4.4.1.3 Invertebrates

There is a paucity of information on offshore invertebrates inhabiting the South Coast. However, two commercially important species that are found in the south coast are described below.

Squid (*Loligo vulgaris reynaudii*) form dense spawning aggregations (at depths ranging from 20 to 130 m) in sheltered bays along the eastern half of the South Coast, especially between Plettenberg Bay and Algoa Bay. These aggregations of adults reach a peak in November and December. Juveniles occur widely in waters of less than 50 m and disperse further offshore into waters of less than 100 m as they grow to intermediate size. Adults and juveniles are however found extensively on the Agulhas Bank out to the shelf edge (500 m depth contour), especially between Plettenberg Bay and Algoa Bay (Augustyn, 1990; Sauer *et al.*, 1992).

The South Coast Rock Lobster (*Palinurus gilchristi*) occurs on rocky substrate in depths of 90 to 170 m. The species is fished commercially along the southern Cape coast between the Agulhas Bank and East London. A number of main fishing grounds are recognised, namely Agulhas Bank (south of Cape Agulhas), the Cape St Francis grounds, the Cape Recife grounds and the Bird Island grounds. The South Coast Rock Lobster is known to migrate across the Agulhas Bank in an east-west direction.

4.4.1.4 Fishes

Many of the fish species inhabiting the South Coast are also found on the West and/or East Coasts, highlighting the location of the South Coast as a transition zone between two different current systems. In addition to the different water types, the Agulhas Bank substrate is also complex comprising areas of sand, mud and coral, which further results in increased diversity of benthic fauna and fish species.

Marine fish can generally be divided in three different groups, pelagic (those species associated with water column), demersal (those associated with the substratum) or meso-pelagic (fish found generally in deeper water and may be associated with both the seafloor and the pelagic environment). Pelagic species include two major groups, the planktivorous clupeid-like fishes such as anchovy or pilchard and piscivorous predatory fish. Demersal fish can be grouped according to the substratum with which they are associated, for example rocky reef or soft substrata. It must be noted that such divisions are generally simplistic, as certain species associate with more than one community. The shallower inshore areas (<100 m) along the South Coast comprise a varied habitat of rocky reefs and soft-bottom substrates, which support a high diversity of endemic sparid and other teleost species (Smale *et al.* 1994). Many of these species form an important component of the commercial and recreational linefishery (see Table 4.10). An important fishing ground, popularly known as *The Blues*, covering an area of approximately 3 650 km^2 is situated an estimated 70 km west of the proposed F-O Production Right area.

<u>Pelagic species</u>

The Agulhas Bank is an important spawning area for anchovy (*Engraulis japonicus*) where they are usually located between the cool upwelling ridge and the Agulhas Current (Crawford, 1980; Hutchings, 1994). Having spawned, most adults move eastwards and shorewards ahead of warm Agulhas Current water. The South Coast is not an important anchovy recruitment ground (Hampton, 1992), with starvation, predation and advective losses to the open ocean (due to currents) all playing a potentially important part in minimising successful recruitment. Pilchards (*Sardinops ocellatus*) also spawn on the Agulhas Bank (Crawford, 1980), with adults apparently moving eastwards and northwards from the eastern border of the West Coast after spawning. Pilchard recruits are found inshore along the South Coast, although the distribution is variable (Hutchings, 1994). The Agulhas Bank may be a refuge for pilchard under low population levels (CSIR and CCA, 1998). Round herring are reported to spawn and recruit along the South Coast, their juveniles being

located inshore, but moving offshore with age (Roel and Armstrong, 1991; Roel *et al.*, 1994; Hutchings, 1994). Adult horse mackerel (*Trachurus trachurus*) are very abundant on the Agulhas Bank (Hutchings, 1994; Smale *et al.*, 1994; CSIR and CCA, 1998).

Large migratory pelagic species that occur in offshore waters and beyond the shelf break include dorado (*Coryphaena hippurus*), sailfish (*Istiophorus platypterus*) and black, blue and striped marlin (*Makaira indica, M. nigricans, Tetrapturus audax*), frigate tuna (*Auxis thazard*), skipjack (*Katsuwonus pelamis*), longfin tuna/albacore (*Thunnus alalunga*), bigeye tuna (*Thunnus obesus*), yellowfin tuna (*Thunnus albacares*), Southern Bluefin tuna and Bluefin tuna (*Thunnus maccoyii* and *T. thynnus thynnus*, respectively) (Van der Elst 1988; Smale *et al.* 1994). The tuna found offshore along the South Coast are not landed in large numbers and their densities are likely to be relatively low.

Demersal species

Cape hake (*Merluccius capensis*) is distributed widely on the Agulhas Bank, while the deep water hake (*M. paradoxus*) is found further offshore in deeper water (Boyd *et al.*, 1992; Hutchings, 1994). Juveniles of both species are distributed in shallower water than adults, and occupy the whole water column. The east coast sole (*Austroglossus pectoralis*) inhabits inshore muddy bottoms on the shelf between Cape Agulhas and Algoa Bay. Kingklip (*Genypterus capensis*) is also an important demersal species (Japp *et al.*, 1994), with adults distributed in deep waters along the whole of the South Coast (especially on rocky substrate) while juveniles are located inshore (although further offshore on the central Agulhas Bank).

Closer inshore (< 30 m), numerous endemic sparid fish species inhabit rocky reefs and soft bottom substrates (Smale *et al.*, 1994), with some species moving into inshore protected bays to spawn (Buxton, 1990). Little is known about reef fish assemblages that inhabit deeper waters. The inshore waters of the Agulhas Bank, especially between the cool water ridge and the shore, acts as a nursery area for numerous fish species (Wallace *et al.*, 1984).

Table 4.10: Some of the more important linefish species landed by commercial and recreational boat fishers and shore anglers along the South Coast (adapted from CCA & CMS 2001).

Common name	Scientific name	Common name	Scientific name
Bank steenbras	Chirodactylus grandis	Red roman	*Chrysoblephus laticeps*
Belman	*Umbrina canariensis*	Red steenbras	*Petrus rupestris*
Blacktail	*Diplodus sargus*	Red stumpnose	*Chrysoblephus gibbiceps*
Blue hottentot	*Pachymetopon aeneum*	Rockcod	*Epinephalus* spp.
Bronze bream	*Pachymetopon grande*	Sand steenbras	*Lithognathus mormyrus*
Cape bank steenbras	*Chirodactylus grandis*	Santer	*Cheimerius nufar*
Cape stumpnose	*Rhabdosargus holubi*	Seventyfour	*Polysteganus undulosus*
Carpenter	*Argyrozona argyrozona*	Spotted grunter	*Pomadasys commersonnii*
Dageraad	*Chrysoblephus christiceps*	Steentjie	*Spondyliosoma emarginatum*
Fransmadam	*Boopsoidea inornata*	Strepie	*Sarpa salpa*
Galjoen	*Dichistius capensis*	White steenbras	*Lithognathus lithognathus*
Grey chub	*Kyphosus biggibus*	White stumpnose	*Rhabdosargus globiceps*
Kob	*Argyrosomus hololepidotus*	Wreckfish	*Polyprion americanus*
Musselcracker	*Sparodon durbanensis*	Zebra	*Diplodus cervinus*
Poenskop	*Cymatoceps nasutus*		

4.4.1.5 Turtles

Three species of turtles (the green (*Chelonia mydas*); leatherback (*Dermochelys coriacea*), loggerhead (*Caretta caretta*), are found in the South Coast region, probably associated with the Agulhas Current, although the latter two more commonly so than the green turtle. According to the IUCN Red listing, the leatherback turtle is described as "critically endangered", and the loggerhead and green turtles are "endangered". The green turtle is a non-breeding resident along the east coast of South Africa and together with loggerhead turtles are expected to occur only as occasional visitors along the South Coast.

Both the leatherback and the loggerhead turtle nest on the beaches of the northern KwaZulu-Natal coastline in summer and these nesting areas are located over 1 000 km to the north of the F-O Production Right area. Nesting populations of these species have been monitored annually and populations are clearly stable or increasing annually. Hatchlings are born from late January through to March and move southward in the Agulhas Current, where survival is low (Hughes, 1989). Beach strandings of juvenile loggerhead and leatherback turtles along the South African coast suggest juvenile turtles in the Agulhas Current between Durban and the Eastern Cape in February, between Algoa Bay and Mossel Bay in March and between Algoa Bay and Cape Point in April (Hughes, 1974). Thereafter the distribution of young turtles is relatively unknown for 5 to 10 years until they reach a length of about 60 cm whereupon they re-appear on the southern African coastline.

The abundance of adult turtles and hatchlings within the F-O Production Right area is expected to be low.

4.4.1.6 Seabirds

South Coast seabirds can be categorised into three categories, 'breeding resident species' (Table 4.11), 'rare vagrants' (Table 4.12) and 'non-breeding migrant species' (Table 4.13) (Shaughnessy, 1977; Harrison, 1978; Liversidge and Le Gras 1981 and Ryan and Rose, 1989). Overall, 60 species are known, or thought likely to occur, along the South Coast.

Thirteen species breed within the South Coast region. These include Cape gannets (Algoa Bay islands), African penguins (Algoa Bay islands), Cape cormorants (a small population at Algoa Bay islands and mainland sites), white-breasted cormorant, Roseate tern (Bird and St Croix Islands), Damara tern (inshore between Cape Agulhas and Cape Infanta), Swift tern (Stag Island) and kelp gulls. Seabird numbers in colonies are well documented, although there are few estimates of seabird densities at sea over the Agulhas Bank. The anchovy and pilchard form important prey items for Agulhas Bank seabirds, particularly the Cape gannet (*Morus capensis*), the African penguin (*Spheniscus demersus*) and, closer inshore, the different cormorant (*Phalacrorax*) species.

Abundance of the Southern Ocean sea birds species (Tables 4.12 and 4.13) on the Agulhas Bank increases in winter with the more northward passing of the frontal systems as well as the northward displacement of the sub-antarctic convergence zone.

African penguin colonies occur at 27 localities around the coast of South Africa and Namibia. Those in the South Coast region are located in the Algoa Bay region at Cape Recife, St Croix Island, Jaheel Island, Bird Island Seal Island, Stag Island and Brenton Rocks. This species forages at sea with most birds being found within 20 km of the coast with the majority of Algoa Bay animals foraging to the south of Cape Recife. As the F-O Gas Field is located approximately 110 km offshore, it would not overlap with the popular foraging areas of the African Penguin.

Table 4.11: Breeding resident seabirds found on the south coast, and their conservation status (from CSIR and CCA 1998).

Common name	Scientific name	Conservation status
African penguin	*Spheniscus demersus*	A (sc), SA (v), WCNC (r)
Cape gannet*	*Morus capensis*	A (sc), WCNC (r)
Great cormorant	*Phalacrocorax carbo*	
Cape cormorant	*Phalacrocorax capensis*	WCNC (a)
Bank cormorant	*Phalacrocorax neglectus*	A (nt), WCNC (r)
Crowned cormorant*	*Phalacrocorax coronatus*	A (nt), WCNC (r)
Kelp gull**	*Larus dominicanus*	WCNC (a)
Greyheaded gull	*Larus cirrocephalus*	
Hartlaub's gull*	*Larus hartlaubii*	WCNC (a)
Caspian tern	*Sterna caspia*	SA r, WCNC (r)
Swift tern**	*Sterna bergii*	WCNC (a)
Roseate tern	*Sterna dougalii*	SA (e), WCNC (r)
Damara tern*	*Sterna balaenarum*	A (r), SA (r), WCNC (r)

Key:

A = Listed in red data book for Africa
SA = Listed in red data book for South Africa
WCNC = Western Cape Province Listing

* Species endemic to southern Africa
** Subspecies endemic to southern Africa
e = Endangered population
sc = Species of special concern

r = Rare
nt = Near threatened
v = Vulnerable
a = amber listing; r = red data listing

Table 4.12: Species list of rare or vagrant seabirds recorded from the South Coast (from CSIR and CCA 1998).

Common name	Scientific name	Common name	Scientific name
Rockhopper penguin	*Eudyptes chrysocome*	Blackbellied stormpetrel	*Fregatta tropica*
Macaroni penguin	*Eudyptes chrysolophus*	Greater frigatebird	*Fregata minor*
Royal albatros	*Diomedea eupomophora*	South pola skua	*Catharacta maccormickki*
Sooty albatros	*Phoebetria fusca*	Sooty tern	*Sterna fuscata*
Freshfooted shearwater	*Puffinus carneipes*	Common noddy (tern)	*Anous stolidus*
Manx shearwater	*Puffinus puffinus*		

Table 4.13: Species list of regular, non-breeding visiting seabirds found along the South Coast (from CSIR and CCA 1998).

Common name	Scientific name	Common name	Scientific name
Wandering albatross	*Diomedea exulans*	Great shearwater	*Puffinus gravis*
Shy albatross	*Diomedea cauta*	Sooty shearwater	*Puffinus griseus*
Blackbrowed albatross	*Diomedea melanorphrys*	Little shearwater	*Puffinus assimilis*
Greyheaded albatross	*Diomedea chrysostoma*	European storm petrel	*Hydrobates pelagicus*
Yellownosed albatross	*Diomedea chlororhynchos*	Wilson's storm petrel	*Oceanites oceanicus*
Southern giant petrel	*Macronectes giganteus*	Whitebellied petrel	*Fregatta grallaria*
Northern giant petrel	*Macronectes halli*	Leach's storm petrel	*Oceanodroma leucorhoa*
Antactic fulmar	*Fulmarus glacialoides*	Grey phalarope	*Phalaropus fulicarius*
Pintando petrel	*Daption capensis*	Arctic skua	*Stercorarius parasiticus*
Greywinged petrel	*Pterodroma macroptera*	Longtailed skua	*Stercorarius longicaudus*
Softplumaged petrel	*Pterodroma mollis*	Pomarine skua	*Stercorarius pomarinus*
Kerguelen petrel	*Lugensa brevirostris*	Subantarctic skua	*Catharacta antartica*
Blue petrel	*Halobaena caerulea*	Sabine's gull	*Larus sabini*
Broadbilled prion	*Pachyptila vittata*	Sandwitch tern	*Sterna sandvicensis*
Slenderbilled prion	*Pachyptila belcheri*	Common tern	*Sterna hirundo*
Whitechinned petrel	*Procellaria aequinoctialis*	Arctic tern	*Sterna paradisaea*
Grey petrel	*Procellaria cinereus*	Antarctic tern	*Syerna vittata*
Cory's shearwater	*Calonectris diomedia*		

