Generally consisting of unconsolidated coarse sand, fine gravel. Occasionally sediments are consolidated/cemented and contain hard/soft coral and algae.
66.656 to 67.746	Flat and featureless seabed containing very soft to firm gravelly clay.
67.746 to 68.405	Area of hummocky seabed containing megaripple/sand waves. Generally consisting of unconsolidated coarse sand, fine gravel. Occasionally sediments are consolidated/cemented and contain hard/soft coral and algae.
68.405 to 72.594	Flat and featureless seabed containing very soft to firm gravelly clay.
72.594 to 76.174	Alternating flat and featureless seabed containing very soft to firm gravelly clay and areas of hummocky seabed containing megaripple/sand waves. Generally consisting of unconsolidated coarse sand, fine gravel. Occasionally sediments are consolidated/cemented and contain hard/soft coral and algae.
76.174 to 78.424	Flat and featureless seabed containing very soft to firm gravelly clay.
78.424 to 84.314	Alternating flat and featureless seabed containing very soft to firm gravelly clay and areas of hummocky seabed containing megaripple/sand waves. Generally consisting of unconsolidated coarse sand, fine gravel. Occasionally sediments are consolidated/cemented and contain hard/soft coral and algae. Drop core recovered a cemented gravel covered in corals at KP82.000.
84.314 to 89.000	Flat and featureless seabed containing very soft to firm gravelly clay.
89.000 to 103.390	Flat and featureless seabed containing very soft to firm gravelly clay with some areas of hummocky seabed containing megaripple/sand waves. Sand waves areas generally consisting of unconsolidated coarse sand/fine gravel, which can be consolidated/cemented and contain hard/soft coral and algae. Drop core recovered unconsolidated worm tube debris at KP99.151.
103.390 to 104.000	Subcropping/outcropping indurated gravelly clay containing hard and soft corals.

KP = kilometre along pipeline route from proposed platform location

■ **Table 2 Offshore Sampling Locations**

Site Description	Date	Time	Grid Coordinates (GDA94)		Pipeline KM (Platform =0 km)	Depth (m)	Sediment Chemistry	Infauna	Water Quality
			EASTING	NORTHING					
Platform North	5/22/2004	10:08	444293.9	8463910.2	0.004	55.0	✓	✓	x
Platform East	5/22/2004	10:53	444276.4	8463790.9	0.035	55.0	✓	✓	✓
Platform South	5/22/2004	11:18	444192.9	8463794.3	-0.043	55.0	✓	✓	x
Platform West	5/22/2004	9:38	444222.9	8463869.5	-0.045	55.0	✓	✓	✓
Pipeline 01	5/21/2004	18:55	465954.5	8454505.1	23.627	44.0	✓	✓	✓
Pipeline 02	5/21/2004	16:49	488235.8	8445389.4	47.708	33.0	✓	✓	✓
Pipeline 03	5/21/2004	16:17	490510.8	8444517.1	50.143	33.0	✓	✓	✓
Pipeline 04	5/21/2004	15:33	495351.9	8441594.0	55.746	40.0	✓	✓	✓
Pipeline 05	5/21/2004	14:33	497380.7	8440794.1	57.927	46.0	✓	✓	✓
Pipeline 06	5/19/2004	15:31	507063.0	8437373.9	68.180	37.9	✓	✓	✓
Pipeline 07	5/19/2004	16:30	509305.3	8436749.2	70.504	34.3	✓	✓	✓
Pipeline 08	5/19/2004	18:14	520019.8	8432563.5	82.004	34.4	✓	✓	✓
Pipeline 09	5/20/2004	7:43	531522.7	8429165.2	93.989	29.8	✓	✓	✓
Pipeline 10	5/20/2004	8:28	536199.4	8427460.0	98.968	29.1	✓	✓	✓
Pipeline 11	5/20/2004	11:02	540517.9	8425907.2	103.559	20.3	✓	✓	✓
PW3.5 Rep1	5/20/2004	11:39	540994.1	8425797.6	104.045	19.7	✓	✓	x
PW3.5 Rep2	5/20/2004	12:07	540999.5	8425796.1	104.050	19.2	✓	✓	✓
PW3.5 Rep3	5/20/2004	12:19	540987.7	8425808.0	104.035	18.9	x	✓	x
PW3.0 Rep1	5/20/2004	12:56	541498.6	8425658.5	104.570	18.0	✓	✓	x
PW3.0 Rep2	5/20/2004	13:00	541499.5	8425658.5	104.571	18.2	✓	✓	✓
PW3.0 Rep3	5/20/2004	13:03	541501.9	8425659.1	104.574	18.1	✓	✓	x
PW2.5 Rep1	5/20/2004	15:18	541928.1	8425625.1	105.003	17.1	✓	✓	x
PW2.5 Rep2	5/20/2004	15:24	541922.0	8425611.5	104.998	17.2	✓	✓	✓
PW2.5 Rep3	5/20/2004	15:30	541903.4	8425567.6	104.983	17.2	✓	✓	x
PWNorth Rep1	5/20/2004	14:13	542852.3	8426614.7	n/a	15.3	✓	✓	x
PWNorth Rep2	5/20/2004	14:33	542881.3	8426806.5	n/a	15.7	✓	✓	✓
PWNorth Rep3	5/20/2004	14:46	542799.8	8427077.8	n/a	14.6	✓	✓	x
Condensate Rep1	5/20/2004	9:38	539896.9	8424581.9	n/a	23.7	✓	✓	x
Condensate Rep2	5/20/2004	10:01	539866.1	8424808.5	n/a	22.9	✓	✓	✓

			Grid Coordinates (GDA94)						
Condensate Rep3	5/20/2004	10:35	539855.8	8424979.7	n/a	22.1	✓	✓	x
Nearshore 2.0 km	5/20/2004	16:11	542436.2	8425557.5	105.515	16.6	✓	✓	✓
Nearshore 1.5 km*	5/20/2004	16:28	542932.9	8425536.9	106.012	9.3	x	x	✓
Nearshore 1.0 km*	5/20/2004	16:50	543442.3	8425483.1	106.524	8.4	x	x	✓
Inshore 0.0 km Rep1	5/20/2004	17:16	544030.6	8425447.4	107.113	6.0	✓	✓	x
Inshore 0.0 km Rep2	5/20/2004	17:35	544124.7	8425403.5	107.211	5.6	✓	✓	x
Inshore 0.0 km Rep3	5/20/2004	17:40	544013.5	8425278.2	107.110	6.0	✓	✓	✓
Inshore 0.0 km Rep4	5/20/2004	17:46	543889.8	8425371.5	106.979	6.3	✓	✓	x

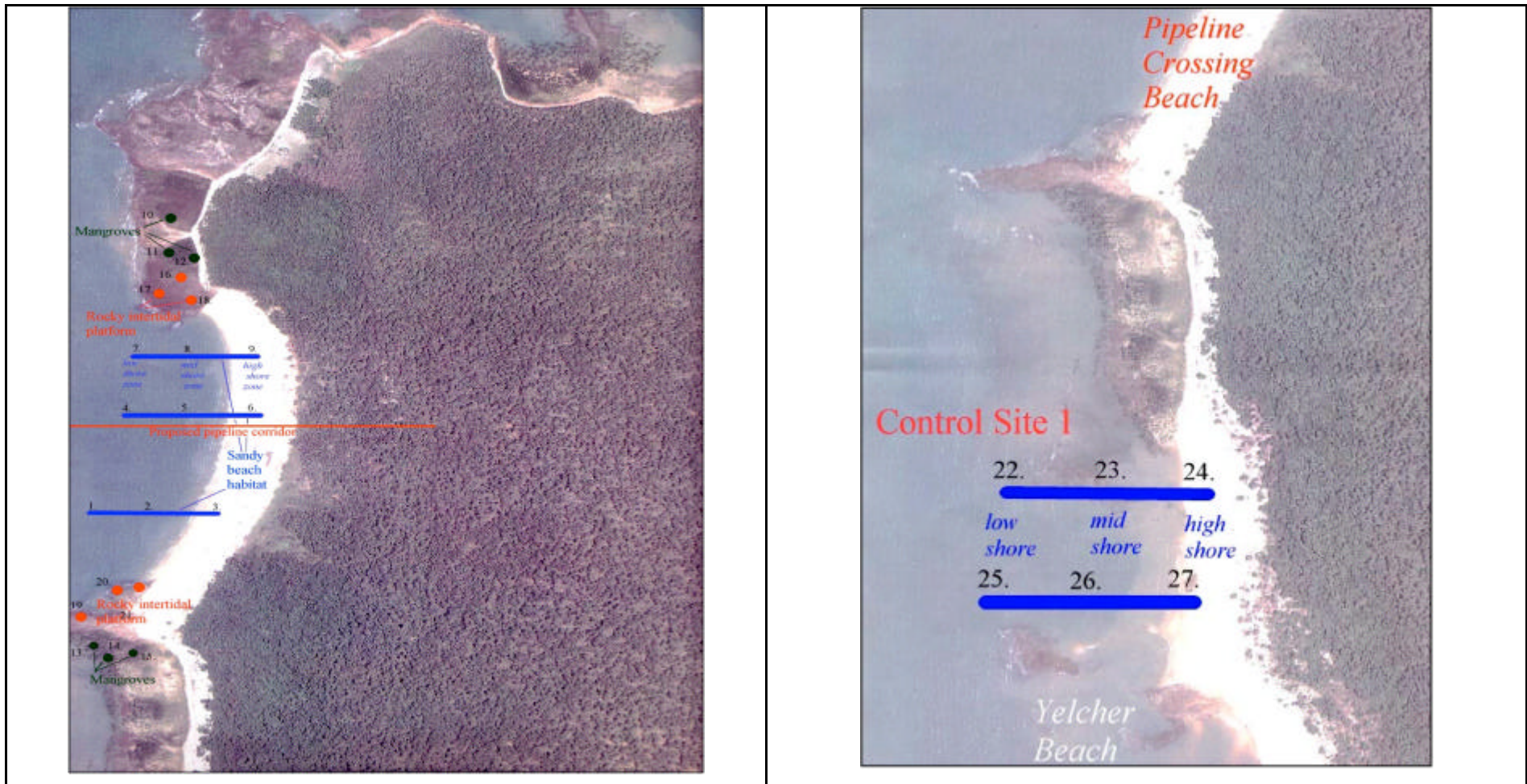
See **Section 2.1.2** for description of sediment chemistry, **Section 2.1.3** for water quality and **Section 2.1.4** for description of faunal sampling.

* Van Veen Grab failed three times in a row and depth sounder suggested substrate was very hard ie rock bottom.

■ **Table 3 Intertidal Sampling Locations**

Site Description	Date	Grid Coordinates (GDA94)		Sediment Chemistry	Faunal quadrats			Anoxic mats	Pitfall trap
		EASTING (m)	NORTHING (m)		0.5 x 0.5	1.0 x 1.0	0.3 x 0.3		
Northern Yelcher Beach B1	2/6/04	544236	8425228	✓			✓		
Northern Yelcher Beach B2	2/6/04	544282	8425210	✓			✓		
Northern Yelcher Beach B3	2/6/04	544317	8425196	✓			✓		
Northern Yelcher Beach B4	2/6/04	544306	8425394	✓			✓		
Northern Yelcher Beach B5	2/6/04	544352	8425386	✓			✓		
Northern Yelcher Beach B6	2/6/04	544381	8425378	✓			✓		
Northern Yelcher Beach B7	2/6/04	544340	8425582	✓			✓		
Northern Yelcher Beach B8	2/6/04	544377	8425582	✓			✓		
Northern Yelcher Beach B9	2/6/04	544418	8425580	✓			✓		
Maninh Point Mangroves M10	3/6/04	543958	8424736	✓		✓		✓	✓
Maninh Point Mangroves M11	3/6/04	544019	8424740	✓		✓		✓	✓
Maninh Point Mangroves M12	3/6/04	544066	8424718	✓		✓		✓	✓
Yulow Point Mangroves M13	4/6/04	544207	8425996	✓		✓		✓	✓
Yulow Point Mangroves M14	4/6/04	544202	8425960	✓		✓		✓	✓
Yulow Point Mangroves M15	4/6/04	544236	8425998	✓		✓		✓	✓
Yulow Point Rock Platform R16	3/6/04	544401	8423502	X	✓				
Yulow Point Rock Platform R17	3/6/04	543875	8424826	X	✓				
Yulow Point Rock Platform R18	3/6/04	543830	8424812	X	✓				
Yelcher Beach B19	2/6/04	544007	8423140	✓			✓		
Yelcher Beach B20	2/6/04	544128	8423106	✓			✓		
Yelcher Beach B21	2/6/04	544450	8423302	✓			✓		
Yelcher Beach B22	2/6/04	544061	8423336	✓			✓		
Yelcher Beach B23	2/6/04	544189	8423354	✓			✓		
Yelcher Beach B24	2/6/04	544382	8423490	✓			✓		

See **Section 2.1.2** for description of sediment chemistry and **Section 2.1.4** for description faunal sampling



Rocky Intertidal Platform sites 19-21 not sampled

- **Figure 2 Intertidal Sampling Locations**

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■ **Table 4 Sediment Metals Analyses**

Metals in Sediment	Analytical Detection Limit (mg/ kg DW)	ANZECC guideline (mg/ kg DW)
Antimony	<2	2
Aluminium (Al)	<20	--
Arsenic (As)	<1	20
Barium (Ba)	<0.5	--
Cadmium (Cd)	<0.1	1.5
Chromium (Cr)	<0.2	80
Cobalt (Co)	<0.2	
Copper (Cu)	<0.1	65
Iron (Fe)	<5	--
Lead (Pb)	<1	50
Mercury (Hg)	<0.15	0.15
Nickel (Ni)	<0.4	21
Silver (Ag)	<1	1
Tin (Sn)	<2	--
Vanadium (V)	<0.1	--
Zinc (Zn)	<0.5	200

3.2.2 Water Sampling

Offshore water quality was profiled using an automated YS660 Probe attached to a 25 m long cable. The YS660 probe was configured to record the following parameters during deployment:

- depth
- temperature
- turbidity
- salinity
- dissolved oxygen
- ph

At some sites, shallow water and strong tidal currents, limited the depth to which the probe could be successfully lowered. However, the first 5 m of the water column were successfully sampled at all sites.