4.4.1.7 Marine mammals

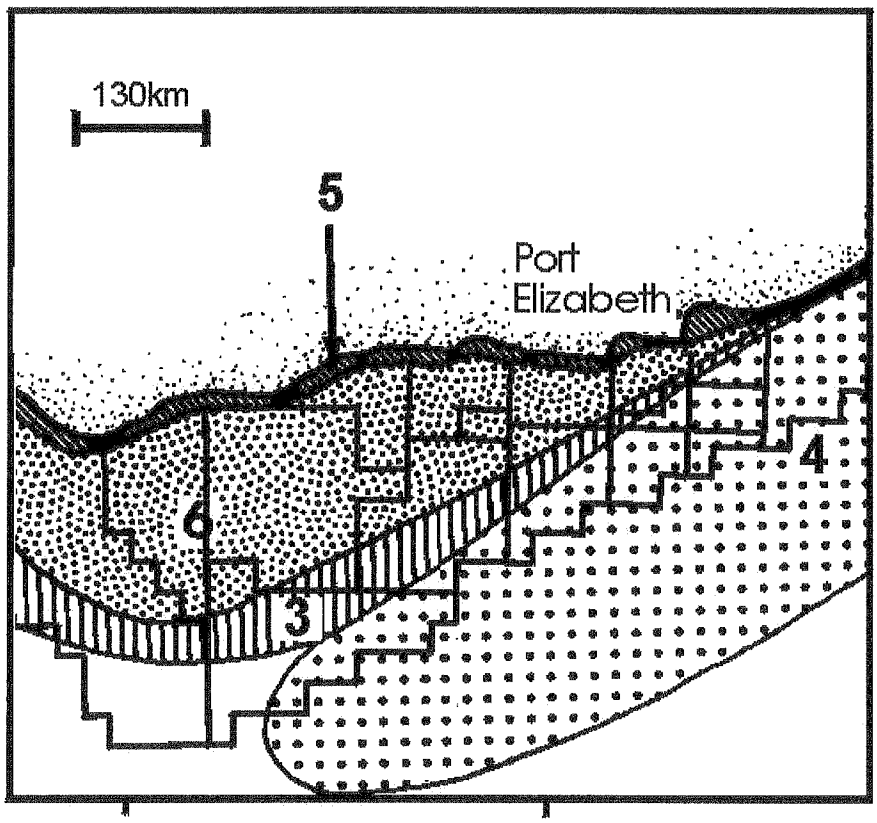
The marine mammal fauna of the South Coast comprises between 35 and 38 species of cetaceans (whales and dolphins) and one seal species, the Cape fur seal (*Arctocephalus pusillus*) (Findlay, 1989; Findlay *et al.,* 1992: Ross, 1984; Peddemors, 1999). The range of cetaceans reflects largely taxonomic uncertainty at species and sub-species level, rather than uncertainty of occurrence or distribution patterns (which are summarised in Table 4.14 and Figure 4.9).

Table 4.14: Whale and dolphin species found along the South Coast.

Common name	Scientific name	Distribution
Migratory cetaceans		
Southern right whale	*Eubalaena australis*	Extreme inshore
Humpback whale	*Megaptera novaeangliae*	Transit inshore
Minke whale	*Balaenoptera acutorostrata*	Cosmopolitan
Blue whale	*Balaenoptera musculus*	Transit offshore
Sei whale	*Balaenoptera borealis*	Transit offshore
Fin whale	*Balaenoptera physalus*	Transit offshore
Possibly migratory cetaceans		
Pygmy right whale	*Caperea marginata*	Possible extreme inshore
Strap-toothed whale	*Mesoplodon layardii*	South Coast offshore
Bryde's whale	*Balaenoptera brydei*	Offshore
Arnoux's beaked whale	*Berardius arnuxii*	South coast offshore
Cetaceans resident on the Agulhas Bank		
Bottlenose dolphin	*Tursiops aduncus*	Extreme Inshore
Indo-Pacific humpback dolphin	*Sousa chinensis*	Extreme Inshore
Longbeaked common dolphin	*Delphinus delphis*	Extreme Inshore, Agulhas Bank
Killer whale	*Orcinus orca*	Cosmopolitan
Bryde's whale	*Balaenoptera brydei?*	Agulhas Bank
Cetaceans resident in pelagic waters offshore of the Agulhas Bank		
Killer whale	*Orcinus orca*	Cosmopolitan
Risso's dolphin	*Grampus griseus*	Offshore
Striped dolphin	*Stenella coeruleoalba*	Agulhas Current
Spotted dolphin	*Stenella attenuata*	Agulhas Current
Fraser's dolphin	*Lagenodelphis hosei*	Agulhas Current
False killer whale	*Pseudorca crassidens*	Offshore
Pygmy killer whale	*Feresa attenuata*	Offshore
Long-finned pilot whale	*Globicephala melas*	South Coast Offshore
Short-finned pilot whale	*G. macrorhynchus*	Agulhas Current
Melonheaded whale	*Peponocephala electra*	Agulhas Current
Sperm whale	*Physeter macrocephalus*	Offshore
Pygmy sperm whale	*Kogia breviceps*	Offshore
Dwarf sperm whale	*Kogia sima*	South Coast Offshore
Southern bottlenose whale	*Hyperoodon planifrons*	Agulhas Current
Cuvier's beaked whale	*Ziphius cavirostris*	Offshore
Blainville's beaked whale	*Mesoplodon densirostris*	Agulhas Current
Gray's beaked whale	*Mesoplodon grayi*	South Coast Offshore
True's beaked whale	*Mesoplodon mirus*	South Coast Offshore
Hector's beaked whale	*Mesoplodon hectori*	South Coast Offshore
Shortbeaked common dolphin	*Delphinus capensis*	Offshore
Bottlenose dolphin	*Tursiops truncatus*	Offshore

Cetaceans (whales and dolphins)

The majority of migratory cetaceans in South African waters are large baleen whales. Populations of large baleen whales in South African waters were decimated by historical whaling and are presently a fraction of their pre-exploitation densities. According to the International Union for Conservation of Nature (IUCN) Red Data book, sei and humpback whales are listed as "Endangered" and the Southern Right and fin whale are recorded as "Vulnerable".



Key:
3. South coast offshore
4. Agulhas "temperate"
5. South and East coast inshore
6. Agulhas bank

Note: South coast offshore and Cosmopolitan species extend to 200 nm limit of the EEZ.

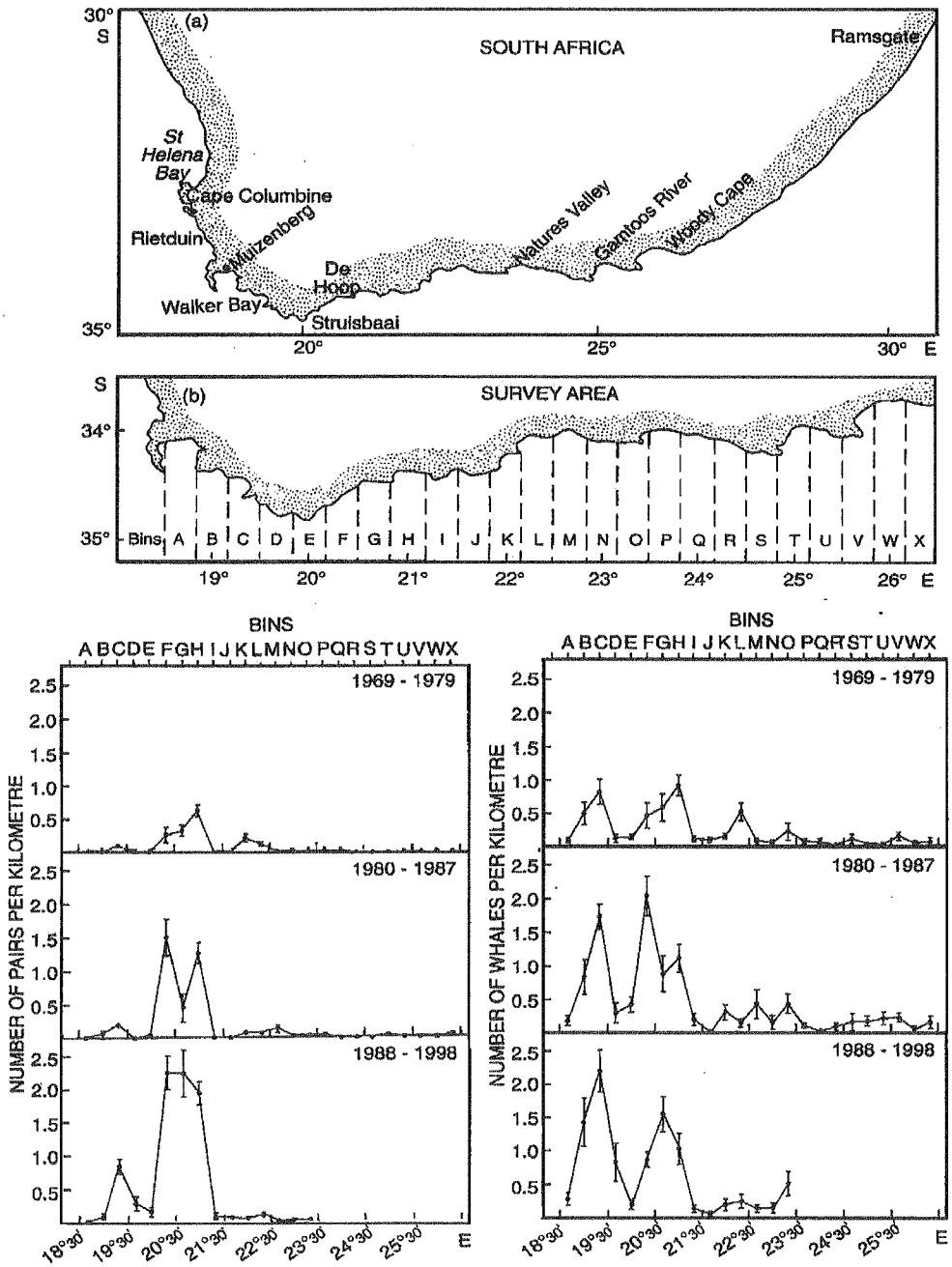
Distribution of resident cetacean species within South Coast waters, with petroleum license blocks. Modified from Findlay (1989).	**Figure 4.9**

Blue (*Balaenoptera musculus*), fin (*B. physalus*), sei (*B. borealis*), minke (*B acutorostrata / B bonaerensis*) and humpback whales (*Megaptera novaeangliae*) make winter migrations through the South Coast region en route from Antarctic summer feeding grounds to winter breeding grounds. While blue, fin and sei whales migrate off or along the continental shelf edge (and are thus distributed in deeper waters), humpback whales migrate over the continental shelf and along the coast. Two types of Bryde's whales are recorded from South African waters (Best, 1977) - a smaller neritic form (of which the taxonomic status is uncertain) and a larger pelagic form described as *Balaenoptera brydei*. While the smaller neritic form is resident (particularly over the Agulhas Bank) the larger offshore form is migratory.

Southern right whales (*Eubalaena australis*) migrate into the near-shore region of the South Coast between June and November each year (although animals may be sighted as early as April and as late as January) (see Figure 4.10). This population is increasing at approximately 7% per annum, yet is still probably around 12–15 % of the initial pre-exploitation abundance. The pygmy right whale (*Caperea marginata*) shows a strong summer seasonality in water depths of less than 50 m along the coast between Algoa Bay in the east and Walvis Bay, Namibia. Killer whales are found year round in the waters of the South Coast, although the seasonality of sightings in the whaling grounds (in September and October) suggests that some killer whales are highly migratory (Findlay, 1989). Arnoux's beaked whale (*Berardius arnuxii*) has been recorded along the West and South Coasts between 18° and 25°E during summer and Layard's beaked whale (*Mesoplodon layardii*) is distributed throughout the South Coast pelagic waters in summer and early autumn.

Five faunal provinces define the distribution of resident cetaceans within the South Coast region (see Table 4.14 and Figure 4.9). These include:

1. *South and East Coast Extreme Inshore (False Bay to Punta do Ouro):* Both Indo Pacific humpbacked dolphins (*Sousa chinensis*) and the smaller bottlenose dolphin (*Tursiops truncatus aduncus*) occur in extreme inshore waters to the east of False Bay.
2. *Agulhas Bank*: Two species, the longbeaked common dolphin (*Delphinus delphis*) and the resident smaller inshore Bryde's whale appear to be strongly associated with the Agulhas Bank region and the West Coast inshore region as far north as Lambert's Bay. Although these will be found elsewhere in southern African waters (the common dolphin will follow the sardine run into KwaZulu-Natal waters and is recorded from strandings on the Namibian coast) the majority of records are from the Agulhas Bank region.
3. *South Coast Offshore*: Two pelagic species of cetacean, True's beaked whale (*Mesoplodon mirus*) and the dwarf sperm whale (*Kogia sima*), appear to be limited to the south coast offshore region between Cape Columbine and the Eastern Cape. A further two species, Gray's beaked whale (*Mesoplodon grayii*) and the long finned pilot whale (*Globicephala melas*), appear to be limited to the south coast offshore region between Namibia and the Eastern Cape. These species are found in deep waters elsewhere in the world and apart from the pilot whale are recorded only as strandings on the South African coast.
4. *Agulhas Current Species*: The movement of warm Agulhas Current water into the South Coast region results in warm water species in the region. Southern bottlenose whales (*Hyperoodon planifrons*) and striped dolphin (*Stenella coeruleoalba*) appear to be associated with Agulhas Current water off the South Coast. Two further pelagic species, Blainville's beaked whale (*Mesoplodon densirostris*) and short finned pilot whale (*Globicephala macrorhynchus*) are recorded as strandings on the South Coast. These species have warm water pelagic distributions elsewhere in the world.
5. *Cosmopolitan*: Killer whales (*Orcinus orca*) and minke whales (possibly *Balaenoptera acutorostrata*) are found in both continental shelf and offshore waters of the South Coast. Cuvier's beaked whale (*Ziphius cavirostris*), pygmy sperm whales (*Kogia breviceps*), False killer whales (*Pseudorca crassidens*), pygmy killer whales (*Feresa attenuata*), Risso's dolphins (*Grampus griseus*), and sperm whales (*Physeter macrocephalus*) are found throughout the offshore waters of the South Coast. The short-beaked common dolphin (*Delphinus capensis*) probably occurs in the offshore region of the South Coast.



The distribution of southern right whales (individuals and cow and calf pairs) recorded on the South Coast in October 1969-1998 (after Best 2000).

Figure 4.10

Seals

The Cape fur seal (*Arctocephalus pusillus pusillus*) is the only seal species that has breeding colonies along the South Coast, namely at Seal Island in Mossel Bay, on the northern shore of the Robberg Peninsula in Plettenberg Bay and at Black Rocks (Bird Island group) in Algoa Bay (see Figure 4.11). Mature bulls arrive at the breeding colonies in Mid-October, while the cows arrive a few weeks later to give birth to a single pup. The bulls establish a harem of several cows and mating takes place about a week after the cow has given birth. The breeding colonies break up and disperse before the end of December.

The movement of seals from the three South Coast colonies are poorly known, although limited tracking of Algoa Bay animals has suggested these seals to be feeding in the inshore region south of Cape Recife. The diet varies with season and availability and includes pelagic species such as horse mackerel, pilchard, and hake, as well as squid and cuttlefish.

4.4.2 NEAR-SHORE REGION

The South Coast is approximately 730 km long and is characterised by a number of capes (e.g. Cape Agulhas, Cape Infanta, Cape Seal, Robberg and Cape Recife) separated by sheltered sandy embayments. The near-shore region comprises mainly sandy beaches, wave-cut rocky platforms and exposed rocky headlands, although estuarine habitat and pebble beaches are also present (Jackson and Lipschitz, 1984).

4.4.2.1 Rocky shores

Some 60% of the South Coast is rocky, 57% of this total comprising exposed rocky headlands, with the remainder comprising wave-cut rocky platforms (Jackson and Lipschitz, 1984). South Coast rocky intertidal fauna is more diverse than that along the West Coast or East Coast due to the presence of species of both tropical and temperate origin.

4.4.2.2 Sandy shores

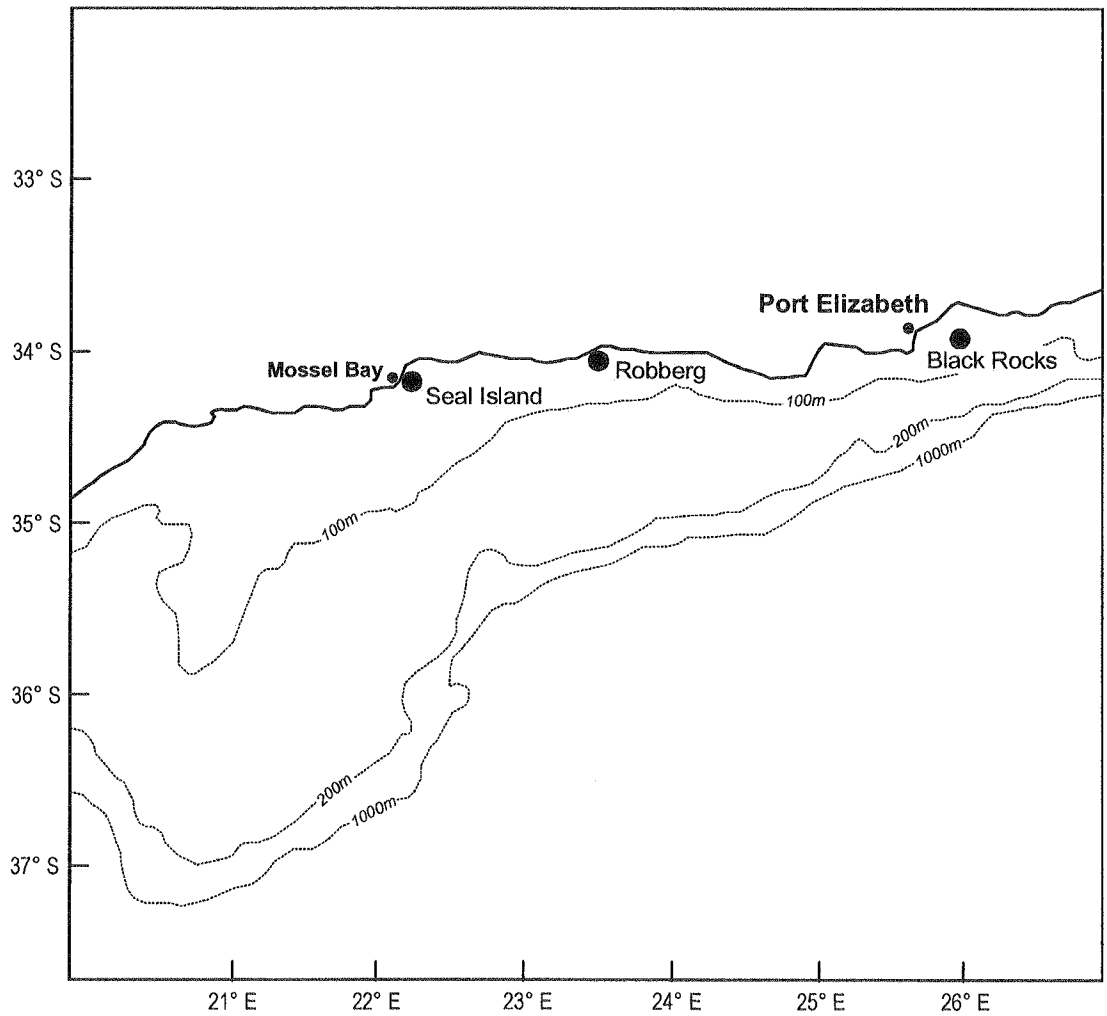
Some 38% of the South Coast comprises sandy beaches (Jackson and Lipschitz, 1984). The sandy beaches of the region are generally high energy and unstable environments and despite having low diversity, biomass may be high. The surf zones off sandy beaches are important nursery areas for a variety of fish species.

4.4.2.3 Shallow subtidal

Shallow subtidal soft sediment communities are relatively simple, containing few species of large organisms, although the most common ones may be very abundant. Communities inhabiting shallow reefs are more diverse.

4.4.2.4 Estuaries

Thirty-six estuarine systems are found along the South Coast, of which 15 are permanently open (Jackson and Lipschitz, 1984). These open systems are important recruitment sites for some inshore linefish species, while certain systems are important roosting and breeding sites for estuarine birds. The Heuningnes estuary, located within the De Mond Nature Reserve, is a Ramsar site (Cowan, 1995).



The distribution of seal colonies on the South Coast (after Wickens *et al.* 1992).

Figure 4.11

4.5 HUMAN UTILISATION

4.5.1 FISHERIES AND OTHER HARVESTING

Many commercially important fish species are found off the South Coast and the region supports many different fisheries. Five fisheries (namely demersal trawl, midwater trawl, demersal longline, pelagic longline and South Coast Rock Lobster longline) are active in the vicinity of the proposed project. Tables 4.15 and 4.16 list fish species commonly commercially trawled and commercially caught linefish:

Table 4.15: Commonly commercially trawled fish species on the Agulhas Bank and proportion of total catch in trawl and line fisheries (from Japp *et al.* 1994).

Scientific name	Common name	% of mass landed by	
		Line fishery	Trawl fishery
Teleosts			
Pelagic species			
Brama brama	Angel fish	-	100
Scomber japonicus	Chub mackerel	0.6	99.4
Thyrsites atun	Snoek	7.2	92.8
Trachurus trachurus capensis	Horse mackerel	-	100
Demersal species			
Austroglossus pectoralis	Aghulas sole	-	100
Chelidonichthyes spp.	Gurnard	-	100
Cynoglossus zanzibarensis	Redspotted tonguefish	-	100
Genypterus capensis	Kingklip	7.2	92.8
Helicolinus dactylopterus	Jacopever	-	100
Lepidopus caudatus		-	100
Lophius sp.	Monkfish	-	100
Merluccius spp.	Hake	0.5	99.5
Pterogymnus laniarius	Panga	8.1	91.9
Zeus capensis	John Dory	-	100
Chondrichthyans (all demersal)			
Callorhincus capensis	St Joseph shark	-	100
Galeorhinus galeus	Soupfin shark	26.6	73.4
Raja straeleni	Biscuit skate	-	100

Table 4.16: Common commercially caught linefish species and proportion of total catch caught in linefish and trawl fisheries (from Japp *et al.* 1994).

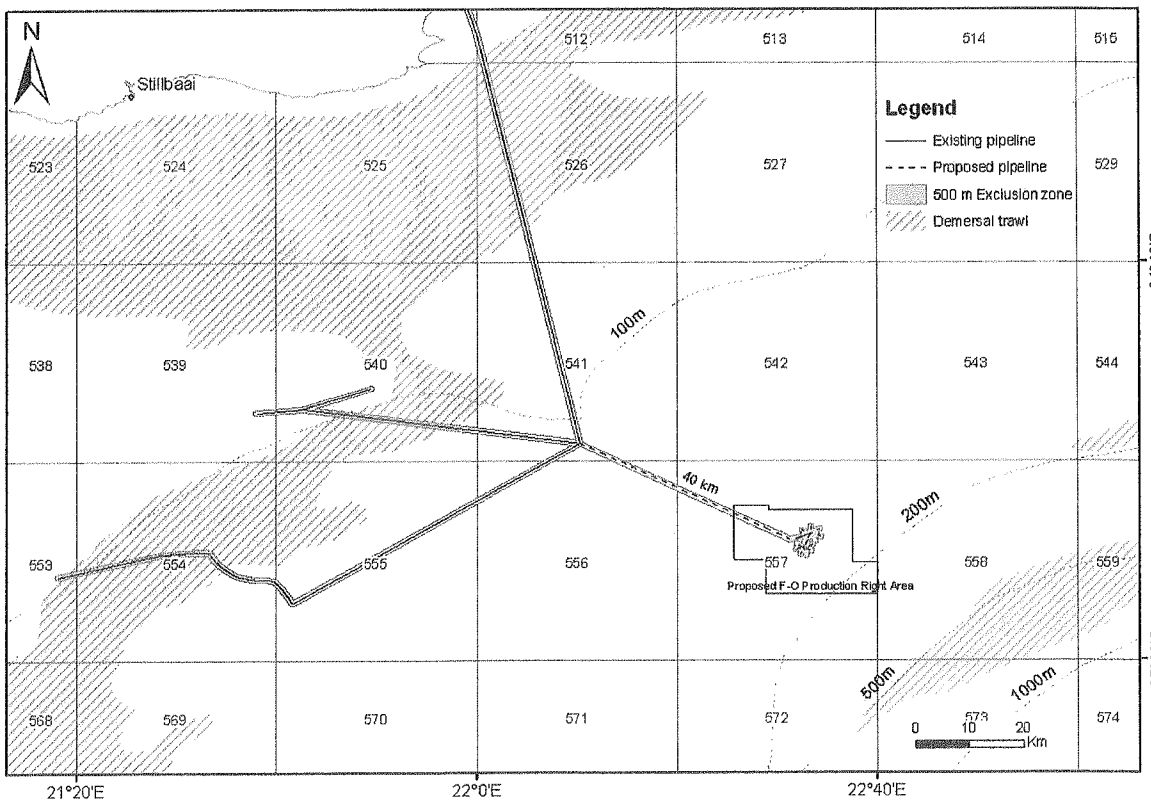
Scientific name	Common name	% of catch landed by	
		Line fishery	Trawling sector
Pelagic species			
Argyrosomus inodorus	Dusky kob	72.8	27.2
Atractoscion aequidens	Geelbek	99.7	0.3
Pomatomus saltatrix	Elf	100	-
Seriola lalandi	Yellowtail	100	-
Demersal species			
Argyrozona argyrozona	Carpenter	96.8	3.2
Cheimerius nufar	Santer	96.9	3.1
Chirodactylus grandis	Cape bank steenbras	-	100
Chrysoblephus gibbiceps	Red stumpnose	94.4	5.6
Chrysoblephus laticeps	Red roman	98.6	1.4
Lithognathus lithognathus	White steenbras	-	100
Petrus rupestris	Red steenbras	100	-
Polyprion americanus	Wreckfish	-	100
Pomadasys commersonnii	Spotted grunter	-	100
Rhabdosargus globiceps	White stumpnose	6.7	93.3
Umbrina canariensis	Belman	-	100

4.5.1.1 Demersal Trawl

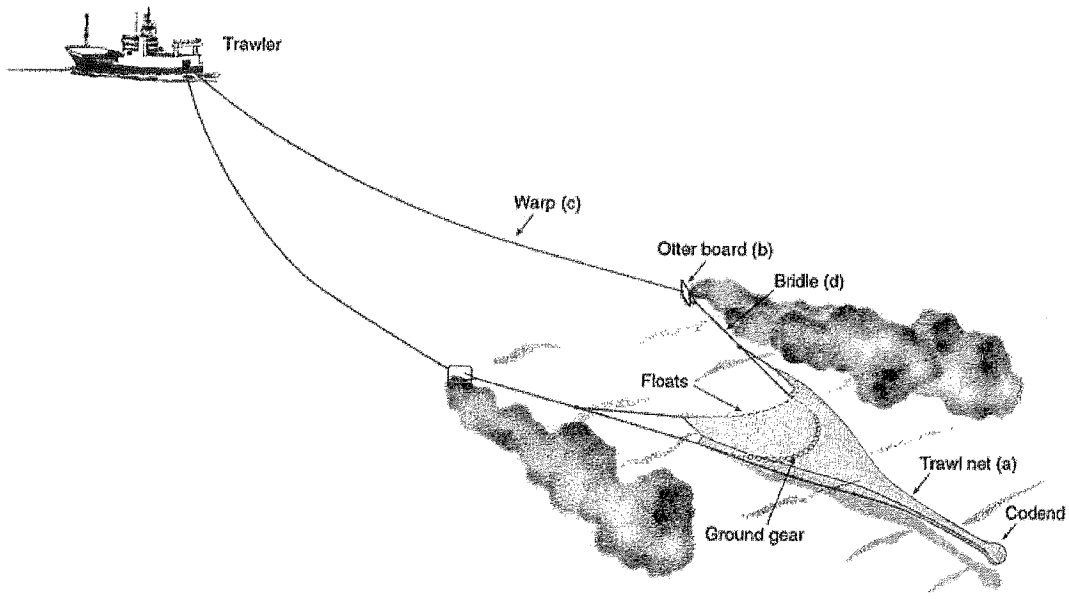
Demersal trawl is South Africa's most valuable fishery accounting for approximately half of the wealth generated from commercial fisheries. Demersal trawlers operate extensively around the coast primarily targeting the bottom-dwelling (demersal) species of hake (*Merluccius paradoxus* and *M. capensis*). Other commercially valuable trawl catch species are kingklip, monk, mackerel, panga, ribbonfish, chokka, gurnards, jacopever, octopus, pilchards and skates. The fishery is divided into the deep-sea and inshore sectors, which differ primarily in terms of the areas in which they operate. The Total Allowable Catch (TAC) of hake for the offshore and inshore sectors was set at 100 125 and 7 372 tons for 2010, respectively.

Trawling activity within the offshore fishery is directed along the shelf break extending in an almost continuous band from Port Nolloth on the West Coast to Port Elizabeth on the East Coast. This band is interrupted by untrawlable (rocky) grounds between longitudes 22°E and 22°30'E. On the South Coast trawl grounds are located between a depth range of180 m to 800 m (average 400 m). The offshore fishery is prohibited from trawling in depths less than 110 m or within 20 nm of the shore. Inshore grounds are located on the Agulhas Bank and extend towards the Great Kei River in the east. Close inshore between Struisbaai and Mossel Bay vessels target sole between the 50 m and 80 m bathycontours. While hake is targeted further offshore in traditional grounds between 100 m and 160 m depth in fishing grounds known as *the Blues* on the Agulhas Bank. The areas of activity of both the deep-sea and inshore trawl fisheries do not coincide with the proposed F-O Gas Field Development (see Figure 4.12). The closest trawling grounds are located approximately 30 km to the south-east of the proposed F-O Gas Field wells.

Both inshore and offshore vessels have a similar gear configuration. The towed gear typically consists of trawl warps, bridles and trawl doors, a footrope, headrope, net and codend (see Figure 4.13).