3.2.3 Fauna

Offshore infauna samples were collected using a 90 mm diameter polycarbonate plastic core inserted to a depth of 100 mm to remove a sample directly from the sediment in the Van Veen grab. The core sample was sieved through a 1 mm sieve to remove the fine sediment material and the remaining fauna and sediment was washed into a whirlpack plastic bag and preserved with a

small volume of 70% ethanol. Grab samples were also searched for large biota such as macroalgae, corals and seagrass.

Sandy beach infauna were sampled using two haphazardly placed 30 by 30 cm quadrats per sampling site, excavated to a depth of 10-15 cm and, due to the coarse nature of the sediments, sieved using a 2 mm sieve.

Rock Platform epifauna at Yulow Point were sampled using two haphazardly placed 50 cm by 50 cm quadrats per sampling station from which all macrofauna were identified directly, or removed and preserved for later identification. Incidental sampling in the vicinity of each station was also undertaken to document less abundant fauna. Three sampling stations at Yulow Point (6 quadrats) were sampled during this survey.

Mangrove fauna at Yulow and Maninh Points were sampled using a variety of techniques. Benthic fauna was sampled within 1 m by 1 m quadrats, placed adjacent to the nearest tree, using timed observation followed by active searches to a height of 2 m up the tree and a depth of 5 cm into the sediments. Infauna was also sampled using anoxic mats, small 0.01 m² plastic discs, which were left on the mud surface overnight to draw infauna. Free-ranging fauna, including fauna in standing water, were sampled using pitfall trap.

3.2.3.1 Observations

Cetacean, seabirds, dugongs, turtles sightings and shipping and fishing activity were recorded during the offshore survey along with any information on the distribution of significant benthic communities such as coral reefs or seagrass beds. A more comprehensive survey of turtle and dugong activity was undertaken by Charles Darwin University and is reported in Guinea (2004). All grab samples were searched for the presence of seagrass, macroalgae and corals.

4. Results and Discussion

4.1 Sediments

4.1.1 Chemistry

4.1.1.1 Hydrocarbons

Total Recoverable Hydrocarbon (TRH) were below detection limits in all samples except for three mangrove samples (**Appendix A**), one from Maninh Point and two from Yulow Point (**Table 5**).

■ **Table 5 Recoverable Hydrocarbons (mg/kg)**

Site	TRH C ₁₀ -C ₁₄	TRH C ₁₅ -C ₂₈	TRH C ₂₉ -C ₃₆
Maninh Point Mangroves M10	2	27	<10
Yulow Point Mangroves M14	<2	6	<10
Yulow Point Mangroves M15	<2	6	13

Refer to **Appendix A** for full set of results

Identification of the hydrocarbons in the sample "Maninh Point Mangroves M10" was investigated further using a Gas Chromatography-Mass Spectrometry and the analytes identified using the National Institute of Standards and Technology Mass Spectra library. A single peak was responsible for the hydrocarbons in the C₁₀-C₁₄ range and it was identified as:

- 1,2,3,4-tetrahydronaphthalene.

For the C₁₅-C₂₈ range, about 50% of the value reported was due to two single peaks which were identified as:

- 9,10-dihydro-9-anthracenamine
- (4-acetylphenyl) phenylmethane.

All three chemicals are long chained hydrocarbon products; 1,2,3,4-tetrahydronaphthalene and (4-acetylphenyl) phenylmethane are Polycyclic Aromatic Hydrocarbons (PAH). While it is not possible to identify the definite source of these chemicals, it is likely that all three are the breakdown products of crude oil. The Petrel and Tern wells, to the north west of the pipeline crossing, are known to leak hydrocarbons (Mick Guinea, Charles Darwin University, *pers comm.* 2004) and the predominate winds during the wet season, which are from the north west, would drive crude oil from these fields ashore. Crude petroleum has a high affinity for organically rich sediments, which is why crude accumulates readily in mangrove sediments. Sand and gravel have little ability to absorb these chemicals and are probably less sensitive indicators for ongoing monitoring.

It is also worth noting that TRH levels were below detection limits in the four samples collected from around the proposed Blacktip platform location, which is positioned about 1000 m from the Blacktip-1 well drilled in 2001.

4.1.1.2 Metals

Sediment metal concentrations are presented in **Appendix B**. Concentrations of most metals were below ANZECC sediment quality guideline values (**Table 4**). One sample collected 2.5 km off the coast (PW2.5 Rep 2) had a chromium concentration of 85 mg/kg, marginally above the ANZECC sediment quality guideline value of 80 mg/kg.

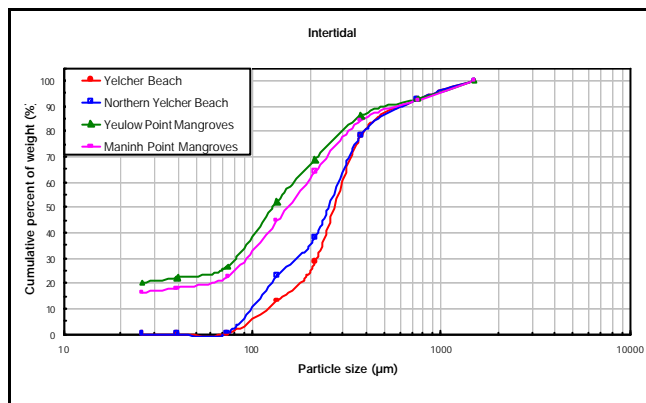
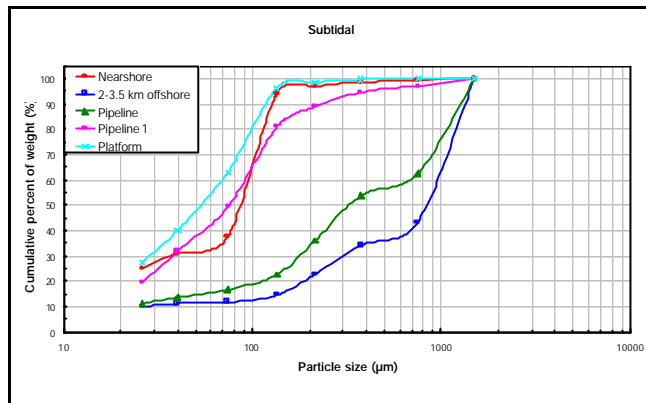
Samples from fifteen offshore sites and one mangrove sample contained sediment arsenic concentrations above the ANZECC sediment quality guideline value of 20 mg/kg, concentrated at sites located 1 to 3 km from the shore crossing. The maximum concentration was 72 mg/kg at the site PWNorth, located 1.5 km from the coast. Similar arsenic levels occur in Darwin Harbour, which are attributed to local geology rather than anthropogenic sources (Padovan 2003).

As there are no known anthropogenic heavy metal sources in the Joseph Bonaparte Gulf, the evaluated sediment arsenic and chromium levels, relative to the guideline values, are also likely to be the result of local geology rather than external contamination.

4.1.2 Sediment Particle Size

The sediment particle size results are presented in **Appendix C** and summarised in **Figure 3**. The variation in sediment particle size distributions is not surprising given the large geographic area (over 100 km) and the range of benthic habitats sampled. Sediments were finest at the platform location and in the intertidal zone, just above the drying height on navigational charts (Inshore sites). Very fine sands with some silt fractions dominated at these sites (**Figure 3**). Sediments were coarsest just off the coast with sediments in the vicinity of the proposed produced water discharge and condensate export mooring locations dominated by very coarse sands, with large amounts of gravel and boulder sized particles (*pers. obs.*). The sediments at these locations were poorly sorted with gravel and boulder sized particles loosely cemented on the seabed surface, covering finer sediment below this cemented surface layer. This very coarse, loosely cemented surface layer limited the effectiveness of the Van Veen Grab, which is more suited to sampling finer sediments. Sediments along the pipeline route from the Victoria River channel inshore were also very coarse mostly comprising coarse to very coarse sands (**Figure 3**).

Intertidal sediments on the beach were generally very fine to medium sands at both northern Yelcher Beach and to the south, at Yelcher Beach. The sediments in the mangroves were relatively coarse, dominated by sand fractions with only about 20% of the sediment weight made up by silt fraction. Sediments at Yulow Point mangroves were slightly finer than the sediments at Maninh Point.



■ **Figure 3 Cumulative Sediment Particle Size Distribution**

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4.2 Water Quality

The offshore water quality sampling occurred during spring tides between the 20st and 22nd of May 2004 (**Figure 4**). Water temperature, salinity, ph, dissolved oxygen and turbidity profiles did not vary with increasing depth within each sampling location, indicating that the water column was well mixed and no stratification was occurring. Stratification may be more likely in the wet season as a result of the large freshwater input into the Joseph Bonaparte Gulf, however this should be confirmed as it may have implications for the produced water discharge. Ph values were all around 8.1, within the ANZECC range for inshore tropical marine waters (8.0 to 8.4). Dissolved oxygen was also generally above 90% saturation, the ANZECC default trigger value for tropical marine waters. Dissolved oxygen levels and ph were consistent and did not vary from the shore crossing to the platform location.

Salinity increased minimally from around 33 ppts near shore to nearly 35 ppts offshore (**Figure 5A**). Again, the range in salinity is likely to be much greater during the wet season, with salinity values lower closer to the coast due to large freshwater input.

Temperature and turbidity showed a more complex pattern with distance offshore (**Figure 5B and 5C**), though the range in temperature was small only ranging between 28 and 29°C. By contrast, the range in turbidity was marked. Lower values (around 2 NTU) were recorded from about the 30 km mark offshore. Values peaked near 40 NTU, 3 km from the coast but where high (> 10 NTU) from 2 to 15 km from the coast. Inshore of the 2 km mark, NTU were slightly lower.

Inshore turbidity values were well above the ANZECC default trigger value range of 1-20 NTU for inshore tropical waters. However, the Joseph Bonaparte Gulf has naturally high levels of turbidity (**Figure 6**) due to large freshwater inputs and large tides which can resuspend sediments. In addition, higher levels of turbidity are likely to occur during the wet season as a result of the input of large volumes of muddy, freshwater.

Water temperature showed a similar, though inverted, pattern to turbidity. The patterns in turbidity and temperature can broadly be related to the strength and direction of tidal currents across the Blacktip Project area. Hydrodynamics modelling indicates the presence of a current eddy, roughly positioned between the rocky headlands at each end of the northern Yelcher Beach (IRCE 2004). This eddy extends from the coast offshore for approximately 1.5 km during spring tides. Inside this eddy, currents are significantly weaker than in waters just offshore of the eddy, from where currents slowly decrease in strength with increasing distance offshore.

4.3 Fauna and Flora

4.3.1 Intertidal

Beach Habitat: Northern Yelcher Beach is fringed with a steep sand dune to 2 m high. Landward of the dune is a broad sandy grassland area that merges with upland monsoon vine-forest and woodland. Only scattered trees including the Tamarind (*Tamarindus indica*) and White Bush

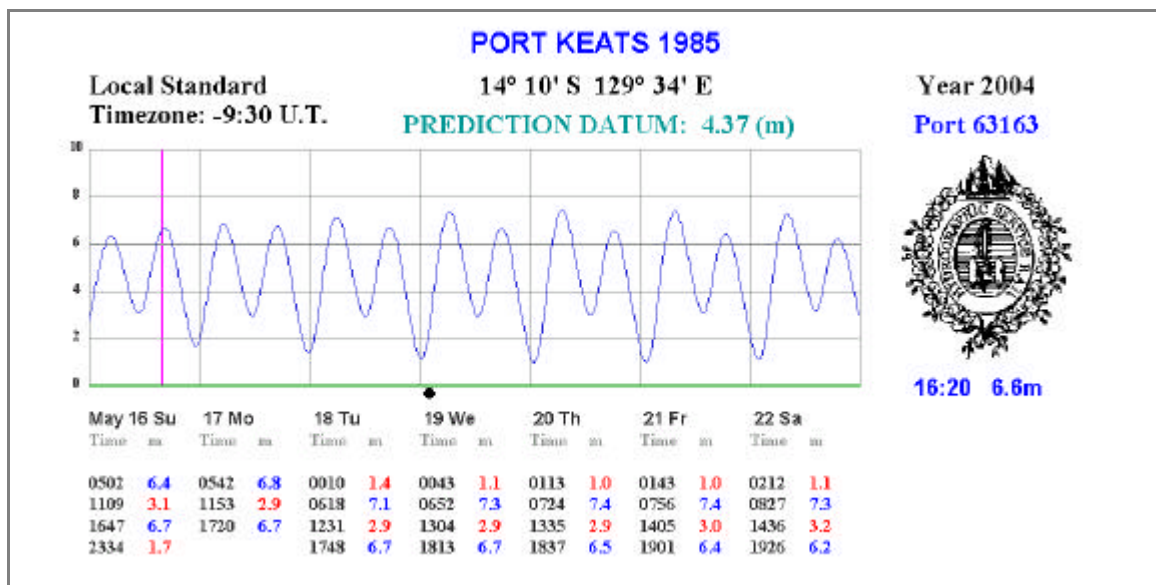
Apple (*Syzygium eucalyptoides* spp. *eucalyptoides*) occur within the grassland. The dominant species in the grassland area behind the beach is Annual Sorghum (*Sorghum timorense*) with Beach Spinifex (*Spinifex longifolius*) and the vines *Ipomoea pes-caprae* and *Carnavalina rosea*. Occasional low trees and shrubs include *Pandanus spiralis*, *Flueggia virosa* and the Class B noxious weed *Calotropis procera* (Smith 2002). The subshrub *Triumphetta* sp. and the sedge *Fimbristylis cymosa* are locally abundant and in combination with Annual Sorghum represent the three most important ground cover species in stabilising the substrate in this sandy habitat.