Spatial extent of the demersal trawl fishery in relation to the proposed F-O Gas Field Development (Japp and Wilkinson, 2010). **Figure 4.12**



Schematic diagram of trawl gear typically used by demersal trawlers.	Figure 4.13

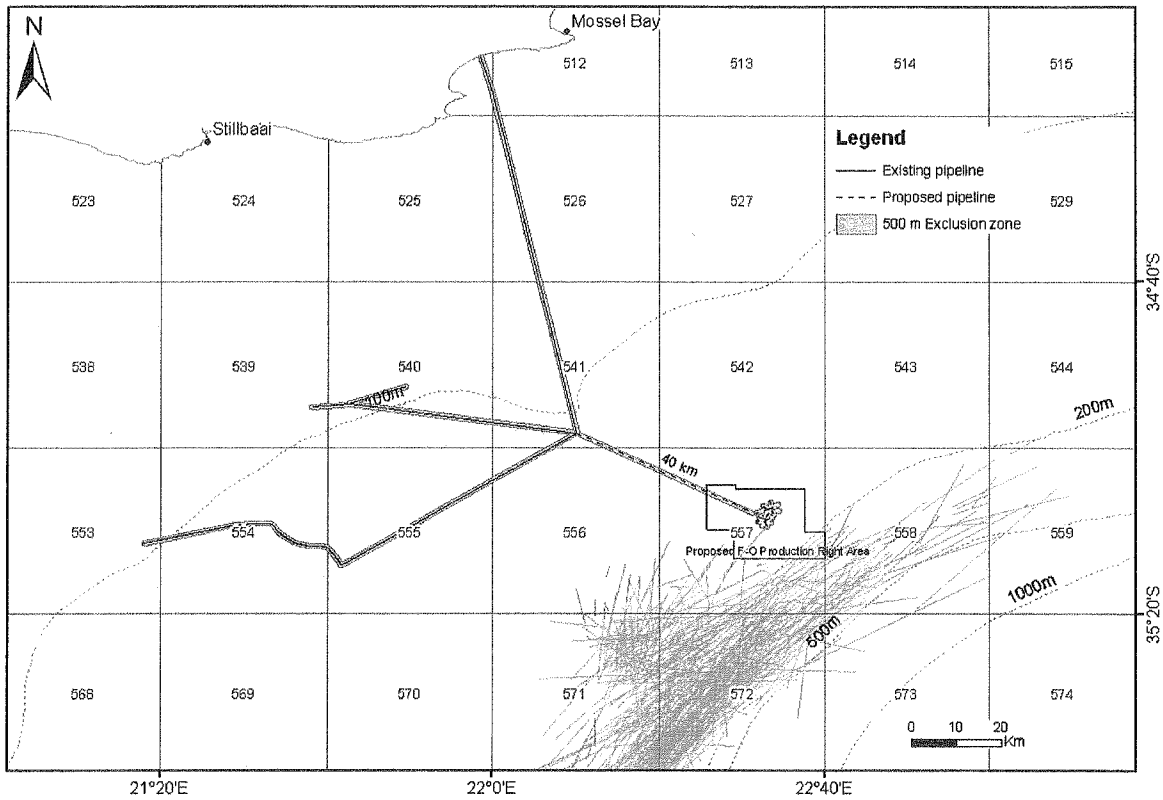
4.5.1.2 Midwater Trawl

The midwater trawl fishery targets adult horse mackerel (*Trachurus capensis*), which aggregate in highest concentration on the Agulhas Bank. Shoals of commercial abundance are found in limited areas and the spatial extent of mid-water trawl activity is relatively limited when compared to that of demersal trawling. Fishing grounds are condensed into three areas on the shelf edge of the south and east coast:

1. Between 22°E and 23°E at a distance of approximately 70 nm offshore from Mossel Bay;
2. Between 24°E to 27°E at a distance of approximately 30 nm offshore; and
3. South of the Agulhas Bank between 21°E and 22°E.

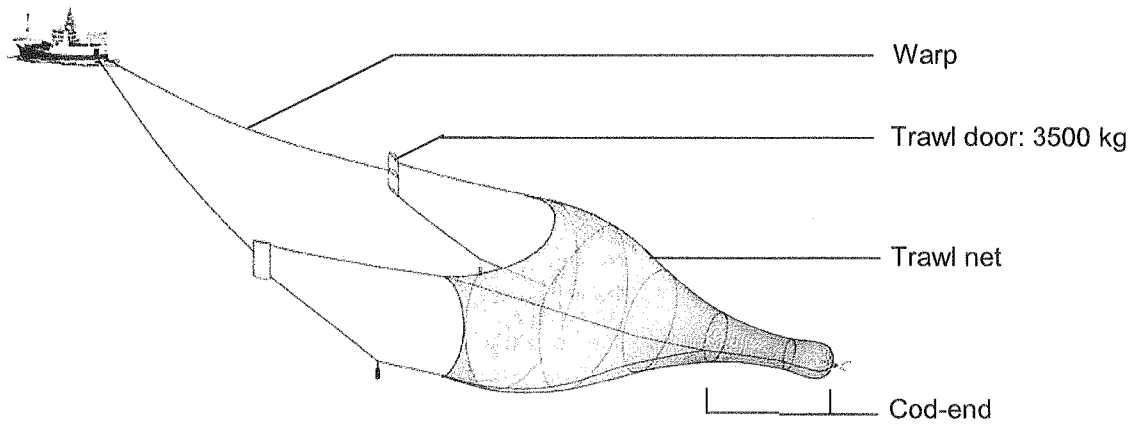
These grounds range in depth from 100 m to 400 m. However, isolated trawls are occasionally made further offshore in deeper water (up to 650 m). There is evidence of midwater trawl activity in the south-eastern area of the proposed F-O Production Right area (see Figure 4.14).

Midwater trawling gear configuration is similar to that of demersal trawlers, except that the net is manoeuvred vertically through the water column. Currently the *Desert Diamond* is the only dedicated midwater trawler. The towed gear may extend up to 1 km astern of the vessel and comprises trawl warps, net and codend (see Figure 4.15). Once the gear is deployed, the net is towed for several hours at a speed of 4.8 to 6.8 knots predominantly parallel with the shelf break. Midwater trawling can occur at any depth between the seabed and the surface of the sea without continuously touching the bottom. However, in practice, midwater trawl gear does occasionally come into contact with the seafloor.



Spatial extent of the midwater trawl fishery in relation to the proposed F-O Gas Field Development (Japp and Wilkinson, 2010).

Figure 4.14



Schematic diagram showing the typical configuration of midwater trawl gear.

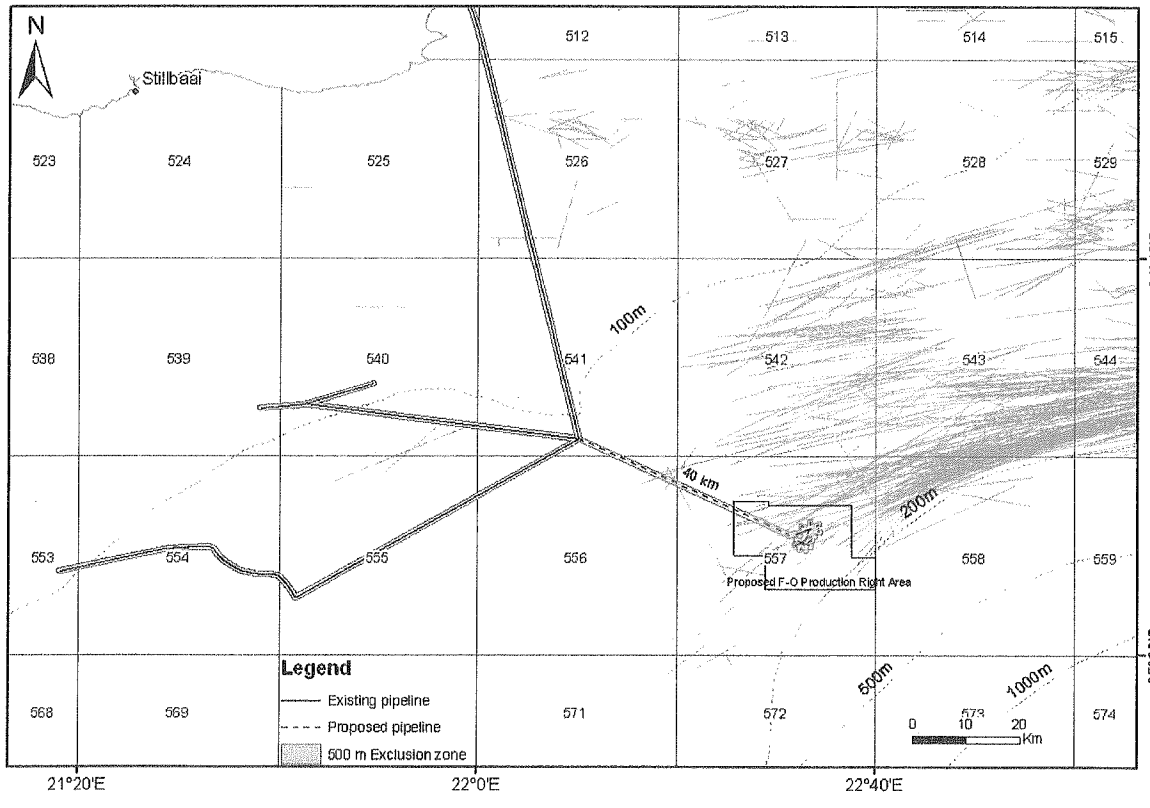
Figure 4.15

4.5.1.3 Demersal Longline

The demersal longline fishery targets hake with a bycatch of kingklip (*Genypterus capensis*). The fishery is active both in inshore and offshore areas. Inshore hake longlining is restricted by the number of hooks that may be set per line while offshore longlining may only take place in water deeper than 110 m and is restricted to the use of no more than 20 000 hooks per line. The TAC of hake for this sector was set at 7 815 tons for 2010.

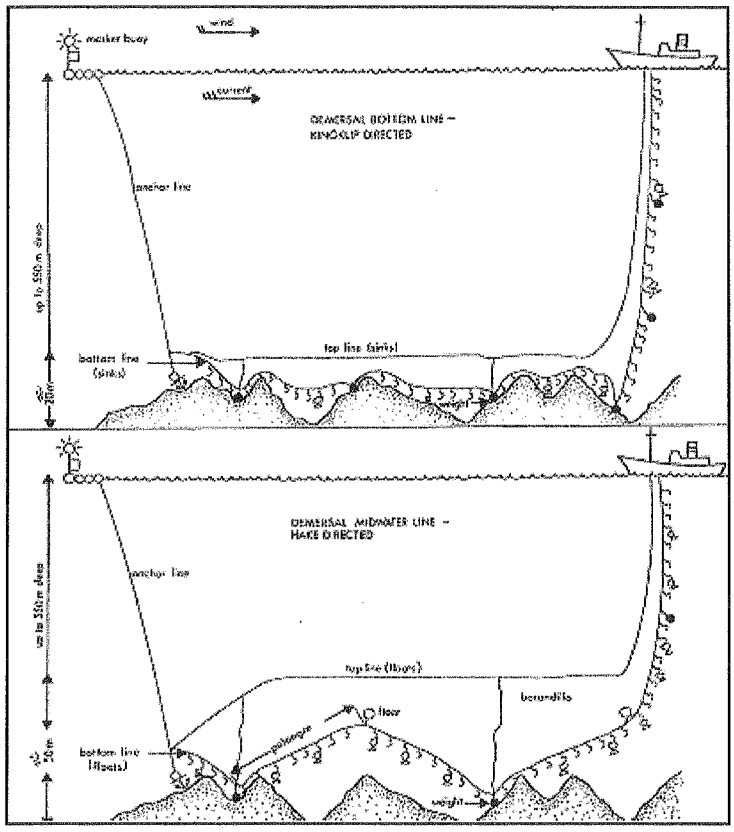
On the South Coast demersal longline activity is centred along (and inshore of) the shelf break between Mossel Bay and Port Elizabeth. Vessels operate at a depth range of 70 m to 400 m with the highest effort occurring between the 200 m and 350 m depth range. The proposed F-O Gas Field development coincides with the western extent of heavily longlined grounds (see Figure 4.16).

A demersal longline vessel typically deploys a double line which is weighted along the seafloor (see Figure 4.17). Concrete blocks are placed at regular intervals to weight the line and each end of the line is attached to a float (with marker buoy). The two lines are set parallel to each other and are connected by means of dropper lines. The purpose of the topline is to aid in gear retrieval if the bottom line breaks at any point along the length of the set line. Lines may be up to 30 km in length and baited hooks are attached to the bottom line at regular intervals by means of snoods.



Spatial extent of the demersal longline fishery in relation to the proposed F-O Gas Field Development (Japp and Wilkinson, 2010).

Figure 4.16

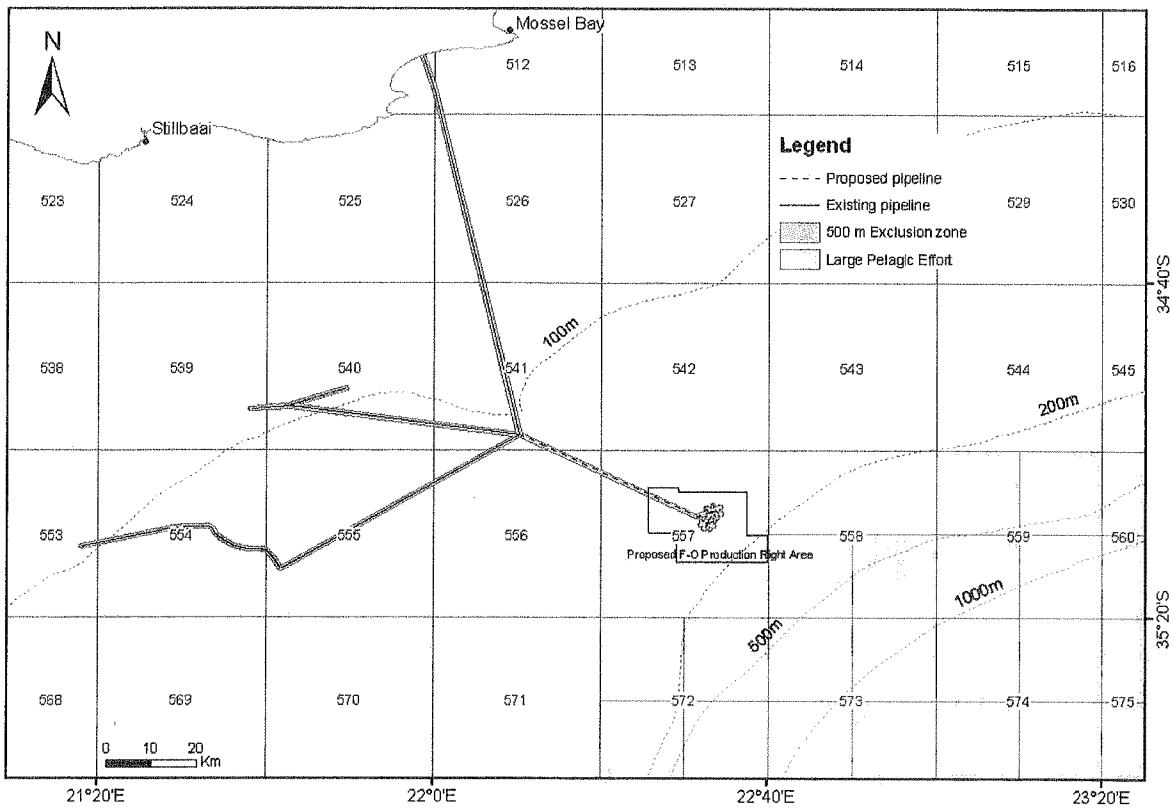


Schematic diagram showing the fishing gear typically used by demersal longliners.	Figure 4.17

4.5.1.4 Pelagic Longline

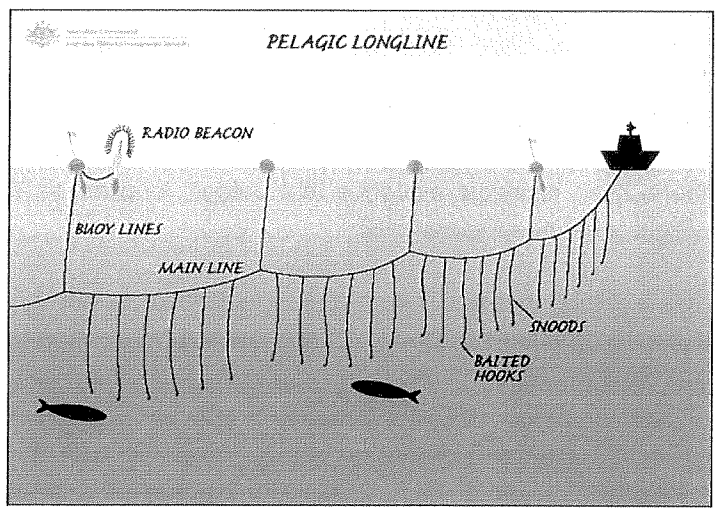
The pelagic longline fishery targets large species namely yellowfin tuna (*T. albacares*), bigeye tuna (*T. obsesus*) and longfin tuna or albacore (*T. alalunga*) and shark. These are highly migratory species, which are caught on the high seas and also seasonally within the South African EEZ well offshore along the edge of the continental shelf. The Total Applied Effort (TAE) for 2007 was set at 50 vessels (30 tuna-directed and 20 swordfish-directed). There is no historical evidence that pelagic longline gear has been set within the proposed F-O Production Right area (see Figure 4.18).

Pelagic long-line vessels set a drifting mainline, which are up to 100 km in length. The mainline is kept near the surface or at a certain depth by means of buoys (connected via "buoy-lines") (see Figure 4.19). Hooks are attached to the mainline on relatively short sections of monofilament line ("snoods") which are clipped to the mainline at intervals of 50 m. A single main line consists of twisted rope (6 to 8 mm diameter) or a thick nylon monofilament (5 to 7.5 mm diameter). Various types of buoys are used in combinations to keep the mainline near the surface and locate it should the line be cut or break for any reason. Each end of the line is marked by a Dahn Buoy and Radar reflector, which marks it's position for later retrieval by the fishing vessel. A line may be left drifting for up to 18 hours before retrieval by means of a powered hauler at a speed of approximately 1 knot. During hauling a vessel's manoeuvrability is severely restricted and, in the event of an emergency, the line may be dropped to be hauled in at a later stage.



Spatial extent of the pelagic longline fishery in relation to the proposed F-O Gas Field Development (Japp and Wilkinson, 2010).

Figure 4.18



Schematic diagram showing the fishing gear typically used by pelagic longliners.

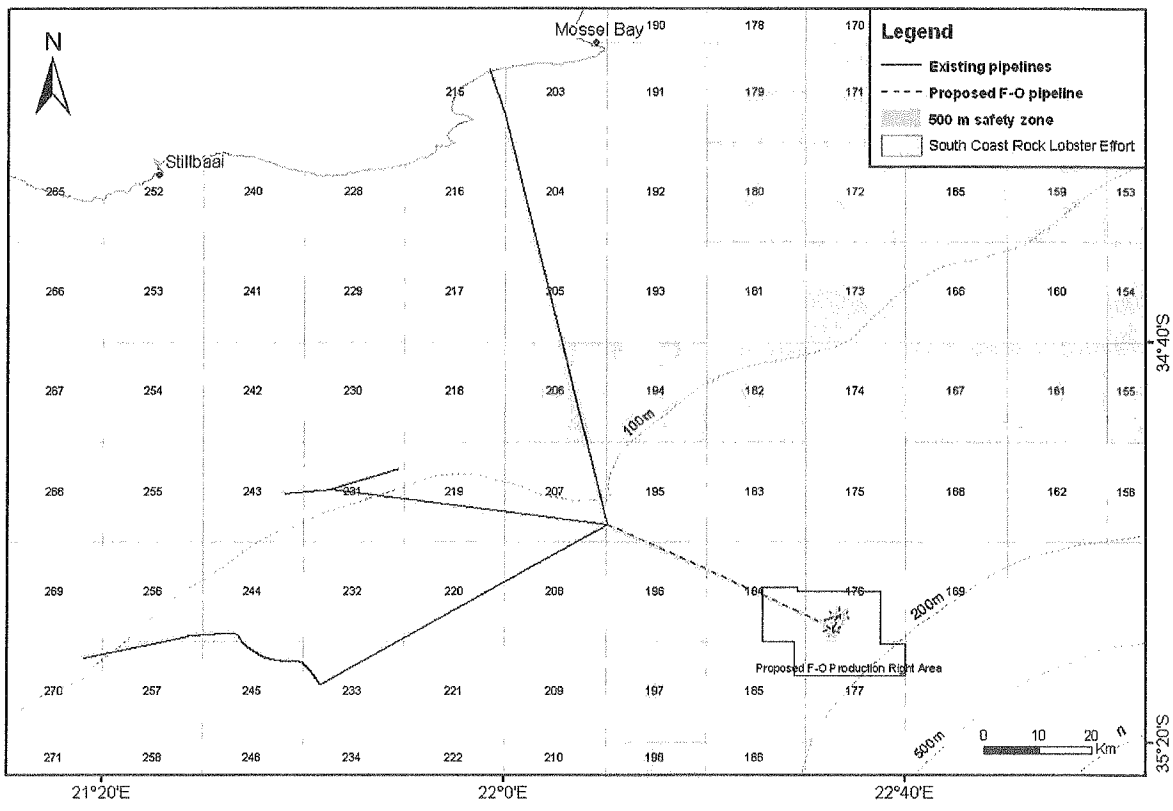
Figure 4.19

4.5.1.5 South Coast Rock Lobster Longline

The South Coast Rock Lobster (*Palinurus gilchristi*) occurs on the continental shelf on rocky substrata between depths of 50 m and 200 m. The Agulhas Bank is known to be a migration route of the species. Two areas are commercially viable to fish, the first is approximately 200 km offshore on the Agulhas Bank and the second is within 50 km of the shoreline between Mossel Bay and East London. The main fished grounds lie to the south-west and north / north-east of the proposed F-O Gas Field Development area and there is no evidence of fishing activity in the vicinity of the development area (see Figure 4.20).

Since 2000 the fishery has been managed by using a combined TAC and TAE strategy which effectively limits the number of days a vessel may remain at sea. The TAC for lobster tails has varied between 340 t and 402 t during this period.

This fishery involves the setting of longlines, which may be up to 2 nm in length, at depths between 80 and 300 m. Barrel-shaped plastic traps are attached to the line, which is left to soak for periods ranging from 24 hours to several days. Each vessel typically hauls and resets approximately 2 000 traps per day in sets of 100 to 200 traps per line. The lines are weighted along the seafloor and are connected at each end to a marker buoy at the sea surface. Vessels are large (30 m to 60 m in length) remain at sea from 7 days (if retaining live catch) up to 40 days (for frozen catch). The fishery operates all year round and vessels operate from Port Elizabeth or Cape Town.



Spatial extent of the South Coast Rock Lobster trap fishery in relation to the proposed F-O Gas Field Development (Japp and Wilkinson, 2010).

Figure 4.20

4.5.2 SHIPPING TRANSPORT

The shipping traffic on the South Coast is high (Table 4.17 and Figure 4.21). This traffic is located relatively close to shore, and includes commercial and fishing vessels. North- and south-bound cargo vessels usually remain over the mid-shelf (100 m isobath), while tankers and bulk carriers usually remain further offshore. The latter do, however, move closer inshore to escape extremely rough conditions that develop within the Agulhas Current.

Laden tankers carrying more than a half percent of their deadweight tonnage should maintain a minimum distance of 20 nautical miles off South Sand Bluff, Mbashe Point, Hood Point and Cape Recife when westbound. Westbound tankers should steer to pass through the westbound or northern lanes of the traffic separation schemes off the F-A Platform and Alphard Banks and maintain a minimum distance of 20 nautical miles off Cape Agulhas, Quion Point, Cape Point, Slangkop Point and Cape Columbine. Laden tankers, when eastbound, should maintain a minimum distance of 25 nautical miles when passing the landmarks mentioned above. Eastbound tankers between Cape Agulhas and Cape Recife should steer to pass through the eastbound or southern lanes of the traffic separation schemes off the Alphard Banks and F-A Platform.

Charted Traffic Separation Schemes, which are International Maritime Organisation (IMO) adapted and other relevant information are listed in the South African Annual Notice to Mariners No 5, of 2010 (see Figure 4.22). The proposed F-O Production Right area is located less than 5 km to the south of the eastbound shipping traffic lane (see Figure 4.23). However, the proposed main production pipeline from the F-A Platform to the northern TIF located on the seabed within the F-O Gas Field would traverse the eastbound shipping traffic lane.

Important South Coast commercial harbours include Port Elizabeth and Mossel Bay, while fishing harbours and slip-ways include Struis Bay, Arniston, Still Bay, Mossel Bay, Plettenberg Bay, St Francis Bay and Port Elizabeth.

Table 4.17: Number of vessels calling at South Coast ports in 1998. From Silvermine Maritime Intelligence.

Vessel type	Ports			
	Cape Town	Mossel Bay	Port Elizabeth	East London
Bulk	421		86	18
Cargo	961	4	262	103
Vehicle carrier	54		26	7
Container carrier	672		376	45
Tanker	217	30	87	70
Total vessels	**2325**	**34**	**837**	**243**

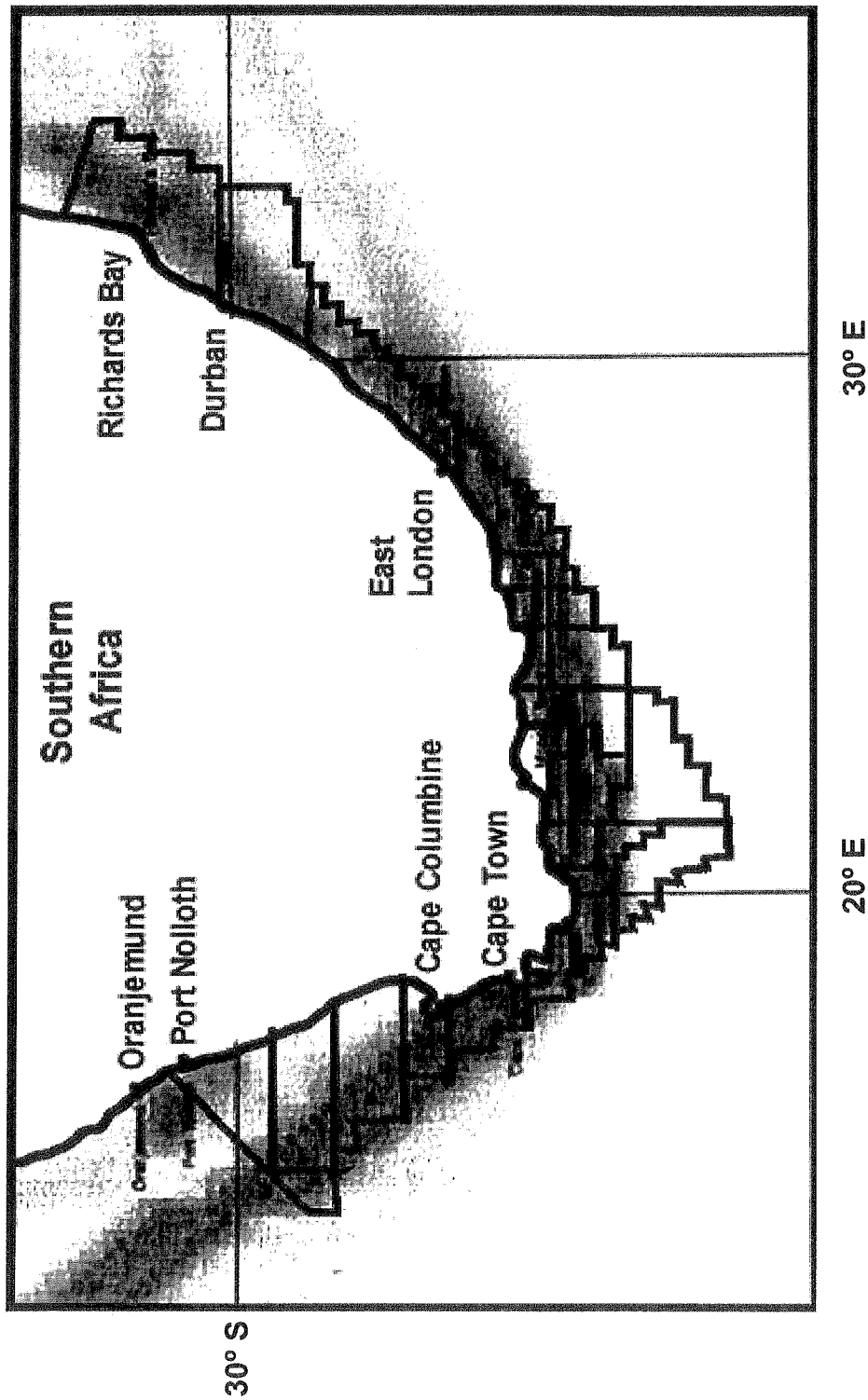


Figure 4.21

The major shipping routes along the South Coast of South Africa showing petroleum license blocks. Data from the South African Centre for Oceanography.