Below the beach dune but above the high spring tide level (at approximately 8 m Wadeye Hydrogeographic Service tidal datum) the beach is gently sloping and composed of very coarse sand with coral fragments and rock. Timber, mangrove leaves and other flotsam and jetsam are abundant in this habitat, though no drift seagrass or macroalgae was observed (**Figure 7A**). This flotsam and jetsam provides shelter for high densities of the terrestrial hermit crab *Coenobita variabilis* (up to 80 hermit crabs per m²). This species is known to extend up to 100 m or so from the beach (Jones and Morgan 2002).

The upper intertidal zone sloped relatively steeply to the flatter mid tidal zone. The invertebrate infauna was abundant, though species richness was low and dominated by the bivalve *Donax faba*. In contrast, the mid-tidal zone at Yelcher Beach is more variable, both in terms of topography and invertebrate fauna. It characteristically had low invertebrate abundance but highest richness. The lower intertidal zone (at approximately 3 m elevation Wadeye Hydrogeographic Service tidal datum) was similarly flat and had the lowest species richness and abundance of the three zones.

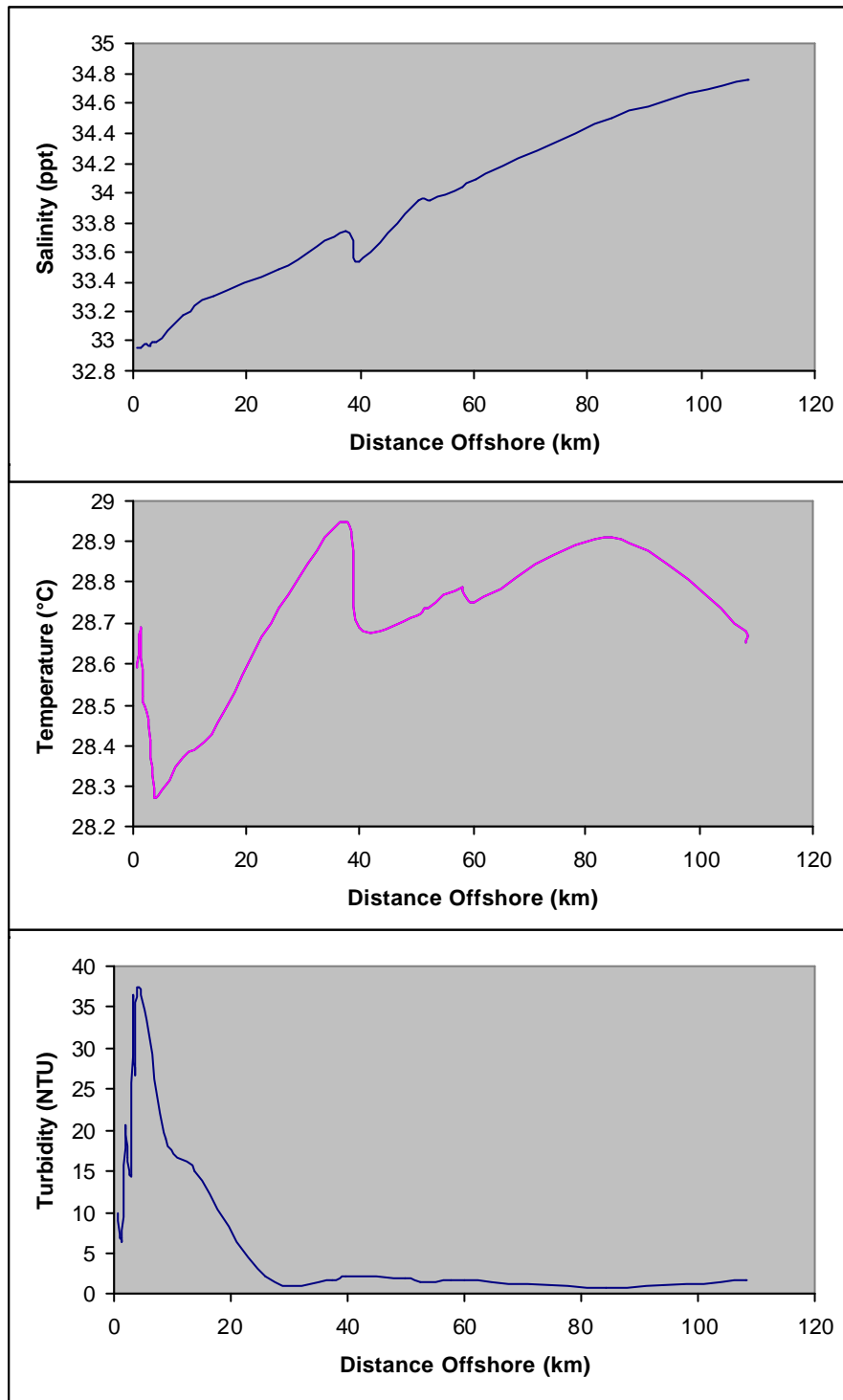
Northern Yelcher Beach has a relatively steep gradient and the width of the intertidal zone is not particularly broad (**Figure 7B**), in comparison to the intertidal zone at Yelcher Beach which is much wider and this beach has a more complex topography (**Figure 7C**). Rocky areas to the north and intertidal sand spits may influence the biotic character of this beach. For instance, large numbers of Soldier Crabs (*Mictyris* sp.) (**Figure 7D**) were common in sections of this beach but uncommon on Northern Yelcher Beach. Also, the mid- and lower intertidal zones on the northern transect at Yelcher Beach, closest to Yulow Point had dark coloured sediments at approximately 5 cm depth and a notably higher invertebrate species richness and abundance. In contrast, 200 m further south, on the second Yelcher Beach transect, the invertebrate fauna was similar to that occurring on Northern Yelcher Beach.

Rocky Shore Habitat: The Yulow Point rock platform at the south of Northern Yelcher Beach comprises a flat lateritic point that extends approximately 400 m from the beach (**Figure 7E**). It is relatively steep sided and flanked with an extensive area of lateritic boulders, up to 100 m wide to the north (**Figure 7F**) and standing water and mangroves to the south. The distribution of the biota was highly variable reflecting microtopography. However, visual assessments indicate that the more seaward section of the rock platform supports a higher diversity and abundance of invertebrate fauna, including sparse corals, anemones, chitons and larger crustaceans than the nearshore sections. No macroalgae was observed.



■ Figure 4 Tides at Wadeye (formerly Port Keats)

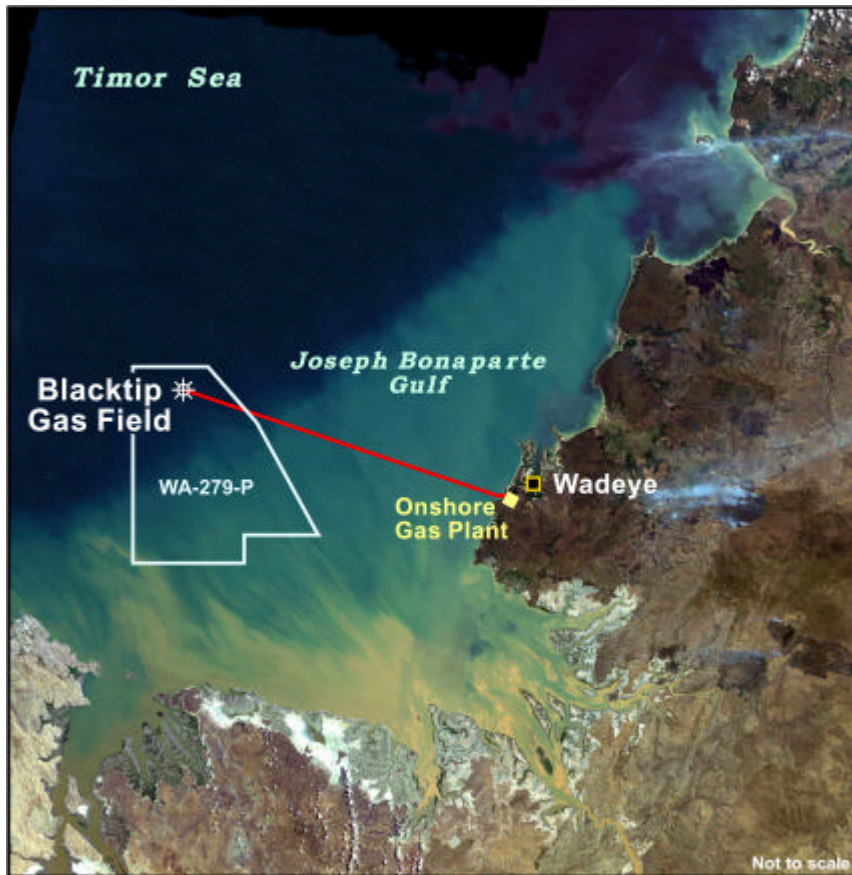
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■ **Figure 5 Water Quality along the Blacktip Pipeline Route from the Shore Crossing to the Platform**

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Date of image unknown but it was not taken during the offshore survey.

■ **Figure 6 Turbidity in the Joseph Bonaparte Gulf**

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A: Northern Yelcher Beach looking north

B: Infauna sampling on northern Yelcher Beach

C: Intertidal zone at Yelcher Beach to the south of the proposed pipeline crossing beach

D: Soldier crabs on Yelcher Beach

E: Yulow Point

F: Boulders on Yulow Point

G: *Rhizophora stylosa* mangrove habitat

H: Mud creeper *Terebralia* spp.

■ **Figure 7 Intertidal Habitats**

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Mangrove Habitats: The Yulow Point mangroves to the south of Northern Yelcher Beach form a strip less than 700 m long and between 100 to 300 m wide. The mangrove habitat at this location is extremely sandy with muds only occurring in the most seaward zone. The mangrove forest is quite sparse with well-spaced trees and a relatively open canopy. This contrasts with the extremely dense mangroves to the north of the proposed shore crossing, which have a muddy to gravelly substrate.

Four mangrove species were recorded within the Yulow Point mangroves (*Sonneratia alba*, *Rhizophora stylosa*, *Aegialitis annulata* and *Avicennia marina*). The mangroves at this location show clear zonation with three main communities arranged in bands roughly parallel to the shoreline (**Figure 8**). The most seaward area has scattered rock outcrop amongst muddy sand and supports a thin forest of *Sonneratia alba* to 12 m high. This narrow seaward strip is densest at the northern end of the mangrove close to the rock platform. The *Sonneratia* zone intergrades with low *Rhizophora stylosa* forest 3 to 7 m high. The *Rhizophora* forest (**Figure 7G**) is the most extensive assemblage or zone at this location extending up to and adjoining the rock platform to the north. To landward, the *Rhizophora* forest is fringed by a band of low *Avicennia marina* (Grey Mangrove) that forms a shrubland of mid-dense trees less than 2 m high. In this landward zone, *Aegialitis annulata* (Club Mangrove) occurs as scattered low trees to 1.5 m along the hinterland margin or beach.

The mangroves occurring on Maninh Point, to the north of northern Yelcher Beach, have a substrate comprising firm, root-structured marine muds. The muddy substrate becomes gravelly to rocky where it abuts the surrounding intertidal rocky habitat. It contrasts markedly with the sandy mangrove habitat at the southern end of northern Yelcher Beach. The mangrove forest at Maninh Point is taller and more dense. The mud mangrove substrate supports a different invertebrate fauna with several species recorded in the northern mangrove area (including the large molluscs *Terebralia palustris*, *T. semistriata* and) were not observed in the southern forest.

Eight species of mangrove were observed in mangroves in this area, including the four species identified from the Yulow Point mangroves (**Figure 9**). The dominant species *Rhizophora stylosa* forms dense mono-specific stands 5 to 7 m high supported by branching stilt roots to several metres high. The landward fringe of the forest adjoins a narrow sandy beach, which merges with coastal vine-forest. and comprised a range of mangrove species not observed at Yulow Point including *Camptostemon schultzei*, *Bruguiera exaristata* and *Ceriops australis*. The River Mangrove *Aegiceras corniculatum* was also common as a low shrub on the fringes of the Maninh Point mangrove.

A total of 8 mangrove species were recorded from both mangrove areas during the intertidal survey. However, the extensive mangroves surrounding tidal creeks to the north and south of Northern Yelcher Beach were not visited as part of this survey and are likely to contain additional mangrove species.

The Joseph Bonaparte Gulf is not considered to be a significant mangrove area, although mangroves occur throughout the Gulf and there are locally important groups, mainly on the southern coast of the Gulf (LDM 1994). There are 48 species of mangroves recorded in northern Australia, of which 38 species have been recorded at Darwin, 39 on the Gove Peninsula and only 20 at the Joseph Bonaparte Gulf (LDM 1994). A total of 18 mangrove species are known from the 1° by 1° grid cell of latitude and longitude that includes Wadeye (Wightman 1989). The Joseph Bonaparte Gulf appears to be one of the least diverse regions in terms of mangrove species richness and densities are up to 20 times lower in the Joseph Bonaparte Gulf than at Gove or Darwin (LDM 1994).

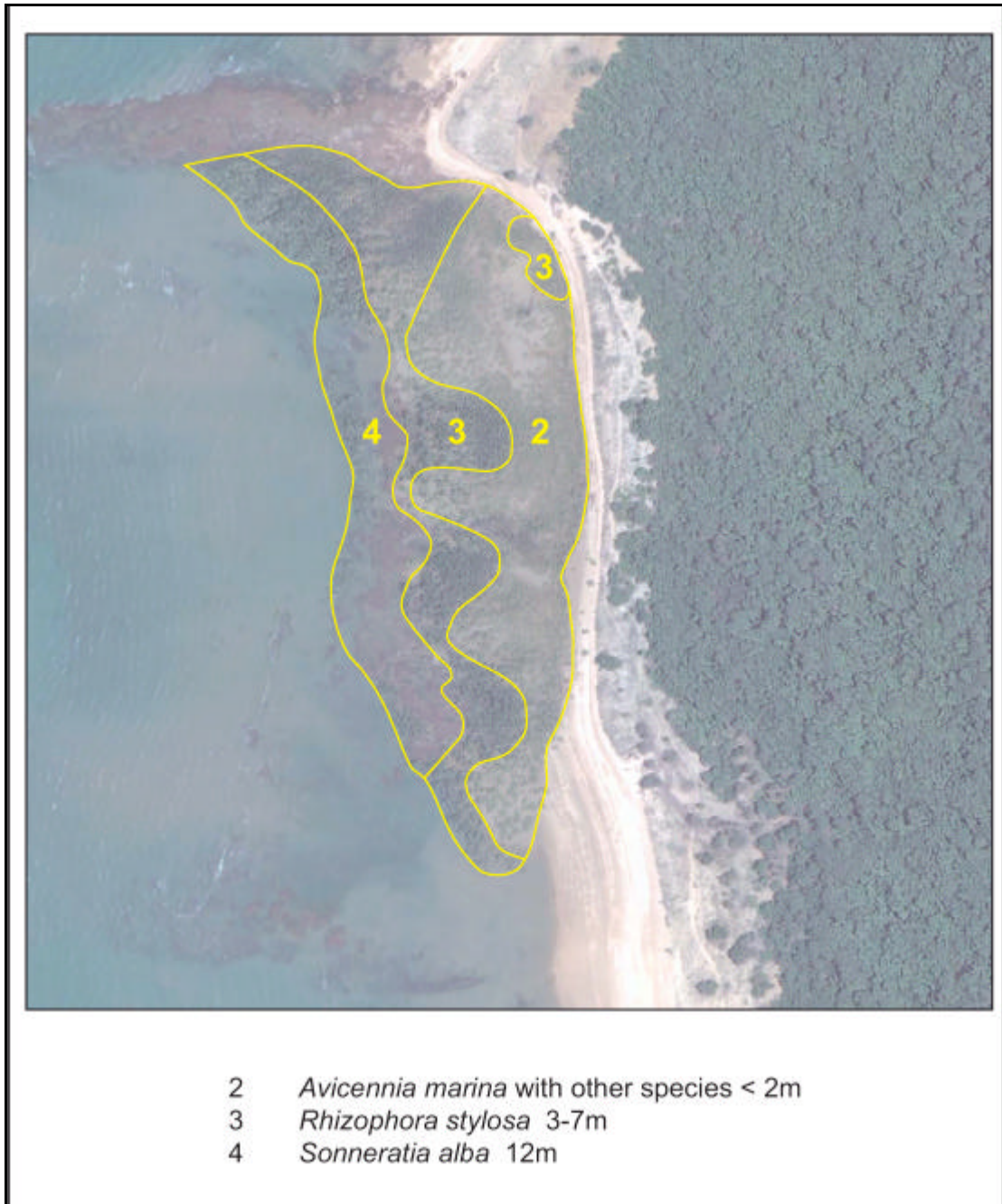
Intertidal Fauna: Ninety-five nominal species were identified during the intertidal survey from the three habitats surveyed (**Appendix D**): 18 in the sandy beach habitat, 60 in the mangrove habitat and 20 in the rocky headland habitat.

Sandy Beach: The sandy beach habitat was dominated, in terms of abundance and occurrence, by the bivalve *Donax faba*. This species had a mean abundance of nearly 300 m⁻² in the upper shore zone of northern Yelcher Beach and 135 m⁻² in the upper zone of Yelcher beach to the south. However, abundances in the mid and lower zones were considerably lower, ranging between 0–70 m⁻². Statistical comparison indicated that there were no significant differences in abundance of this bivalve between the two beaches (ANOVA df:1,3 F=1.61, P=0.294) but, as outlined above, there were marked differences in abundance between the three different zones (ANOVA df: 2,3 F=37.68, P=0.00). The only other species to occur in significant numbers was the gastropod, *Isanda coronata*, however, this species was only recorded on Yelcher Beach to the south of the proposed shore crossing.

Mangroves: The dominant fauna in the mangroves were hermit crabs and littorinid gastropods. Hermit crabs predominantly occurred on the sediment surface and the littorinid gastropods reside on the trunks of mangroves. Of note, three specimens of the littorinid, *Littoraria ianthostoma*, were collected from the mangroves at Maninh Point, at the northern end of the pipeline crossing beach. This species is epiphytic on the trunks of mangrove trees in the seaward zone and is endemic to the Joseph Bonaparte Gulf. The barnacle, *Chthamalus malayensis*, was also abundant but was only recorded in two of the 12 epifaunal quadrats. Four species of the fiddler crabs and two species of mud creepers (**Figure 7H**) were also collected.

Rocky Headland: Sampling effort on the rocky headlands was low with only the Yulow Point rocky headland being sampled. This rocky substrate was also dominated by a littorinid gastropod, *Echinolittorinia trochoides*, with an average density of 70 m².

This littorinid, along with the littorinids and hermit crabs in the mangroves and the bivalve, *Donax faba*, are numerically abundant which makes them suitable taxa for ongoing monitoring programs.



■ **Figure 8 Zonation of Mangroves on Yulow Point at the Southern End of the Pipeline Crossing Beach**

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- 1 Mixed Landward Zone
- 2 *Avicennia marina* with other species < 2m
- 3 *Rhizophora stylosa* 3-7m

■ Figure 9 Zonation of Mangroves on Maninh Point at the Northern End of the Pipeline Crossing Beach

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4.3.2 Offshore

No attached, drift or remnants of seagrass or macroalgae were collected in any sample of the 35 successful grab samples. The grab failed to collect any sediment from the 1.5 and 1 km near shore locations where the vessel's depth sounder suggested that the substrate at and between these two locations was probably a flat hard reef. While a grab is an inefficient sampling device for hard substrates, no hard or soft coral fragments or macroalgae were collected in the six grabs attempted across these two locations suggesting that the substrate did not support a high abundance of scleractinian or reef building corals or macroalgae. Even on the intertidal Yulow Point rock platform, only a few scattered corals (probably *Goniastrea*) and no macroalgae were observed, again indicating that the project area is unlikely to support significant benthic communities. Subtidally, corals were limited to two small gorgonian corals collected at Site Pipeline 11, four kilometres from the pipeline crossing beach.

The infauna collected was species rich with 135 nominal species identified. By contrast, faunal abundance was low with only 528 individuals recorded and only 14 species recording more than 10 individuals across all the offshore samples. The most abundant species were a porcelain crab followed by a brittle star (**Appendix E**). Both the abundance of infauna and the number of species were generally greater at sites near the coast, particularly at sites between about 2 to 3.5 km off the coast, than at sites further offshore. However, the correlations in abundance and species richness with distance were marginally not significant ($r^2=0.31$ $P=0.065$ and $r^2=0.32$ $P=0.0712$, respectively). Significant correlations were observed between the coarsest sediment fraction gravel (very coarse sands and above) and both abundance and species richness ($r^2=0.47$ $P=0.005$ and $r^2=0.46$ $P=0.006$, respectively). This contrasts with another study conducted in the Joseph Bonaparte Gulf which found that infauna species richness and abundance increased with distance from the mouth of the Victoria River, which coincided with an increasing proportion of fine particles in the sediment (BBG 2000).

An NMDS ordination of the infaunal community is presented in **Figure 10**. No clear groupings are obvious however there is some evidence of a pattern with sites with finer sediments on the right hand side of the plot and sites with coarser sediments to the left of the plot. The strongest correlation between the similarity measures and the environmental variables was recorded for the coarse sand fraction ($r^2=0.281$).

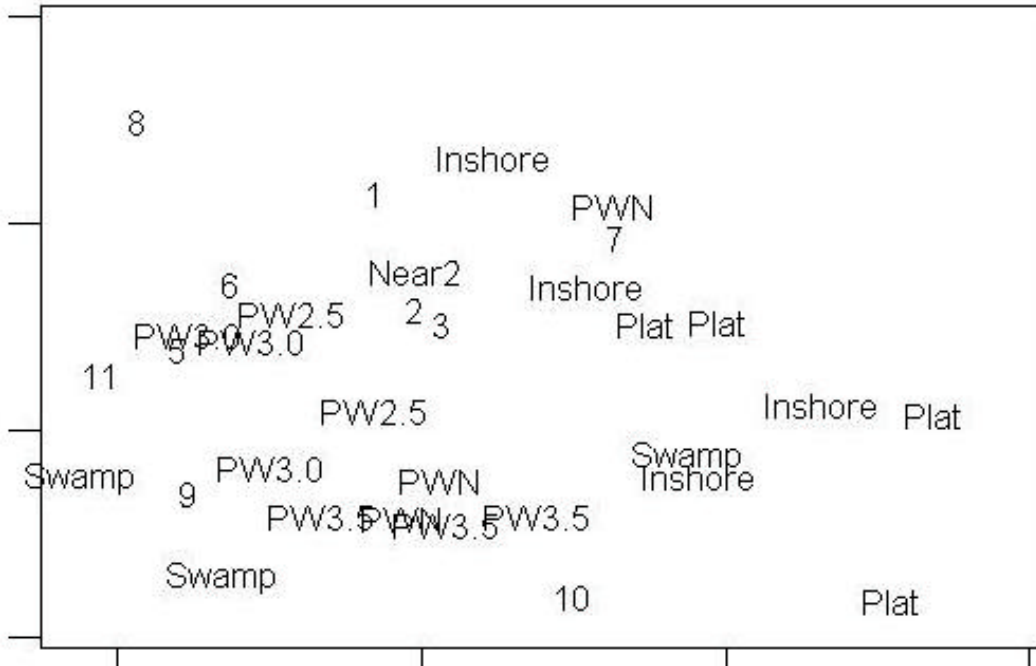
The composition of the infaunal community is unusual as continental shelf infauna are generally dominated by polychaete worms. However, nearly three times as many crustaceans were collected as polychaetes; bryozoans and hydroids were the next most abundant group after the crustaceans; and, nearly as many molluscs and echinoderms were collected as polychaetes. The BBG (2000) study observed that sites near the Victoria River mouth, which generally had coarser sediments, had a greater proportional abundance of crustaceans and cnidarians (hydroids and soft corals) compared to sites further offshore, which supported a predominantly deposit feeding infauna. The very coarse sediments probably limit the development of a deposit feeding community.

4.3.2.1 Faunal Observations

Fauna observed during the offshore environmental survey are presented in **Table 6**. No cetaceans were sighted during the offshore environmental survey or any of the offshore geophysical and geotechnical surveys which occurred throughout most of May and June 2004. Similarly, no seabirds were observed and turtle numbers were low with only four turtles observed during the offshore survey.