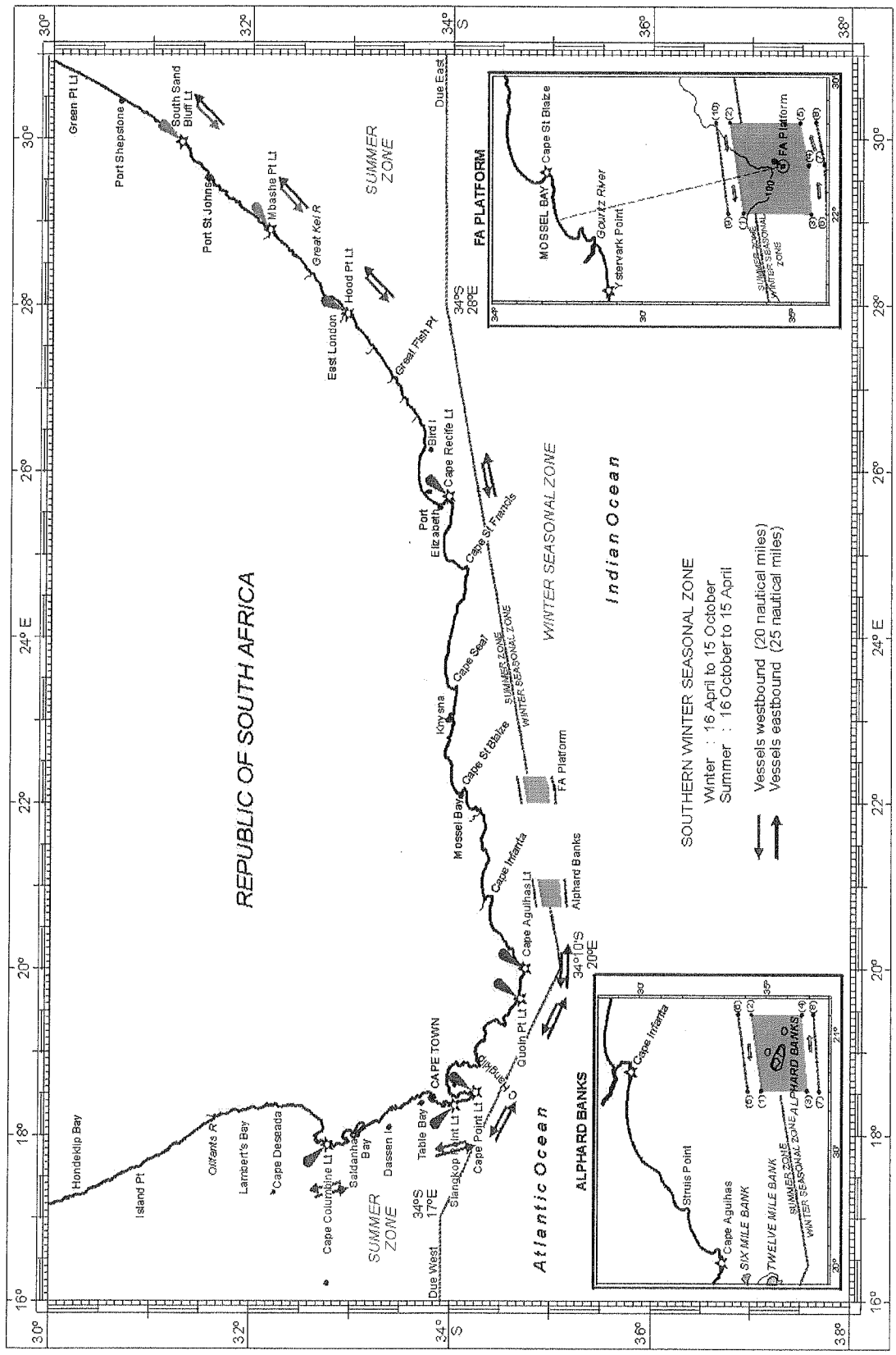
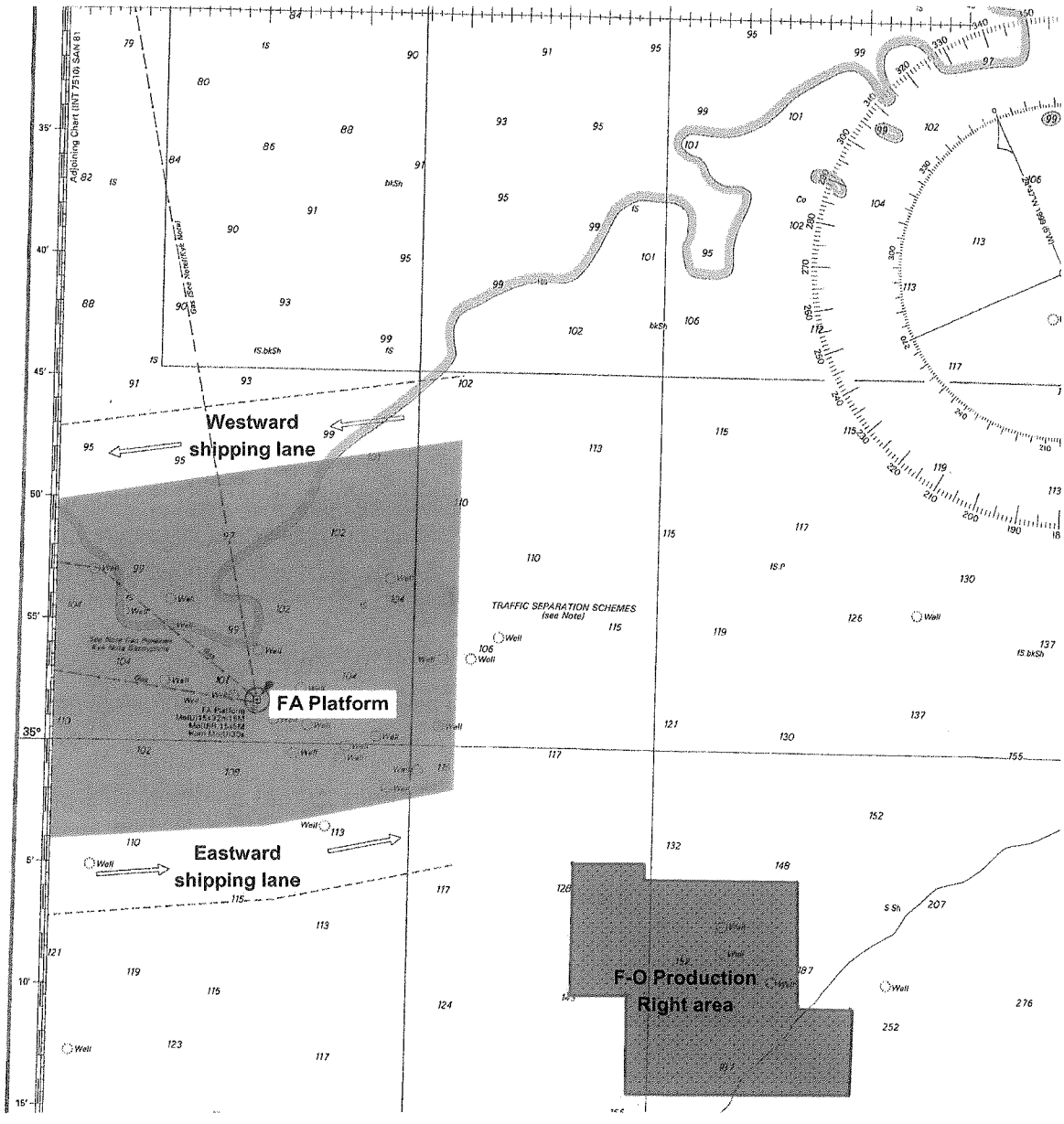


Figure 4.22

Safe shipping routes around the coast of South Africa. From the South African Notices to Mariners No 5 of 2010 with authorisation from the Navy Hydrographic Office.



The proposed F-O production Right area in relation to the shipping lanes off the coast of South Africa. SAN chart 82 has been reproduced with permission of the Hydrographer SA Navy.

Figure 4.23

4.5.3 EXPLORATION AND MINING

4.5.3.1 Oil and Gas exploration and production

Exploration

Oil and gas exploration in the South Coast offshore commenced with seismic surveys in 1967. Up until 1999, approximately 96 000 km of 2D seismic surveying has been carried out. A further 1 493 km^2 of 3D seismic survey was carried out in 2000 by PetroSA in Block 9 and Block 11a.

Over 200 wells have been drilled on the South Coast since 1968. Of these, wellheads of approximately 70 % remain on the seafloor (Figure 4.24). The precise location and wellhead status are also available from the Hydrographic Office of the South African Navy. In Block 9 exploration activities have centred on the F-A, E-M, E-BT, South Coast Gas (SCG) and F-O gas fields, as well as in the central part of the Bredasdorp Basin where exploration has resulted in the discovery of a number of small oil fields. Exploration sub-leases have been allocated on the South Coast to PetroSA (Blocks 9 and 11a), to Pioneer Natural Resources (Blocks 7 & 10-14b) and CNR International (South Africa) (Blocks 11B/12B). CNR International (South Africa) is currently applying for an Exploration Rights within Block 11B/12B to drill up to ten wells.

Existing Production

PetroSA operates the F-A production platform, which was brought into production in 1992. The F-A platform is located 85 kilometres south of Mossel Bay in a water depth of 102 meters. Gas and associated condensate from the F-A, E-M and associated fields and the SCG field, are processed through the platform. The produced gas and condensate are exported through two separate 93 km pipelines to the PetroSA GTL plant in Mossel Bay.

PetroSA is currently producing oil from the Oryx/Oribi oil fields (E-AR and E-BT fields). These fields are tied back to the ORCA floating production platform. The ORCA lies approximately 130 km south-west of Mossel Bay. The gas and oil are separated on the ORCA and the gas is flared (burned off). The stabilised (degassed) oil is exported through a calm buoy to a shuttle tanker.

PetroSA successfully brought the Sable Oil Field into production in 2003. The Sable Field consists of the E-BD and E-CE reservoirs, which lie 17 km to the west of the Oryx/Oribi Oil Field and 85 km south-west of the F-A Platform. Sable is currently not producing.

A 500 m statutory exclusion zone around any floating production storage and offloading unit and sea structures prohibits entry of all unauthorized vessels and aircraft. Larger safety zones around the E-M, F-A, South Coast Gas and Oryx/Oribi developments, established by the SA Navy Hydrographic Office, prohibit any activities that impact on the seafloor, i.e. anchoring, deploying of trawling gear, etc. to take place in these areas.

4.5.3.2 Prospecting and mining of other minerals

Glauconite and phosphorite

Glauconite pellets and bedded and peletal phosphorite occur on the seafloor over large areas of the continental shelf on the South Coast. Table 4.18 gives the co-ordinates for prospecting blocks for glauconite and phosphorite and Figure 4.25 shows the location of these blocks, none of which are positioned within the proposed F-O Production Right area. These concentrations represent potentially commercial sources of agricultural phosphate and potassium (Birch, 1979a, b; Dingle *et al.*, 1987; Rogers and Bremner, 1991). Two separate companies have been granted prospecting permits for glauconite and phosphorite.

Table 4.18: Limits of prospecting blocks for glauconite and phosphorite off the south coast.

Agrimin 3	Latitude (S)	Longitude (E)
A	6km from coast	22° 30' E
B	34° 30 S	22° 30' E
C	34° 30 S	25° 00' E
D	6km from coast	25° 00' E
SOM 3		
A	34° 40' 41" S	22° 04' 08" E
B	34° 37' 27" S	21° 34' 29" E
C	35° 18' 50" S	21° 41' 30" E
D	35° 00' 31" S	22° 01' 47" E
E	34° 52' 15" S	22° 01' 51" E

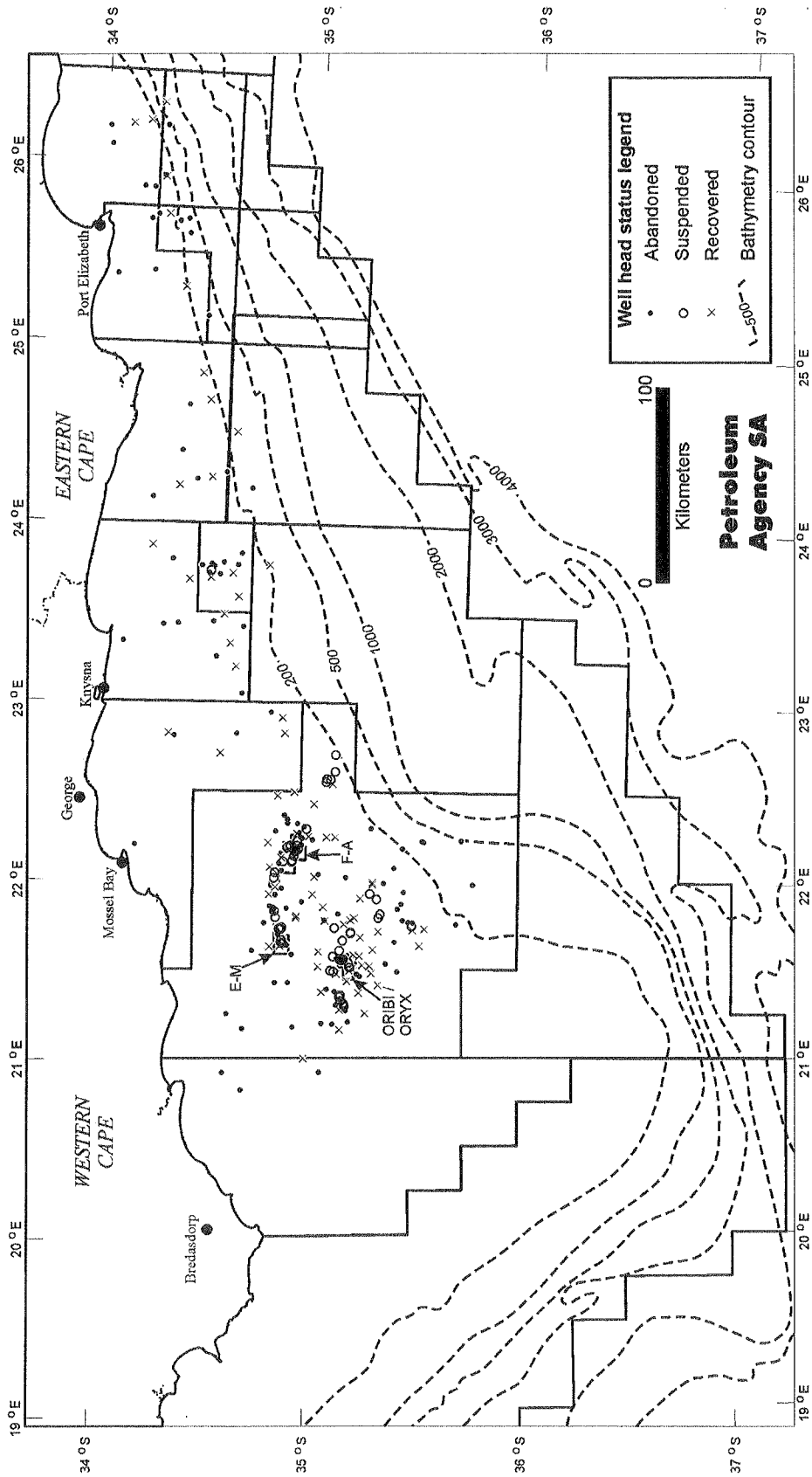


Figure 4.24

Wellhead status for South Coast offshore, excluding the South Coast Gas wells (from Petroleum Agency).

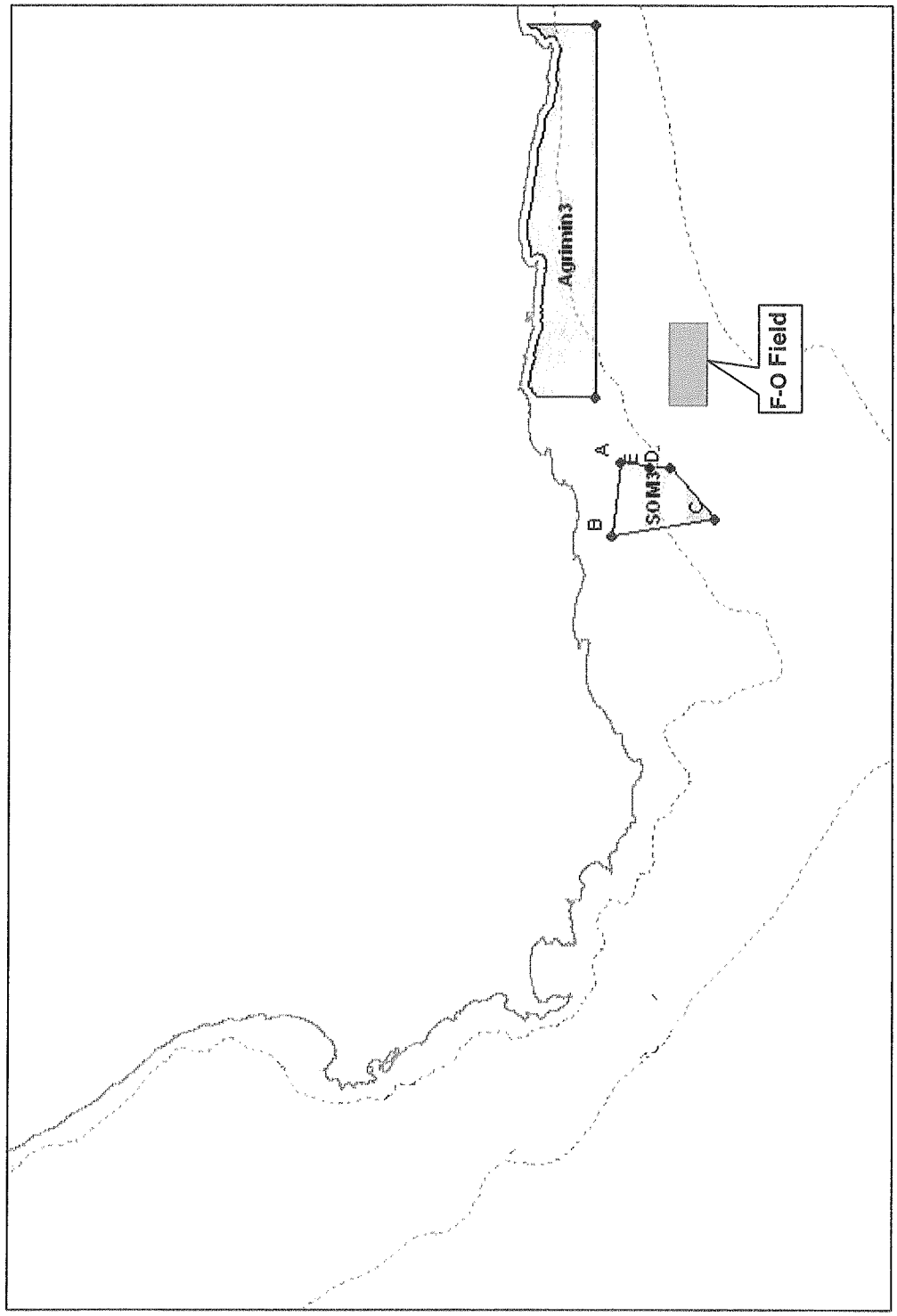


Figure 4.25

Location of glauconite and phosphorite prospecting blocks off the south-eastern coast of South Africa. Approximate locaition of the F-O Production Right area is also indicated.

Manganese nodules in ultra-deep water

Manganese nodules enriched in valuable metals occur in deep water areas (> 3 000 m) on the South Coast (Rogers, 1995; Rogers and Bremner, 1991). However, nickel, copper and cobalt contents of the nodules fall below the current mining economic cut-off grade of 2% over most of the area. No prospecting permits have been applied for to date.

4.5.4 RECREATIONAL UTILISATION

Coastal recreation along the South Coast may involve either consumptive or non-consumptive use of the marine environment. Consumptive utilisation involves recreational shore and boat-based anglers and spear-fishers, skin divers collecting subtidal invertebrates and exploiters of intertidal organisms. Non-consumptive utilisation includes surfing and related practices, wind surfing, boating, SCUBA diving, nature watching and beach recreation.

Since F-O Gas Field is located approximately 110 km offshore the proposed development is unlikely going to impact these activities.

4.5.5 OTHER

4.5.5.1 Anthropogenic marine hazards

Seafloor Hazards

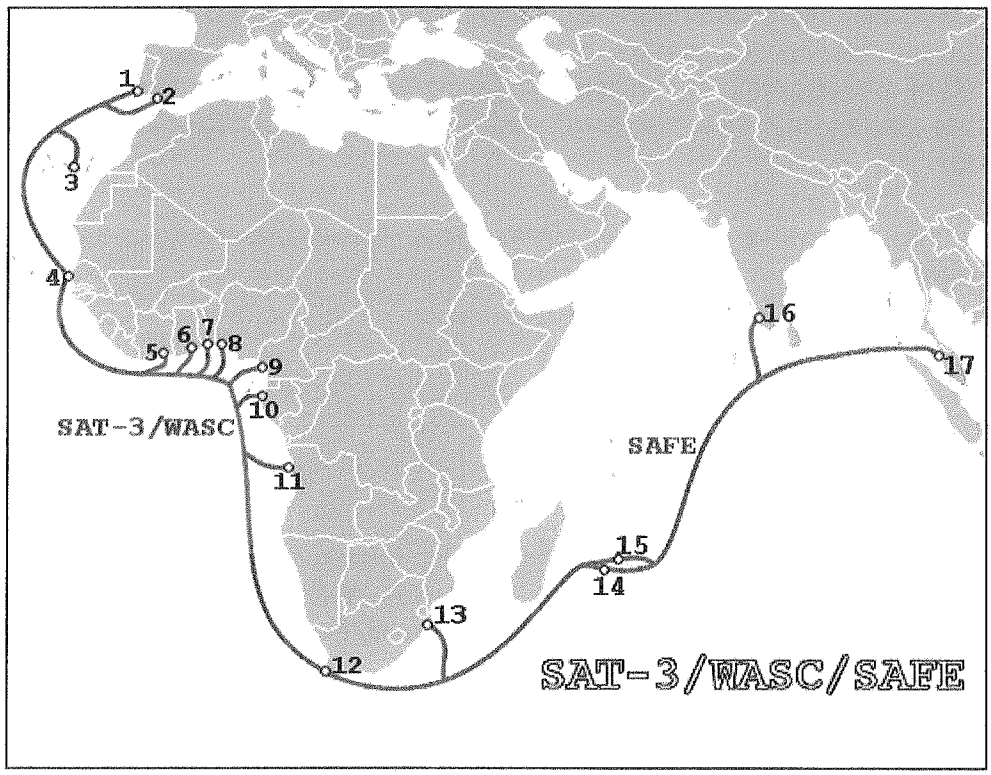
Human use of the marine environment has resulted in the addition of numerous hazards on the sea floor. The Annual Summary of South African Notices to Mariners No. 5 or charts from the South African Navy or Hydrographic Office identifies the location of different underwater hazards along the South Coast.

Undersea cables

A submarine telecommunications cable system is located on the seafloor across the Atlantic and the Indian Ocean. This system is called "SAT3/WASC/SAFE" (South Atlantic Telecommunications Cable no.3 / West African Submarine Cable / South Africa Far East). The cable system is divided into two sub-systems, SAT3/WASC in the Atlantic Ocean and SAFE in the Indian Ocean. The SAT3/WASC sub-system connects Portugal (Sesimbra) with South Africa (Melkbosstrand) and has intermediate landing points at Chipiona Spain, Alta Vista Spain, Dakar Senegal, Abidjan Côte d'Ivoire, Accra Ghana, Cotonou Benin, Lagos Nigeria, Douala Cameroon, Libreville Gabon, Luanda Angola and Melkbosstrand South Africa. From Melkbosstrand SAT-3/WASC sub-system is extended via the SAFE sub-system to Malaysia (Penang) and has intermediate landing points at Mtunzini South Africa, Saint Paul Reunion, Bale Jacot Mauritius and Cochin India (www.safe-sat3.co.za). Between 19°E and 29°E, the SAT3/SAFE cable runs along the 4 000 m isobar which lies south of the Pletmos Inshore Area and just to the south of Block 11B/12B (see Figure 4.26). There is an activity exclusion zone one nautical mile each side of telecommunication cables in which no anchoring is permitted. Precise details of the cable route can be obtained from the SAN Hydrographic office.

4.5.5.2 Archaeological sites

Over 2 000 shipwrecks are present along the South African coastline (Gribble, 1997). The majority of known wrecks along the South Coast are located in relatively shallow water close inshore (Turner, 1988). Wrecks older than 50 years old are national monuments. No wrecks have been identified within the F-O Production Right area.



The "SAT3/WASC/SAFE" submarine telecommunications cable system across the Atlantic and the Indian Ocean (http://en.wikipedia.org).	**Figure 4.26**

4.5.5.3 Marine coastal reserves

Two fully protected marine reserves (De Hoop Marine Reserve and Sardinia Bay Marine Reserve), one partially protected (Tsitsikamma National Park) and numerous marine protected areas, protecting some form of marine life, are located along the South Coast (SFRI, 1998) (see Table 4.19). A further four islands are bird and seal sanctuaries. The proposed F-O development area is located far from these reserves.

Table 4.19: The name, location and regulations enforced within the different marine protected areas located along the South Coast (after SFRI, 1998).

Site	Location	Regulations
Fully protected marine reserves:		
De Hoop Marine Reserve	From beacon DH1 at Still Bay Point to beacon DH2 between Rys Punt and Skipskop for 3 nautical miles seawards from the high-water mark. > 150 km from SCG development area.	General marine reserve
Sardinia Bay Marine Reserve	From beacon PECR1 near Schoenmakerskop to beacon PECR2 near Bushy Park, for 1 nautical mile seawards from the high-water mark. > 300 km from SCG development area.	General marine reserve
Almost fully protected marine reserve:		
Tsitsikamma National Park	From Groot River at Oubos to Groot River at Nature's Valley, for 3 nautical miles seawards from the low-water mark. ± 300 km from SCG development area.	No marine life may be caught or disturbed. Shore angling is permitted.
Marine protected areas:		
Goukamma Marine Reserve	Between the eastern boundary of Portion 1 of Walker's Point farm and the western boundary of the Goukamma Nature Reserve from 1 nautical mile seawards from the high-water mark.	Only shore angling permitted.
Robberg Marine Reserve	For 1 nautical mile offshore from the high-water mark in the Robberg Nature Reserve.	Only shore angling permitted.
Knysna Lagoon	Within certain areas delineated by beacons within the lagoon.	No invertebrates may be caught or disturbed.
Seabird and seal sanctuaries:		
Seal Island	Mossel Bay. ± 85 0 km from SCG development area.	
Bird Island	Just east of Algoa Bay. > 350 km from SCG development area.	
Stag Island	Just east of Algoa Bay. > 350 km from SCG development area.	
Seal Island	Just east of Algoa Bay. > 350 km from SCG development area.	
Black Rocks	Just east of Algoa Bay. > 350 km from SCG development area.	

4.5.5.4 Mariculture industries

Perlemoen, mussel and oyster farming facilities are located near Port Elizabeth (O'Sullivan, 1998). Oysters are also farmed within the Knysna Lagoon, while they are reported to be exploited commercially at numerous other sites along the South Coast (Jackson and Lipschitz, 1984). Irvin & Johnson Limited is proposing to develop a fish farm within a concession area located off the coast of Mossel Bay approximately 2.5 km offshore from the Klein-Brak River.

4.5.5.5 Marine outfall/intake pipes

Eleven outfalls and one intake are located along the South Coast (Jackson and Lipschitz, 1984). The most important pipelines include the sewerage outfall at Port Elizabeth, which discharges 60 000 m^3/day, and the PetroSA refinery outfall at Vlees Bay, which discharges approximately 8 000 m^3/day of saline effluent. Other less important outfalls are located off Cape Recife and Drift Sands in Port Elizabeth, and at Mossel Bay. A 2.5 km long product pipeline is also located off Voorbaai, which is used to import and export hydrocarbon products.

4.5.5.6 Ammunition dump sites

The location of the ammunition dumpsites situated along the South Coast and details of dumped ammunition are given on the relevant SAN charts. There are no ammunition dumpsites within Petroleum Licence Block 9.

4.6 SUMMARY

1. The main features affecting weather patterns are the mid-latitude cyclones, and the South Atlantic high pressure and Indian Ocean high-pressure systems. Easterly winds predominate during summer, westerly winds during winter.
2. The majority of waves (often >6 m in height) are generated in the Southern Ocean and arrive from the south-west, dominating wave patterns during winter and spring. Easterly wind generated 'seas' occur during summer.
3. The Agulhas Bank dominates the bathymetry, extending 250 km offshore.
4. The Agulhas Current is the dominant current, transporting water southwestwards with a volume transport of over 60×10^6 m^3/sec. It may shed eddies that advect onto the Agulhas Bank.
5. Wind-driven upwelling occurs inshore when easterly winds blow during summer. It usually starts at the prominent capes, progressing westwards, and may be intense.
6. Shelf edge upwelling occurs on the eastern shelf edge of the Agulhas Bank, resulting in strong summer thermocline structure, which breaks down in winter due to turbulent mixing.
7. Plankton, fish and marine mammal diversities on the Agulhas bank are high and result from the location of the bank between major warm and cold current systems.
8. Five key fisheries are active in the vicinity of the proposed project and include demersal and midwater trawl, demersal and pelagic longline and south coast rock lobster longline.
9. The Agulhas Bank is an important spawning area for some pelagic species (e.g. anchovy, pilchard, and horse mackerel) and for the Cape hake.
10. Squid form dense spawning aggregations in sheltered bays at the eastern boundary of the South Coast. Juveniles remain in shallow waters, but disperse to greater depth with age.
11. The South Coast is an important recruitment area for many linefish species that spawn along the East Coast.
12. Over 35 cetacean species are found along the South Coast.
13. The extreme inshore region of the South Coast seasonally (July to December) harbours possibly the largest concentrations of breeding Southern Right Whales in the world.
14. Sixty seabird species are likely to occur along the coast, with breeding species usually inhabiting island colonies.
15. The region offshore of Mossel Bay is important for the extraction of gas and oil.
16. The F-A, E-M and South Coast gas fields are exploited through the F-A Platform and supply gas to the onshore PetroSA (formerly Mossgas) refinery.
17. PetroSA produce oil from the Oribi/Oryx Field and Sable Field.