■ Table 6 Macrofaunal Observations

Date	Time	Grid Co-ordinates (GDA 94)		KP	Depth (m)	Sighting details
		Easting	Northing			
5/22/2004	8:38	444187	8463798	-0.051	55	2x Prawn trawlers, steaming tosw. One with trial nets in the water.
5/21/2004	21:15	465886	8454621	23.52	44	2 sea snakes (separate) - black/white banded 1x 2ft, 1x 4ft, moving with current
5/21/2004	19:45	465921	845432	23.59	44	Sea snake - 3ft long, curled up. Pale, difficult to distinguish colours at night.
5/21/2004	18:10	472547	8451895	30.72	42	Sea snake - black/white banded, approx 7ft long
5/21/2004	13:23	497444	8440828	57.973	46	Turtle - flatback, adult
5/21/2004	13:35	497429	8440717	58.001	46	Manta Ray - approx 1.5m across, 100m off vessel
5/21/2004	13:16	499185	8440214	59.804	46	Turtle - flatback, 0.6m across shell.
5/21/2004	12:45	507645	8437468	68.701	38	Turtle - small flatback, heading SSE
5/19/2004	16:53	510024	8436438	71.287	34	Turtle - small. Probably green, but possibly flatback
5/21/2004	02:00	540190	8426000	103.218	20	Tree Martin - landed on board vessel during fresh winds 0200-0800
5/20/2004	10:31	539863	8424981	103.246	22	Redbacked Kingfisher, landed on vessel, then resumed flight to east



Site codes: Plat=Platform, PWN=PWF NORTH, numbers refer to sample number along pipeline eg 1=pipeline .

- **Figure 10 A Two Dimensional NMDS Ordination of Infauna Collected from the Sites Listed in Table 2 (stress=0.19)**

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5. References

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Appendix A Sediment Hydrocarbons (TRH-mg/kg)

Site Description	Date	Depth	TRH C6-C9	TRH C10-C14	TRH C15-C28	TRH C29-C36
Platform North	5/22/04	55.0	<5	<2	<5	<10
Platform East	5/22/04	55.0	<5	<2	<5	<10
Platform South	5/22/04	55.0	<5	<2	<5	<10
Platform West	5/22/04	55.0	<5	<2	<5	<10
Pipeline 01	5/21/04	44.0	<5	<2	<5	<10
Pipeline 02	5/21/04	33.0	<5	<2	<5	<10
Pipeline 03	5/21/04	33.0	<5	<2	<5	<10
Pipeline 04	5/21/04	40.0	<5	<2	<5	<10
Pipeline 05	5/21/04	46.0	<5	<2	<5	<10
Pipeline 06	5/19/04	37.9	<5	<2	<5	<10
Pipeline 07	5/19/04	34.3	<5	<2	<5	<10
Pipeline 08	5/19/04	34.4	<5	<2	<5	<10
Pipeline 09	5/20/04	29.8	<5	<2	<5	<10
Pipeline 10	5/20/04	29.1	<5	<2	<5	<10
Pipeline 11	5/20/04	20.3	<5	<2	<5	<10
PW3.5 Rep1	5/20/04	19.7	<5	<2	<5	<10
PW3.5 Rep2	5/20/04	19.2	<5	<2	<5	<10
PW3.5 Rep3	5/20/04	18.9	No sample	No sample	No sample	No sample
PW3.0 Rep1	5/20/04	18.0	<5	<2	<5	<10
PW3.0 Rep2	5/20/04	18.2	<5	<2	<5	<10
PW3.0 Rep3	5/20/04	18.1	<5	<2	<5	<10
PW2.5 Rep1	5/20/04	17.1	<5	<2	<5	<10
PW2.5 Rep2	5/20/04	17.2	<5	<2	<5	<10
PW2.5 Rep3	5/20/04	17.2	<5	<2	<5	<10
PWNorth Rep1	5/20/04	15.3	<5	<2	<5	<10
PWNorth Rep2	5/20/04	15.7	<5	<2	<5	<10
PWNorth Rep3	5/20/04	14.6	<5	<2	<5	<10
Condensate Rep1	5/20/04	23.7	<5	<2	<5	<10
Condensate Rep2	5/20/04	22.9	<5	<2	<5	<10
Condensate Rep3	5/20/04	22.1	<5	<2	<5	<10
Nearshore 2.0 km	5/20/04	16.6	<5	<2	<5	<10
Nearshore 1.5 km*	5/20/04	9.3	No sample	No sample	No sample	No sample
Nearshore 1.0 km*	5/20/04	8.4	No sample	No sample	No sample	No sample
Nearshore 0.0 km Rep1	5/20/04	6.0	<5	<2	<5	<10
Nearshore 0.0 km Rep2	5/20/04	5.6	<5	<2	<5	<10
Nearshore 0.0 km Rep3	5/20/04	6.0	<5	<2	<5	<10
Nearshore 0.0 km Rep4	5/20/04	6.3	<5	<2	<5	<10
Northern Yelcher Beach B1	2/6/04	Intertidal	<5	<2	<5	<10
Northern Yelcher Beach B2	2/6/04	Intertidal	<5	<2	<5	<10
Northern Yelcher Beach B3	2/6/04	Intertidal	<5	<2	<5	<10
Northern Yelcher Beach B4	2/6/04	Intertidal	<5	<2	<5	<10
Northern Yelcher Beach B5	2/6/04	Intertidal	<5	<2	<5	<10
Northern Yelcher Beach B6	2/6/04	Intertidal	<5	<2	<5	<10

Site Description	Date	Depth	TRH C6-C9	TRH C10-C14	TRH C15-C28	TRH C29-C36
Northern Yelcher Beach B7	2/6/04	Intertidal	<5	<2	<5	<10
Northern Yelcher Beach B8	2/6/04	Intertidal	<5	<2	<5	<10
Northern Yelcher Beach B9	2/6/04	Intertidal	<5	<2	<5	<10
Maninh Point Mangroves M10	3/6/04	Intertidal	<5	2	27	<10
Maninh Point Mangroves M11	3/6/04	Intertidal	<5	<2	<5	<10
Maninh Point Mangroves M12	3/6/04	Intertidal	<5	<2	<5	<10
Yulow Point Mangroves M13	4/6/04	Intertidal	<5	<2	<5	<10
Yulow Point Mangroves M14	4/6/04	Intertidal	<5	<2	6	<10
Yulow Point Mangroves M15	4/6/04	Intertidal	<5	<2	6	13
Yelcher Beach B19	2/6/04	Intertidal	<5	<2	<5	<10
Yelcher Beach B20	2/6/04	Intertidal	<5	<2	<5	<10
Yelcher Beach B21	2/6/04	Intertidal	<5	<2	<5	<10
Yelcher Beach B22	2/6/04	Intertidal	<5	<2	<5	<10
Yelcher Beach B23	2/6/04	Intertidal	<5	<2	<5	<10
Yelcher Beach B24	2/6/04	Intertidal	<5	<2	<5	<10

Appendix B Sediment Metals (mg/kg)

Site Description	Ag	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Ni	Pb	Sb	Sn	V	Zn	TOC (%)
Platform North	<1	12000	6	14	<0.06	8.3	20	5.2	14000	<0.01	8.9	<5	<2	<2	28	13	<0.4
Platform East	<1	11000	5	14	<0.06	7.7	18	4.7	14000	<0.01	8.3	<5	<2	<2	26	12	<0.4
Platform South	<1	11000	5	13	<0.06	7.9	18	4.8	14000	<0.01	8.7	<5	<2	<2	26	12	<0.4
Platform West	<1	13000	5	14	<0.06	8.5	20	5.4	15000	0.01	9.3	<5	<2	<2	28	13	<0.4
Pipeline 01	<1	9700	5	10	<0.06	7.4	16	4.1	13000	<0.01	7.6	<5	<2	<2	27	10	<0.4
Pipeline 02	<1	4100	20	6.7	<0.06	5.7	11	1.9	12000	<0.01	4.7	<5	<2	<2	31	5.6	<0.4
Pipeline 03	<1	4000	18	6.7	<0.06	7.2	11	2.8	14000	<0.01	5.0	<5	<2	<2	60	8.7	<0.4
Pipeline 04	<1	3500	14	5.5	<0.06	6.3	9.2	1.9	11000	<0.01	4.6	<5	<2	<2	32	5.8	<0.4
Pipeline 05	<1	11000	9	11	<0.06	9.4	20	5.8	18000	<0.01	8.5	<5	<2	<2	55	14	<0.4
Pipeline 06	<1	6600	18	8.5	<0.06	6.3	11	2.9	13000	<0.01	5.1	<5	<2	<2	31	6.5	<0.4
Pipeline 07	<1	12000	13	11	<0.06	8.6	19	5.5	15000	0.03	8.0	<5	<2	<2	42	12	<0.4
Pipeline 08	<1	6300	27	9.2	<0.06	5.9	11	2.9	15000	0.02	5.2	<5	<2	<2	27	5.3	<0.4
Pipeline 09	<1	14000	19	18	<0.06	8.6	19	6.0	15000	0.02	8.2	5	<2	<2	38	11	<0.4
Pipeline 10	<1	13000	17	12	<0.06	7.8	19	5.4	17000	0.01	7.8	<5	<2	<2	34	10	<0.4
Pipeline 11	<1	9100	18	9.5	<0.06	5.8	15	3.6	15000	0.01	5.4	<5	<2	<2	26	8.6	<0.4
PW3.5 Rep1	<1	11000	20	12	<0.06	7.5	18	5.1	16000	0.01	6.9	<5	<2	<2	32	9.8	<0.4
PW3.5 Rep2	<1	17000	21	16	<0.06	10	25	8.0	20000	0.01	9.4	<5	<2	<2	38	16	<0.4
PW3.5 Rep3	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	X
PW3.0 Rep1	<1	14000	26	14	<0.06	10	30	6.5	25000	0.02	9.4	<5	<2	<2	47	13	<0.4
PW3.0 Rep2	<1	8800	33	11	<0.06	7.8	30	4.3	27000	0.01	6.5	<5	<2	<2	51	7.8	<0.4
PW3.0 Rep3	<1	13000	21	13	<0.06	8.2	23	5.8	20000	0.02	7.6	<5	<2	<2	38	11	<0.4
PW2.5 Rep1	<1	9300	55	25	<0.06	9.0	62	5.7	53000	0.01	7.7	12	<2	<2	120	11	<0.4
PW2.5 Rep2	<1	6900	52	10	<0.06	8.6	52	5.2	47000	<0.01	9.0	6	<2	<2	100	10	<0.4
PW2.5 Rep3	<1	6600	61	9.6	<0.06	9.5	85	4.0	63000	<0.01	12	8	<2	<2	140	13	<0.4
PWNorth Rep1	<1	17000	48	18	<0.06	12	46	10	53000	0.02	14	7	<2	<2	96	22	<0.4
PWNorth Rep2	<1	16000	72	20	<0.06	11	64	11	67000	0.02	14	7	<2	<2	130	26	<0.4
PWNorth Rep3	<1	6100	65	22	<0.06	11	50	4.4	48000	<0.01	7.4	6	<2	<2	110	7.1	<0.4
Condensate Rep1	<1	4800	33	7.1	<0.06	5.2	9.1	1.7	13000	0.01	3.1	<5	<2	<2	24	2.8	<0.4
Condensate Rep2	<1	6800	18	7.3	<0.06	5.1	12	2.7	11000	0.01	3.6	<5	<2	<2	23	4.2	<0.4
Condensate Rep3	<1	9700	18	9.5	<0.06	6.3	16	4.2	13000	<0.01	5.8	<5	<2	<2	28	7.0	<0.4
Nearshore 2.0 km	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	X
Nearshore 1.5 km*	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	X
Nearshore 1.0 km*	<1	11000	58	15	<0.06	8.5	57	6.3	52000	0.01	11	9	<2	<2	120	17	<0.4
Nearshore 0.0 km Rep1	<1	8600	10	12	<0.06	6.1	16	4.2	14000	0.02	5.7	<5	<2	<2	27	13	<0.4
Nearshore 0.0 km Rep2	<1	10000	9	14	<0.06	6.9	19	4.8	15000	0.01	6.5	<5	<2	<2	30	13	<0.4
Nearshore 0.0 km Rep3	<1	4700	11	8.9	<0.06	4.3	13	1.9	11000	<0.01	3.8	<5	<2	<2	22	7.9	<0.4
Nearshore 0.0 km Rep4	<1	3000	14	14	<0.06	3.6	11	1.3	9000	<0.01	2.9	<5	<2	<2	20	6.6	<0.4

Site Description	Ag	Al	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Ni	Pb	Sb	Sn	V	Zn	TOC (%)
Northern Yelcher Beach B1	<1	1900	17	8.1	<0.06	1.6	9.6	1.1	9700	0.02	2.2	<5	<2	<2	21	5.7	<0.4
Northern Yelcher Beach B2	<1	1700	17	8.2	<0.06	1.8	11	0.9	10000	0.01	1.8	<5	<2	<2	25	3.5	<0.4
Northern Yelcher Beach B3	<1	1800	19	8.6	<0.06	1.8	12	0.9	11000	0.02	1.7	<5	<2	<2	27	3.7	<0.4
Northern Yelcher Beach B4	<1	1500	19	6.4	<0.06	1.2	6.2	0.7	6900	0.01	1.3	<5	<2	<2	17	2.5	<0.4
Northern Yelcher Beach B5	<1	1800	17	5.8	<0.06	1.5	9.2	0.9	8600	<0.01	1.6	<5	<2	<2	22	2.9	<0.4
Northern Yelcher Beach B6	<1	1600	15	6.0	<0.06	1.3	7.7	0.7	7600	<0.01	1.4	<5	<2	<2	19	2.5	<0.4
Northern Yelcher Beach B7	<1	1500	15	7.3	<0.06	1.3	6.8	0.8	7000	<0.01	1.4	<5	<2	<2	17	2.8	<0.4
Northern Yelcher Beach B8	<1	1300	11	5.4	<0.06	1.3	4.9	0.5	4800	<0.01	1.3	<5	<2	<2	12	2.2	<0.4
Northern Yelcher Beach B9	<1	1300	12	4.5	<0.06	1.3	6.1	0.6	5900	<0.01	1.4	<5	<2	<2	15	2.4	<0.4
Maninh Point Mangroves M10	<1	7800	7	9.9	<0.06	3.7	14	3.0	10000	<0.01	4.0	<5	<2	<2	22	6.8	<0.4
Maninh Point Mangroves M11	<1	6300	11	7.1	<0.06	3.3	16	2.6	11000	<0.01	3.7	<5	<2	<2	29	5.9	<0.4
Maninh Point Mangroves M12	<1	1400	8	5.2	<0.06	1.3	6.4	0.6	5000	<0.01	1.2	<5	<2	<2	13	2.2	<0.4
Yulow Point Mangroves M13	<1	14000	15	13	<0.06	6.8	25	6.4	22000	<0.01	8.3	<5	<2	<2	43	13	1.5
Yulow Point Mangroves M14	<1	9000	21	12	<0.06	5.1	37	4.7	29000	<0.01	8.2	<5	<2	<2	61	15	0.9
Yulow Point Mangroves M15	<1	11000	10	11	<0.06	5.4	20	4.7	17000	0.02	6.9	<5	<2	<2	34	11	1.2
Yelcher Beach B19	<1	1200	11	1.7	<0.06	1.1	12	0.4	6300	<0.01	1.3	<5	<2	<2	15	1.6	<0.4
Yelcher Beach B20	<1	1600	14	2.7	<0.06	1.3	11	0.5	7800	<0.01	1.4	<5	<2	<2	20	2.0	<0.4
Yelcher Beach B21	<1	1300	9	4.6	<0.06	1.2	5.2	0.5	4400	<0.01	1.1	<5	<2	<2	11	1.8	<0.4
Yelcher Beach B22	<1	1100	11	1.9	<0.06	1.2	6.8	0.4	5000	<0.01	1.1	<5	<2	<2	13	1.4	<0.4
Yelcher Beach B23	<1	1200	11	2.2	<0.06	1.1	8.3	0.7	5600	<0.01	1.0	<5	<2	<2	14	1.7	<0.4
Yelcher Beach B24	<1	1500	11	4.2	<0.06	1.2	6.6	0.5	5600	<0.01	1.2	<5	<2	<2	14	2.1	<0.4

Appendix C Sediment Particle Size (% weight)

Site Description	>1mm	500µm-1mm	250-500 µm	180-250 µm	90-180 µm	63-90 µm	38-63µm	< 38 µm
Platform North	<0.1	<0.1	0.6	1.6	29.8	24.6	15.2	28.1
Platform East	0.1	0.2	0.7	1.6	27.5	24	12.8	33.2
Platform South	<0.1	0.3	1.4	2.8	39.2	22.3	11.2	22.5
Platform West	0.1	0.3	1.5	2.8	37	21.2	11.2	25.9
Pipeline 01	2.9	2.4	5.8	7.9	31.6	17.7	12.2	19.5
Pipeline 02	48.3	8.2	17.3	15.8	3.8	1.6	1.2	3.7
Pipeline 03	34.9	14.8	30.3	9	2	0.7	0.8	7.4
Pipeline 04	27.1	4.3	38	11.9	4.3	2.1	1.6	10.7
Pipeline 05	17	0.7	16.3	28.2	11.1	3.5	3.4	19.7
Pipeline 06	27.3	12.7	23.2	9.2	7.4	5.2	4	11
Pipeline 07	24.3	8.6	10.5	13.4	10.9	7.3	5.5	19.7
Pipeline 08	55.9	13.1	11.9	8.9	4	1.9	1.2	3.1
Pipeline 09	43.3	11.3	9.8	12.8	6.3	3.2	3	10.3
Pipeline 10	45.1	7	13.6	5.2	5	3.5	3.3	17.2
Pipeline 11	52.4	4.5	7.8	19.3	6.4	0.5	1.2	8
PW3.5 Rep1	73.2	4.4	4.4	3.2	1.7	0.6	1.2	11.3
PW3.5 Rep2	55.2	6	8	5.8	2.2	1	1.8	19.9
PW3.5 Rep3	72.1	5.5	5	2.7	2.9	0.5	0.6	10.6
PW3.0 Rep1	50.7	12.1	13.2	2	2.2	1	1.9	17
PW3.0 Rep2	61	13.7	12.3	1.5	1.4	0.5	1.2	8.4
PW3.0 Rep3	52.3	12.4	13	1.9	2.2	1.1	2.4	14.8
PW2.5 Rep1	57.4	12.2	19.5	2.7	1.4	0.4	0.6	5.8
PW2.5 Rep2	73.5	8.1	12.5	1.8	1	0.2	0.3	2.7
PW2.5 Rep3	61.1	11	19.2	2.6	1.2	0.2	0.4	4.2
PWNorth Rep1	58.4	8.4	6.6	3.1	4	1	1.3	17.1
PWNorth Rep2	X	X	X	X	X	X	X	X
PWNorth Rep3	58.7	24.3	14.6	1	0.5	0.1	0.2	0.6
Condensate Rep1	48.5	3.7	8.1	22.9	6.5	0.4	1	8.8
Condensate Rep2	36	5.1	11.5	26.9	5.9	0.7	1.8	12.1
Condensate Rep3	33.3	4.8	11.7	31.8	5.7	0.6	1.7	10.5
Nearshore 2.0km	58.5	4.9	12.8	11.2	4.6	0.3	0.4	7.4
Nearshore 1.5km*	X	X	X	X	X	X	X	X
Nearshore 1.0km*	X	X	X	X	X	X	X	X
Nearshore 0.0km Rep1	0.3	0.8	2	2.6	38	8	8.8	39.5
Nearshore 0.0km Rep2	1.2	1	1.7	1.8	31	8	10.6	44.9
Nearshore 0.0km Rep3	0.4	0.5	1	3.2	78.6	5.3	2.4	8.6
Nearshore 0.0km Rep4	0.8	0.7	1.5	3.5	78.8	5.5	1.6	7.5
Northern Yelcher Beach B1	7.4	19.9	30.6	13.3	27.8	0.8	<0.1	0.1
Northern Yelcher Beach B2	1.9	7.1	37.3	19.1	34	0.4	0.1	<0.1
Northern Yelcher Beach B3	10.2	4.8	25.5	30.9	28.4	0.2	<0.1	<0.1
Northern Yelcher Beach B4	13.6	28.3	31.2	10.1	16.4	0.4	<0.1	<0.1
Northern Yelcher Beach B5	6.8	12.5	32.8	15.3	32	0.6	<0.1	<0.1
Northern Yelcher Beach B6	9.7	6.6	25.7	25.2	32.6	0.1	<0.1	<0.1
Northern Yelcher Beach B7	10.4	22.7	25.8	12.6	28.1	0.4	<0.1	<0.1
Northern Yelcher Beach B8	9.5	16.9	21.6	12.7	38.2	1.1	<0.1	<0.1
Northern Yelcher Beach B9	5.8	4	11.3	18.6	59.6	0.7	<0.1	<0.1
Maninh Point Mangroves M10	3.5	0.6	2	3.5	44	2.9	3.9	39.6
Maninh Point Mangroves M11	0.5	0.3	1.5	4.3	70.8	3.3	1.3	18
Maninh Point Mangroves M12	1.5	6.6	23	67.9	0.3	<0.1	<0.1	0.6
Yulow Point Mangroves M13	15.4	16.9	10.6	3	10.4	13.7	2.8	27.3
Yulow Point Mangroves M14	15	5.9	21.5	18.3	20.4	3.6	2.5	12.8
Yulow Point Mangroves M15	6.4	9.6	44.9	4.1	7	2.3	2.5	23.2
Yelcher Beach B19	1.4	7	74.4	13.9	3.4	<0.1	<0.1	<0.1
Yelcher Beach B20	8	28.7	42.8	14.4	6	<0.1	<0.1	<0.1
Yelcher Beach B21	14.6	23.2	26.6	10.4	24.6	0.4	0.2	<0.1
Yelcher Beach B22	0.6	3	64.6	24.5	7.3	<0.1	<0.1	<0.1
Yelcher Beach B23	3.1	13.2	64.7	13.9	5.1	<0.1	<0.1	<0.1
Yelcher Beach B24	17	11.3	25.5	14.5	30.9	0.8	<0.1	<0.1

Appendix D Intertidal Fauna

Habitat	Location	Sample	Phyla	Species	Abundance
Beach	B1	Quadrat 1	Mollusca	Donax faba	2
Beach	B19	Incidentals	Crustacea	Anomura	1
Beach	B19	Incidentals	Crustacea	Anomura	1
Beach	B19	Incidentals	Crustacea	Macrophthalmus sp. 2	1
Beach	B19	Incidentals	Crustacea	Penaeidae sp.2	1
Beach	B19	Quadrat 1	Mollusca	Isanda coronata	1
Beach	B19	Quadrat 1	Mollusca	Cadella semen	1
Beach	B19	Quadrat 1	Mollusca	Divaricella irpex	1
Beach	B2	Quadrat 1	Crustacea	Anomura	1
Beach	B20	Quadrat 1	Mollusca	Cadella semen	2
Beach	B20	Quadrat 1	Mollusca	Isanda coronata	3
Beach	B20	Quadrat 2	Mollusca	Cadella semen	1
Beach	B20	Quadrat 2	Echinodermata	Echinoid sp. 1	1
Beach	B20	Quadrat 2	Mollusca	Isanda coronata	2
Beach	B20	Quadrat 2	Polychaeta	Polychaete	1
Beach	B21	Quadrat 1	Mollusca	Donax faba	6
Beach	B21	Quadrat 2	Mollusca	Donax faba	4
Beach	B21	Quadrat 2	Crustacea	Isopoda sp. 3	1
Beach	B22	Quadrat 1	Mollusca	Barbatia iota	1
Beach	B22	Quadrat 1	Mollusca	Cadella semen	2
Beach	B22	Quadrat 1	Mollusca	Dosinia laminata	1
Beach	B22	Quadrat 1	Mollusca	Isanda coronata	11
Beach	B22	Quadrat 1	Polychaeta	Polychaete	1
Beach	B22	Quadrat 2	Mollusca	Isanda coronata	9
Beach	B22	Quadrat 2	Polychaeta	Polychaete	2
Beach	B23	Quadrat 1	Mollusca	Donax faba	9
Beach	B23	Quadrat 1	Mollusca	Isanda coronata	3
Beach	B23	Quadrat 1	Crustacea	Mictyris sp.	2
Beach	B23	Quadrat 2	Crustacea	Anomura	1
Beach	B23	Quadrat 2	Mollusca	Donax faba	8
Beach	B23	Quadrat 2	Mollusca	Dosinia laminata	1
Beach	B23	Quadrat 2	Echiura	Echiuran sp. 1	1
Beach	B23	Quadrat 2	Mollusca	Isanda coronata	2
Beach	B23	Quadrat 2	Crustacea	Mictyris sp.	1
Beach	B23	Quadrat 2	Polychaeta	Polychaete	1
Beach	B24	Quadrat 1	Mollusca	Donax faba	1
Beach	B24	Quadrat 1	Mollusca	Donax faba	19
Beach	B24	Quadrat 1	Polychaeta	Glyceridae sp. 1	1
Beach	B24	Quadrat 1	Crustacea	Isopoda sp. 3	3
Beach	B24	Quadrat 2	Mollusca	Donax faba	17
Beach	B24	Quadrat 2	Polychaeta	Polychaete	1
Beach	B28	Quadrat 1	Mollusca	Cadella semen	1
Beach	B3	Incidentals	Crustacea	Anomura	2
Beach	B3	Incidentals	Insecta	Insect sp. 1	1
Beach	B3	Incidentals	Insecta	Insect sp. 2	1
Beach	B3	Incidentals	Insecta	Insect sp. 3	1
Beach	B3	Incidentals	Crustacea	Talitridae	1
Beach	B3	Quadrat 1	Mollusca	Donax faba	17
Beach	B3	Quadrat 2	Mollusca	Donax faba	24
Beach	B4	Quadrat 2	Mollusca	Donax faba	2
Beach	B4	Quadrat 2	Polychaeta	Polychaete	1
Beach	B5	Incidentals	Crustacea	Matuta sp.	1

Habitat	Location	Sample	Phyla	Species	Abundance
Beach	B5	Incidentals	Echinodermata	Echinoid sp. 1	2
Beach	B5	Quadrat 1	Crustacea	Mictyris sp.	1
Beach	B5	Quadrat 2	Mollusca	Donax faba	2
Beach	B5	Quadrat 2	Polychaeta	Polychaete	1
Beach	B5	Quadrat 2	Polychaeta	Polychaete	1
Beach	B6	Quadrat 1	Mollusca	Donax faba	27
Beach	B6	Quadrat 2	Mollusca	Donax faba	30
Beach	B6	Quadrat 2	Polychaeta	Glyceridae sp. 1	1
Beach	B7	Quadrat 1	Mollusca	Donax faba	1
Beach	B8	Quadrat 1	Mollusca	Donax faba	6
Beach	B8	Quadrat 1	Crustacea	Mictyris sp.	1
Beach	B8	Quadrat 2	Mollusca	Donax faba	2
Beach	B8	Quadrat 2	Polychaeta	Glyceridae sp. 1	1
Beach	B9	Quadrat 1	Mollusca	Donax faba	28
Beach	B9	Quadrat 1	Polychaeta	Glyceridae sp. 1	1
Beach	B9	Quadrat 1	Crustacea	Isopoda sp. 2	1
Beach	B9	Quadrat 2	Mollusca	Donax faba	29
Beach	B9	Quadrat 2	Crustacea	Isopoda sp. 2	2
Beach	B9	Quadrat 2	Polychaeta	Polychaete	1
Mangrove	M10	Anoxic mat 1	Polychaeta	Polychaete	6
Mangrove	M10	Anoxic mat 1	Polychaeta	Polychaete	2
Mangrove	M10	Anoxic mat 2	Polychaeta	Polychaete	1
Mangrove	M10	Anoxic mat 2	Crustacea	Uca sp. 2	1
Mangrove	M10	Epifauna 1	Crustacea	Anomura	1
Mangrove	M10	Epifauna 1	Crustacea	Anomura	27
Mangrove	M10	Epifauna 1	Mollusca	Littoraria articulata	1
Mangrove	M10	Epifauna 1	Mollusca	Littoraria ianthostoma	1
Mangrove	M10	Epifauna 1	Mollusca	Pseudoanachis duclosianus	1
Mangrove	M10	Epifauna 2	Mollusca	Littoraria articulata	4
Mangrove	M10	Epifauna 2	Mollusca	Littoraria filosa	4
Mangrove	M10	Pitfall 1	Crustacea	Alpheidae sp. 2	1
Mangrove	M10	Pitfall 1	Crustacea	Anomura	12
Mangrove	M10	Pitfall 1	Mollusca	Circe australis	1
Mangrove	M10	Pitfall 1	Crustacea	Leandrites celebensis	1
Mangrove	M10	Pitfall 1	Mollusca	Littoraria ianthostoma	1
Mangrove	M10	Pitfall 1	Crustacea	Nanosesarma batavicum	1
Mangrove	M10	Pitfall 2	Crustacea	Anomura	5
Mangrove	M10	Pitfall 2	Crustacea	Leandrites celebensis	7
Mangrove	M10	Pitfall 2	Crustacea	Periclimenes ? suvativensis	3
Mangrove	M10	Pitfall 2	Crustacea	Portunus sp.	1
Mangrove	M10	Quadrat 1	Crustacea	Anomura	49
Mangrove	M10	Quadrat 1	Crustacea	Sphaeromatidae	1
Mangrove	M10	Quadrat 2	Crustacea	Anomura	16
Mangrove	M10	Quadrat 2	Mollusca	Cerithideopsis cingulata	9
Mangrove	M10	Quadrat 2	Mollusca	Clypeomorphus batillariaeformis	2
Mangrove	M10	Quadrat 2	Mollusca	Clypeomorphus bifasciata	1
Mangrove	M10	Quadrat 2	Mollusca	Clypeomorphus bifasciata	1
Mangrove	M10	Quadrat 2	Crustacea	Macrophthalmus sp. 1	2
Mangrove	M10	Quadrat 2	Mollusca	Nassarius moestus	3
Mangrove	M10	Quadrat 2	Mollusca	Patelloida cryptalirata	1
Mangrove	M11	Epifauna 1	Mollusca	Clypeomorphus bifasciata	1
Mangrove	M11	Epifauna 1	Mollusca	Clypeomorphus bifasciata	2
Mangrove	M11	Epifauna 1	Mollusca	Littoraria filosa	9
Mangrove	M11	Epifauna 1	Mollusca	Littoraria ianthostoma	1
Mangrove	M11	Epifauna 1	Mollusca	Pseudoanachis duclosianus	2
Mangrove	M11	Epifauna 2	Mollusca	Clypeomorphus batillariaeformis	1

Habitat	Location	Sample	Phyla	Species	Abundance
Mangrove	M11	Epifauna 2	Mollusca	Littoraria filosa	20
Mangrove	M11	Epifauna 2	Crustacea	Metapograpsus frontalis	1
Mangrove	M11	Epifauna 2	Mollusca	Pseudoanachis duclosianus	1
Mangrove	M11	Pitfall 1	Crustacea	Anomura	9
Mangrove	M11	Pitfall 1	Crustacea	Ilyograpsus paludicola	1
Mangrove	M11	Pitfall 1	Crustacea	Periclimenes suvativensis	1
Mangrove	M11	Pitfall 2	Chordata: Pieces	Amoya gracilis	1
Mangrove	M11	Pitfall 2	Mollusca	Clypeomorphus bifasciata	4
Mangrove	M11	Pitfall 2	Crustacea	Heteropanope glabra	1
Mangrove	M11	Pitfall 2	Crustacea	Ilyograpsus paludicola	1
Mangrove	M11	Pitfall 2	Crustacea	Leandrites celebensis	1
Mangrove	M11	Pitfall 2	Crustacea	Macrophthalmus sp. 1	1
Mangrove	M11	Quadrat 1	Crustacea	Anomura	31
Mangrove	M11	Quadrat 1	Crustacea	Clibanarius longitarsus	1
Mangrove	M11	Quadrat 1	Chordata: Pieces	Periophthalmus sp. 1	1
Mangrove	M11	Quadrat 1	Crustacea	Uca hirsutimanus	1
Mangrove	M11	Quadrat 1	Crustacea	Uca polita	1
Mangrove	M11	Quadrat 2	Crustacea	Anomura	9
Mangrove	M11	Quadrat 2	Mollusca	Patelloida cryptalitrata	1
Mangrove	M11	Quadrat 2	Crustacea	Uca mjobergi	1
Mangrove	M12	Epifauna 1	Crustacea	Chthamalus malayensis	100
Mangrove	M12	Epifauna 1	Mollusca	Littoraria articulata	2
Mangrove	M12	Epifauna 1	Mollusca	Littoraria filosa	7
Mangrove	M12	Epifauna 2	Mollusca	Littoraria filosa	11
Mangrove	M12	Pitfall 1	Crustacea	Anomura	4
Mangrove	M12	Pitfall 1	Crustacea	Clibanarius longitarsus	1
Mangrove	M12	Pitfall 1	Chordata: Pieces	Mugilogobius (probably M. mertoni)	1
Mangrove	M12	Pitfall 1	Crustacea	Penaeidae sp.1	4
Mangrove	M12	Pitfall 2	Crustacea	Anomura	13
Mangrove	M12	Quadrat 1	Crustacea	Anomura	2
Mangrove	M12	Quadrat 1	Mollusca	Cerithideopsilla cingulata	1
Mangrove	M12	Quadrat 1	Mollusca	Clypeomorphus batillariaeformis	1
Mangrove	M12	Quadrat 1	Mollusca	Clypeomorphus bifasciata	8
Mangrove	M12	Quadrat 1	Mollusca	Littoraria filosa	1
Mangrove	M12	Quadrat 1	Crustacea	Melita sp.	1
Mangrove	M12	Quadrat 1	Chordata: Pieces	Periophthalmus sp. 1	1
Mangrove	M12	Quadrat 2	Mollusca	Cerithideopsilla cingulata	2
Mangrove	M12	Quadrat 2	Crustacea	Clibanarius longitarsus	1
Mangrove	M12	Quadrat 2	Chordata: Pieces	Periophthalmus sp. 1	1
Mangrove	M13	Epifauna 1	Mollusca	Littoraria filosa	8
Mangrove	M13	Epifauna 2	Crustacea	Clibanarius longitarsus	1
Mangrove	M13	Epifauna 2	Mollusca	Littoraria filosa	5
Mangrove	M13	Epifauna 2	Mollusca	Monodonta labio	2
Mangrove	M13	Epifauna 2	Mollusca	Nerita balteata	1
Mangrove	M13	Incidentals	Crustacea	Uca capricornis	1
Mangrove	M13	Pitfall 1	Chordata: Pieces	Acentrogobius viridipunctatus	1
Mangrove	M13	Pitfall 1	Crustacea	Heteropanope glabra	1
Mangrove	M13	Pitfall 2	Crustacea	Ilyograpsus paludicola	1
Mangrove	M13	Pitfall 2	Crustacea	Leandrites celebensis	1
Mangrove	M13	Pitfall 2	Crustacea	Periclimenes suvativensis	1
Mangrove	M13	Quadrat 1	Crustacea	Anomura	4
Mangrove	M13	Quadrat 1	Crustacea	Heteropanope glabra	1
Mangrove	M13	Quadrat 1	Chordata: Pieces	Periophthalmus argentilineatus	1
Mangrove	M13	Quadrat 1	Crustacea	Perisesarma semperi	1
Mangrove	M13	Quadrat 1	Crustacea	Uca flammula	4
Mangrove	M13	Quadrat 2	Crustacea	Metapograpsus frontalis	1

Habitat	Location	Sample	Phyla	Species	Abundance
Mangrove	M13	Quadrat 2	Polychaeta	Polychaete	1
Mangrove	M14	Anoxic mat 1	Polychaeta	Polychaete	1
Mangrove	M14	Anoxic mat 1	Polychaeta	Polychaete	1
Mangrove	M14	Anoxic mat 2	Polychaeta	Polychaete	1
Mangrove	M14	Epifauna 1	Crustacea	Isopoda sp. 1	1
Mangrove	M14	Epifauna 1	Mollusca	Littoraria filosa	14
Mangrove	M14	Epifauna 1	Mollusca	Littoraria filosa	1
Mangrove	M14	Epifauna 1	Mollusca	Monodonta labio	1
Mangrove	M14	Epifauna 1	Crustacea	Talitridae	1
Mangrove	M14	Epifauna 2	Mollusca	Littoraria filosa	12
Mangrove	M14	Epifauna 2	Mollusca	Monodonta labio	1
Mangrove	M14	Epifauna 2	Mollusca	Nerita balteata	2
Mangrove	M14	Incidentals	Mollusca	Gaffraria tubum	1
Mangrove	M14	Incidentals	Insecta	Hymenoptera	1
Mangrove	M14	Incidentals	Mollusca	Littoraria filosa	1
Mangrove	M14	Incidentals	Mollusca	Littoraria filosa	1
Mangrove	M14	Incidentals	Mollusca	Nassarius melanoides	1
Mangrove	M14	Pitfall 1	Crustacea	Alpheidae sp. 1	1
Mangrove	M14	Pitfall 1	Crustacea	Anomura	18
Mangrove	M14	Pitfall 1	Crustacea	Periclimenes ? suvavivensis	1
Mangrove	M14	Pitfall 2	Crustacea	Alpheidae sp. 1	3
Mangrove	M14	Pitfall 2	Crustacea	Anomura	4
Mangrove	M14	Pitfall 2	Chordata: Pieces	Gobiidae (juv. - Mugilogobius or Calamiana)	1
Mangrove	M14	Pitfall 2	Crustacea	Ilyograpsus paludicola	1
Mangrove	M14	Quadrat 1	Crustacea	Anomura	4
Mangrove	M14	Quadrat 1	Mollusca	Clypeomorphus bifasciata	10
Mangrove	M14	Quadrat 1	Crustacea	Metapograpus frontalis	1
Mangrove	M14	Quadrat 1	Mollusca	Monodonta labio	1
Mangrove	M14	Quadrat 1	Mollusca	Patelloida cryptalitrata	1
Mangrove	M14	Quadrat 1	Polychaeta	Polychaete	1
Mangrove	M14	Quadrat 1	Crustacea	Uca sp. 2	6
Mangrove	M14	Quadrat 2	Crustacea	Anomura	1
Mangrove	M14	Quadrat 2	Crustacea	Clibanarius longitarsus	1
Mangrove	M14	Quadrat 2	Mollusca	Clypeomorphus bifasciata	1
Mangrove	M14	Quadrat 2	Mollusca	Monodonta labio	1
Mangrove	M14	Quadrat 2	Mollusca	Neritina violacea	1
Mangrove	M15	Anoxic mat 1	Crustacea	Sarmatium germaini	1
Mangrove	M15	Anoxic mat 2	Polychaeta	Polychaete	2
Mangrove	M15	Anoxic mat 2	Crustacea	Thalassina squamifera	1
Mangrove	M15	Epifauna 1	Mollusca	Littoraria articulata	1
Mangrove	M15	Epifauna 1	Mollusca	Littoraria filosa	1
Mangrove	M15	Epifauna 1	Mollusca	Nerita balteata	2
Mangrove	M15	Epifauna 2	Crustacea	Chthamalus malayensis	5
Mangrove	M15	Epifauna 2	Mollusca	Littoraria filosa	5
Mangrove	M15	Epifauna 2	Mollusca	Littoraria filosa	1
Mangrove	M15	Epifauna 2	Crustacea	Metapograpus frontalis	7
Mangrove	M15	Epifauna 2	Mollusca	Nerita balteata	2
Mangrove	M15	Incidentals	Crustacea	Saelatium brockii	1
Mangrove	M15	Pitfall 1	Crustacea	Clibanarius longitarsus	1
Mangrove	M15	Pitfall 1	Crustacea	Heteropanope longipedes	2
Mangrove	M15	Pitfall 2	Crustacea	Heteropanope glabra	1
Mangrove	M15	Pitfall 2	Crustacea	Heteropanope longipedes	2
Mangrove	M15	Pitfall 2	Mollusca	Nassarius moestus	1
Mangrove	M15	Pitfall 2	Crustacea	Penaecidae sp.2	1
Mangrove	M15	Quadrat 1	Crustacea	Clibanarius longitarsus	1
Mangrove	M15	Quadrat 1	Chordata: Pieces	Periophthalmus sp. 1	1

Habitat	Location	Sample	Phyla	Species	Abundance
Mangrove	M15	Quadrat 1	Crustacea	Perisesarma semperi	1
Mangrove	M15	Quadrat 1	Mollusca	Terebralia palustris	3
Mangrove	M15	Quadrat 1	Mollusca	Terebralia semistriata	5
Mangrove	M15	Quadrat 1	Crustacea	Uca sp. 1	1
Mangrove	M15	Quadrat 2	Crustacea	Clistocoeloma merguiensis	1
Mangrove	M15	Quadrat 2	Sipuncula	Sipunculid	1
Mangrove	M15	Quadrat 2	Mollusca	Terebralia palustris	10
Mangrove	M15	Quadrat 2	Crustacea	Uca flammula	2
Rocky shore	Lower	Incidentals	Mollusca	Anthopleura gemmata	1
Rocky shore	Lower	Incidentals	Mollusca	Emarginula variegata	1
Rocky shore	Lower	Incidentals	Mollusca	Isognomon ephippium	3
Rocky shore	Lower	Incidentals	Mollusca	Morula marguaritcola	1
Rocky shore	Lower	Incidentals	Mollusca	Thais biturcularis	1
Rocky shore	R16	Incidentals	Mollusca	Clypeomorus batillariaeformis	1
Rocky shore	R16	Incidentals	Chordata: Pieces	Valamugil sp. (juv)	1
Rocky shore	R16	Quadrat 1	Unknown	Porifera	1
Rocky shore	R16	Quadrat 1	Chordata: Pieces	Mugilogobius (probably M. mertoni) juv.	3
Rocky shore	R17	Incidentals	Crustacea	Anomura	1
Rocky shore	R17	Incidentals	Crustacea	Anomura	1
Rocky shore	R17	Incidentals	Mollusca	Planaxis sulcatus	4
Rocky shore	R17	Incidentals	Mollusca	Saccostrea cucullina	2
Rocky shore	R17	Quadrat 1	Mollusca	Echinolittorina trochoides	89
Rocky shore	R17	Quadrat 2	Unknown	Ascidian	2
Rocky shore	R17	Quadrat 2	Mollusca	Echinolittorina trochoides	8
Rocky shore	R17	Quadrat 2	Mollusca	Littoraria filosa	1
Rocky shore	R17	Quadrat 2	Crustacea	Periclimenes ? suvadiensis	5
Rocky shore	R17	Quadrat 2	Mollusca	Saccostrea cucullina	2
Rocky shore	R18	Incidentals	Crustacea	Metapograpsus frontalis	1
Rocky shore	R18	Incidentals	Mollusca	Morula marguaritcola	1
Rocky shore	R18	Incidentals	Mollusca	Nerita balteata	1
Rocky shore	R18	Incidentals	Chordata: Pieces	Periophthalmus novaeguineensis	1
Rocky shore	R18	Incidentals	Crustacea	Tetraclita squamosa	2
Rocky shore	R18	Quadrat 1	Mollusca	Echinolittorina trochoides	2
Rocky shore	R18	Quadrat 2	Mollusca	Echinolittorina trochoides	6
Rocky shore	R18	Quadrat 2	Crustacea	Metapograpsus frontalis	1

Appendix E Subtidal Fauna arranged by Phyla

Taxa	Pipeline 1	Pipeline 2	Pipeline 3	Pipeline 4	Pipeline 5	Pipeline 6	Pipeline 7	Pipeline 8	Pipeline 9	Pipeline 10	Pipeline 11	Condensate 1	Condensate 2	Condensate 3	PW 2.5 1	PW 2.5 2	PW 2.5 3	PW 3.0 1	PW 3.0 2	PW 3.0 3	PW 3.5. 1	PW 3.5 2	PW 3.5 3	PW North 1	PW North 2	PW North 3	Nearshore 2	Inshore 1	Inshore 2	Inshore 3	Inshore 4	Platform E	Platform N	Platform W	Platform S	
acoetid sp.										1												2	1													
Ampharetid sp.										1																							1	1		
capitellid sp. 1							1																1													
capitellid sp. 2																	1		1				1			1	2	1		1			1	1		
chrysopetalid sp. 1	1																							1						1						
cirratulid sp.																																1				
eunicid sp. 1	1							1																	1	1										
eunicid sp. 2			1																											1						
eunicid sp. 3																						1														
goniadiid sp.		1	1	2				2						1			1	1	1																	
lumbrinerid sp. 1	1	2	1	1	1	1		1							1											1					2					
lumbrinerid sp. 2																																			1	
magelonid sp.																																			1	
maldanid sp.												1					1										1									
nephtydid sp.		2	1														1														1					
neriid sp.																						1														
onuphid sp. 1	1					1	1																													
ophelid sp.				1													1																			
orbinid sp.																							2													
Paralacyclonid sp.		1																								1			1							
paraonid sp.			1															1																		
poecelochaetid sp.																										1				1		1	1			
polynoid sp. 1																							1													

Taxa	Pipeline 1	Pipeline 2	Pipeline 3	Pipeline 4	Pipeline 5	Pipeline 6	Pipeline 7	Pipeline 8	Pipeline 9	Pipeline 10	Pipeline 11	Condensate 1	Condensate 2	Condensate 3	PW 2.5 1	PW 2.5 2	PW 2.5 3	PW 3.0 1	PW 3.0 2	PW 3.0 3	PW 3.5. 1	PW 3.5 2	PW 3.5 3	PW North 1	PW North 2	PW North 3	Nearshore 2	Inshore 1	Inshore 2	Inshore 3	Inshore 4	Platform E	Platform N	Platform W	Platform S			
polynoid sp. 2																							2															
Sabellarid sp1			1																				1															
sigalionid sp.																																1						
spionid sp.	1																								3						2		1	1				
syllid sp. 1											1																											
syllid sp. 2		1																																				
syllid sp. 3																												1										
terebellid sp. 1																								3														
terebellid sp. 2		1																																				
trichobranchid sp.	1																		1				1															
Bryozoan sp1						1																1	3		2													
Bryozoan sp10		1																																				
Bryozoan sp11																					7		1															
Bryozoan sp12						2																																
Bryozoan sp13						1																																
Bryozoan sp14						1																																
Bryozoan sp15																								1														
Bryozoan sp16																							1															
Bryozoan sp17																											1											
Bryozoan sp2			5																																			
Bryozoan sp3			1																																			
Bryozoan sp4																						6																
Bryozoan sp5							1												1																			
Bryozoan sp6								3		1	7	1			1		1	1	1		1	1	1	1	2													
Bryozoan sp7										4											1	1		8	3													

Taxa	Pipeline 1	Pipeline 2	Pipeline 3	Pipeline 4	Pipeline 5	Pipeline 6	Pipeline 7	Pipeline 8	Pipeline 9	Pipeline 10	Pipeline 11	Condensate 1	Condensate 2	Condensate 3	PW 2.5 1	PW 2.5 2	PW 2.5 3	PW 3.0 1	PW 3.0 2	PW 3.0 3	PW 3.5. 1	PW 3.5 2	PW 3.5 3	PW North 1	PW North 2	PW North 3	Nearshore 2	Inshore 1	Inshore 2	Inshore 3	Inshore 4	Platform E	Platform N	Platform W	Platform S		
Bryozoan sp8		1																					15	6													
Bryozoan sp9		1																																			
Gorgonian sp1											1																										
Hydroid sp1																							3														
Hydroid sp2										1													8														
Hydroid sp3															1	1		1	1																		
Hydroid sp4			1			1																1															
Hydroid sp5						1									20																						
Hydroid sp6								1																													
Hydroid sp7																							2														
Hydroid sp8																							3														
Plumularid sp1									6															3													
Sertularid sp1															3	1																					
alphaid sp.			1								1								1			3		4	3												
Amphipod sp. 1											1				2								1	1										1			
Amphipod sp. 11							1																1						1								
Amphipod sp. 12																									1												
Amphipod sp. 13																																			1		
Amphipod sp. 14																														3							
Amphipod sp. 2											1																										
Amphipod sp. 3											1																										
Amphipod sp. 4								1	1																												
Amphipod sp. 5									1																		1										
Amphipod sp. 6																																		1			
Amphipod sp. 7								1							3	1	2	1	1	1	5			1	1									1	2		

Taxa	Pipeline 1	Pipeline 2	Pipeline 3	Pipeline 4	Pipeline 5	Pipeline 6	Pipeline 7	Pipeline 8	Pipeline 9	Pipeline 10	Pipeline 11	Condensate 1	Condensate 2	Condensate 3	PW 2.5 1	PW 2.5 2	PW 2.5 3	PW 3.0 1	PW 3.0 2	PW 3.0 3	PW 3.5. 1	PW 3.5 2	PW 3.5 3	PW North 1	PW North 2	PW North 3	Nearshore 2	Inshore 1	Inshore 2	Inshore 3	Inshore 4	Platform E	Platform N	Platform W	Platform S	
Amphipod sp. 8																						1														
Amphipod sp. 9																									1	1										
Barnacle sp1									1		4	2																								
callianasid sp. 1														1								1		1	1							1	2	4	1	
crustacean sp. 1																							1													
cumacean sp. 1																							1					3					1			
cumacean sp. 2																	1															1				
cumacean sp. 3																									1											
gnathophyllid sp.										1		1																	1	1						
grapsid sp. 1																								1												
isopod sp. 1																					1	1	2		1		1									
isopod sp. 2											1																									
isopod sp. 3								1										1																		
isopod sp. 4																																1				
leucosid sp.												1								1				1												
majid sp.																	1					1														
mysid sp.																							1					1	1							
mysid sp.																	1			3											2					
penaeid																																			2	
porcelanid sp. 1			1					1	9					1					1	8	16	23	7	11	1	1										
porcelanid sp. 2																							1													
portunid sp. 1																																		1		
stomatopod sp.			1																																	
tanaid sp. 1			4	1				1						1								1		7												
tanaid sp. 2																												1								

Taxa	Pipeline 1	Pipeline 2	Pipeline 3	Pipeline 4	Pipeline 5	Pipeline 6	Pipeline 7	Pipeline 8	Pipeline 9	Pipeline 10	Pipeline 11	Condensate 1	Condensate 2	Condensate 3	PW 2.5 1	PW 2.5 2	PW 2.5 3	PW 3.0 1	PW 3.0 2	PW 3.0 3	PW 3.5. 1	PW 3.5 2	PW 3.5 3	PW North 1	PW North 2	PW North 3	Nearshore 2	Inshore 1	Inshore 2	Inshore 3	Inshore 4	Platform E	Platform N	Platform W	Platform S		
Thalamita sp1																					1																
trapezid sp. 1										1																											
trapezid sp. 2																							1														
Asteroid sp1	1																																				
Crinoid sp1																		1																			
Ophiuroid sp. 3	1	1		1					1			1	1		1	1				1	2	5		6	14												
Ophiuroid sp. 4																											1										
Ophiuroid sp1																							1														
Ophiuroid sp2																							24														
Buccinid sp1				2																																	
Cerithid sp1											1																						1				
Littorinid sp1						1					1															2											
Mollusc sp1											1																										
Mollusc sp2																												1									
Mollusc sp3																		1																			
Mollusc sp4																						1															
Mytilid sp1																							1	1	1												
Nassarid sp1																																					
Ostreid sp1																																				1	
Scaphopod sp1						1																															
Venerid sp1																											1										
Venerid sp2																																			1		
nemertean sp.		2	1			1							1																								
Poriferan sp. 1	1																					1															
Poriferan sp. 2																						1															

Taxa	Pipeline 1	Pipeline 2	Pipeline 3	Pipeline 4	Pipeline 5	Pipeline 6	Pipeline 7	Pipeline 8	Pipeline 9	Pipeline 10	Pipeline 11	Condensate 1	Condensate 2	Condensate 3	PW 2.5 1	PW 2.5 2	PW 2.5 3	PW 3.0 1	PW 3.0 2	PW 3.0 3	PW 3.5. 1	PW 3.5 2	PW 3.5 3	PW North 1	PW North 2	PW North 3	Nearshore 2	Inshore 1	Inshore 2	Inshore 3	Inshore 4	Platform E	Platform N	Platform W	Platform S		
Tunicate sp. 1								1							1												1										
Tunicate sp. 1												1									3	1															
Tunicate sp. 2			1														1																				
Tunicate sp. 3																					2																
known sp. 5																												7	2								
known sp. 6																												1									
known sp. 7																											2	1									
unknown sp. 1						1																			1												
unknown sp. 2		3						1							1	1									2									1			
unknown sp. 3																							1											1			
unknown sp. 4																						1	1														