Table 4.20 summarises the coastal sensitivity per petroleum licence block, for the South Coast.

Table 4.20: Coastal sensitivity for each Petroleum Licence block on the South Coast.

REGION	SETTLEMENTS	COASTAL FORMATION	ESTUARIES AND WETLANDS	SENSITIVE AREAS	HUMAN UTILISATION	OIL SPILL CONTINGENCY PLAN
BLOCK 7 (bounded on the inshore border by OP8)	Cape Agulhas, Struisbaai, Arniston, Infanta, Witsand	Exposed rocky headlands, fine grain sandy beaches, wave cut rocky platforms	Heuningnes River, Breede River	De Hoop Marine Reserve and nature reserve Seasonal (June to November) right whale breeding ground	Recreation / tourism	Zone 5 (Uilkraals River to Breede River) Zone 6 (Breede River to Gouritz River)
BLOCK 9 (bounded on the inshore border by OP8)	Stilbaai, Puntjie	Exposed rocky headlands, fine grain sandy beaches, wave cut rocky platforms	Duivenhoks River, Goukou River	Seasonal (June to November) right whale breeding ground	Recreation / tourism	Zone 6 (Breede River to Gouritz River)
BLOCK 10 – 14B (bounded on the inshore border by OP8 in the west)	Vleesbaai, Gouritzmond, Mossel Bay, Hartenbos, Kleinbrakrivier, Tergniet, Grootbrakrivier, Glentana, Herolds Bay, Victoria Bay, Wilderness, Sedgefield, Buffels Bay, Knysna, Plettenberg Bay, Nature's Valley, Oesterbaai, Cape St Francis, Jeffreys Bay, van Stadens River, Greater Port Elizabeth Metropolitan Area	Exposed rocky headlands, fine grain sandy beaches, wave cut rocky platforms, pebble beaches	Gouritz River, Grootbrakrivier, Swartvlei, Goukamma River, Knysna Lagoon, Keurbooms River, Bloukrans River, Storms River, Krom River, Gamtoos River, Van Stadens River, Swartkops River, Sundays River.	Goukamma Marine Reserve, Knysna Lagoon, Robberg Marine Reserve, Tsitsikamma Coastal National Park, Sardinia Bay Marine Reserve, Mossel Bay Seal Island, Bird and St Croix Island groups Seasonal (June to November) right whale breeding ground	Recreation / tourism, pelagic and demersal fishing, squid fishing Harbours : Mossel Bay, Port Elizabeth	Zone 6 (Breede River to Gouritz River) Zone 7 (Gouritz River to Touws River) Zone 8 (Touws River to Bloukrans River) Zone 9 (Bloukrans River to Gamtoos River) Zone 10 (Gamtoos River to Great Fish River)

5. WELL DRILLING: IMPACT DESCRIPTION AND ASSESSMENT

This chapter describes and assesses the significance of potential impacts related to the proposed drilling of 14 wells in F-O Gas Field. All impacts are systematically assessed and presented according to predefined rating scales (see Appendix 3). Mitigation or optimisation measures are proposed which could ameliorate the negative impacts or enhance potential benefits, respectively. The status of all impacts should be considered to be negative unless otherwise indicated. The significance of impacts with and without mitigation is also assessed.

Specialists were appointed to address the three key issues, namely the effect on the fishing industry (see Appendix 4), the effect on marine benthic fauna (see Appendix 5) and risk assessment of the proposed onshore drilling and completion fluids plant (see Appendix 6). In addition, this EIA used as a basis the issues identified in the Generic EMP (Crowther Campbell & Associates and Centre for Marine Studies 1999) and similar studies. The project team have assessed the relevance of these issues to this project.

Sections 5.1 to 5.4 assess impacts related to the proposed project assuming a normal drilling operations scenario, where it is assumed that operations proceed smoothly and without any major incidents (i.e. no major gas or oil leaks). Potential risks associated with the proposed onshore drilling and completion fluids plant located in the Mossel Bay Harbour are assessed in Section 5.5. The potential impacts of an accidental gas release or oil spill (upset conditions) are assessed in Section 5.6.

5.1 IMPACT OF NORMAL DRILLING UNIT, SUPPORT VESSELS AND HELICOPTER OPERATION

5.1.1 EMISSIONS TO THE ATMOSPHERE

Description of impact

Domestic and industrial discharges to the atmosphere during drilling may include exhaust gases from the use of diesel as fuel for generators and motors, flaring and the burning of wastes. Diesel exhaust comprises mainly carbon dioxide (CO_2) as well as several toxic gases such as nitrogen oxides (NO_X), sulphur oxides (SO_X) and carbon monoxide (CO). In addition, diesel combustion can produce hydrocarbons (THC and VOC). Smoke and particulate matter (soot) are also produced during diesel combustion. Incineration of waste onboard would also release soot as well as CO, CO_2 and dioxins (depending on the composition of waste).

Assessment

The atmospheric emissions from drilling activities, as well as the operation of all support vessels, are expected to be similar to those from similar diesel-powered vessel of comparable tonnage. The volumes of solid waste incinerated on board, and hence also the volumes of atmospheric emissions, would be minimal and incineration must comply with the relevant MARPOL 73/78[4] standards.

The potential impact of emissions due to drilling activities would be limited to the drilling area, of low intensity over the short-term and is considered to be of **VERY LOW** significance with or without the implementation of mitigation measures (see Table 5.1).

[4] MARPOL 73/78 is an International Convention for the Prevention of Pollution from Ships 1973, as modified by the Protocol of 1978 relating thereto. All vessels operating within the South African Exclusive Economic Zone are required to conform to legal requirements for waste management and pollution control, including the Marine Pollution Act (No 2 of 1986 - which incorporate MARPOL 73/78 standards) and the Dumping at Sea Control Act (No 73 0f 1965). These Acts make provision for the discharge of sewage, plastics, oil, galley wastes, hazardous liquids and packaged hazardous material.

Mitigation

It is recommended that all diesel motors and generators receive adequate maintenance to minimise soot and un-burnt diesel released to the atmosphere.

Table 5.1: Impact of atmospheric emissions from drilling unit and support vessels.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Without mitigation	Local	Short-term	Low	Definite	**Very Low**	High
With mitigation	Local	Short-term	Low	Definite	**VERY LOW**	High
Degree to which impact can be reversed					Fully reversible	
Degree to which impact may cause irreplaceable loss of resources					N/A	
Degree to which impact can be mitigated					Very Low	

5.1.2 DISCHARGES/DISPOSAL TO THE SEA

Discharges to the marine environment of deck drainage, machinery space drainage, sewage, galley wastes and solid wastes from drilling unit and support vessels.

5.1.2.1 Deck Drainage

Description of impact

Drainage of deck areas may result in small volumes of oils, solvents or cleaners being introduced into the marine environment.

Assessment

Oils, solvents and cleaners could be introduced into the marine environment in small volumes through spillage and drainage of deck areas. The potential impact of deck drainage on the marine environment would, therefore, be of low intensity across the drilling site over the short-term, and is considered to be of **VERY LOW** significance with or without mitigation (see Table 5.2).

Table 5.2: Impact of deck drainage from drilling unit and support vessels.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Without mitigation	Local	Short-term	Low	Highly Probable	**Very Low**	High
With mitigation	Local	Short-term	Low	Highly Probable	**VERY LOW**	High
Degree to which impact can be reversed					Fully reversible	
Degree to which impact may cause irreplaceable loss of resources					N/A	
Degree to which impact can be mitigated					Very Low	

Mitigation

The following measures are recommended for mitigation of deck drainage discharges from vessels:

- Deck drainage should be collected in oily water catchment systems. Discharged water must meet MARPOL standards;
- Training and awareness of crew in spill management could minimise contamination;

- Low-toxicity biodegradable detergents should be used in cleaning of all deck spillage; and
- All hydraulic systems should be adequately maintained and hydraulic hoses should be frequently inspected.

5.1.2.2 Machinery space drainage

Description of impact

Small volumes of oil such as diesel fuel, lubricants, grease, etc. used within the machinery space of the vessels could enter the marine environment.

Assessment

All operations would comply fully with international agreed standards regulated under MARPOL 73/78. All machinery space drainage would pass through an oil/water filter to reduce the oil in water concentration to 15 mg/l, in accordance with MARPOL 73/78 requirements.

Concentrations of oil reaching the marine environment through drainage of machinery spaces are therefore expected to be low. The potential impact of such low concentrations would be of low intensity and limited to the drilling area over the short-term. The potential impact of machinery space drainage on the marine environment is therefore considered to be of **VERY LOW** significance (see Table 5.3).

Mitigation

No mitigation measures are deemed necessary (assuming compliance with the MARPOL 73/78 standards).

Table 5.3: Impact of machinery space drainage from drilling unit and support vessels.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Without mitigation	Local	Short-term	Low	Highly Probable	**Very Low**	High
With mitigation	Local	Short-term	Low	Highly Probable	**VERY LOW**	High
Degree to which impact can be reversed					Fully reversible	
Degree to which impact may cause irreplaceable loss of resources					N/A	
Degree to which impact can be mitigated					Very Low	

5.1.2.3 Sewage

Description of impact

Sewage poses an organic and bacterial loading on the natural degradation processes of the sea, resulting in an increased biological oxygen demand.

Assessment

The volumes of sewage wastes released from a drilling unit amount to about 2 448 m^3 for a 100-day drilling operation (see Section 3.4.11.2). The volumes of sewage wastes released from the support vessels would be small and comparable to volumes produced by vessels of similar crew compliment. All sewage would be treated to the required MARPOL 73/78 standard prior to release into the marine environment, where the high wind and wave energy is expected to result in rapid dispersal.

The potential impact of sewage effluent from a drilling unit and support vessels on the marine environment is expected to be limited to the drilling area over the short-term, and is therefore considered to be of **VERY LOW** significance (see Table 5.4).

Mitigation
No mitigation measures are recommended (assuming sewage discharges are in compliance with the MARPOL 73/78 standards).

Table 5.4: Impact of sewage effluent discharge from drilling unit and support vessels.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Without mitigation	Local	Short-term	Low	Highly Probable	**Very Low**	High
With mitigation	Local	Short-term	Low	Highly Probable	**VERY LOW**	High
Degree to which impact can be reversed					Fully reversible	
Degree to which impact may cause irreplaceable loss of resources					N/A	
Degree to which impact can be mitigated					Very Low	

5.1.2.4 Galley waste

Description of impact
Galley wastes, comprising mostly of biodegradable food waste, would place a small organic and bacterial loading on the marine environment.

Assessment
The volume of galley waste from the drilling unit would be small and comparable to wastes form any vessel of a similar crew compliment. Discharges of galley wastes, according to MARPOL 73/78 standards, would be comminuted to particle sizes smaller than 25 mm prior to disposal to the marine environment if less than 12 nautical miles (± 22 km) from the coast and no disposal within 3 nautical miles (± 5.5 km) of the coast. The potential impact of galley waste disposal on the marine environment would be of low intensity and limited to the drilling area over the short-term. The potential impact of galley waste on the marine environment is therefore considered to be of **VERY LOW** significance (see Table 5.5).

Mitigation
No mitigation measures are deemed necessary (assuming discharge is in compliance with the MARPOL 73/78 standards).

Table 5.5: Impact of galley waste disposal from drilling unit and support vessels.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Without mitigation	Local	Short-term	Low	Highly Probable	**Very Low**	High
With mitigation	Local	Short-term	Low	Highly Probable	**VERY LOW**	High
Degree to which impact can be reversed					Fully reversible	
Degree to which impact may cause irreplaceable loss of resources					N/A	
Degree to which impact can be mitigated					Very Low	

5.1.2.5 Solid waste

Description of impact

The disposal of solid waste comprising non-biodegradable domestic waste, packaging and operational industrial waste into the sea could pose a hazard to marine fauna, may contain contaminant chemicals and could end up as visual pollution at sea, on the seashore or on the seabed.

Assessment

Solid waste would be incinerated or transported onshore for disposal, and consequently would have no impact on the marine environment. However, a spill may result in a small amount of waste entering the marine environment (e.g. blown by wind, spill during transfer to workboat, etc.). Specialist waste disposal contractors would dispose of hazardous waste. The potential impact of the disposal of solid waste on the marine environment is therefore **INSIGNIFICANT** (see Table 5.6).

Mitigation

The following measures are recommended for mitigation of solid waste:

- Secure on board storage and safe transfer of solid waste;
- Initiate a waste minimisation system on board; and
- Ensure that contractors co-operate with the relevant local authority to ensure that solid and hazardous waste disposal is carried out in accordance with the appropriate laws and ordinances.

Table 5.6: Impact of solid waste disposal from drilling unit and support vessels.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Without mitigation	Local	Short-term	Zero	Improbable	**Insignificant**	Medium
With mitigation	Local	Short-term	Zero	Improbable	**INSIGNIFICANT**	Medium
Degree to which impact can be reversed					N/A	
Degree to which impact may cause irreplaceable loss of resources					N/A	
Degree to which impact can be mitigated					Very Low	

5.1.3 NOISE FROM DRILLING UNIT, SUPPORT VESSELS AND HELICOPTER OPERATIONS

5.1.3.1 Noise from drilling unit and support vessel operations

Impact description

The noise from a drilling unit and support vessels could result in localised disturbance of marine fauna.

Impact assessment

Noise from a drilling unit and support vessels is likely to be no higher than those from other shipping vessels in the region and is deemed a neutral impact. The potential impact of noise from a drilling unit and support vessel operations on marine fauna is considered to be localised, of low intensity in the short-term. The significance of this impact is therefore assessed to be **VERY LOW** (Table 5.7).

Mitigation measures

No measures are deemed necessary to mitigate noise impacts from support vessel operations.

Table 5.7: Impact of noise from drilling unit and support vessel operations.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Without mitigation	Local	Short-term	Low	Probable	**Very Low**	Medium
With mitigation	Local	Short- term	Low	Probable	**VERY LOW**	Medium
Degree to which impact can be reversed					Fully reversible	
Degree to which impact may cause irreplaceable loss of resources					N/A	
Degree to which impact can be mitigated					None	

5.1.3.2 Noise from helicopter operations

Impact description

Helicopters would be utilised for crew / supply transfers between the drilling unit and the mainland, which could result in localised disturbance of fauna (seal and seabird colonies).

Impact assessment

Low altitude flight paths over bird breeding colonies could result in temporary abandonment of nests and exposure of eggs and chicks leading to increased predation risk. Low altitude flight paths over seal colonies can cause stampedes of animals to sea resulting in trampling of pups and nesting seabirds within seal colonies. Disturbance of cetaceans by helicopter would depend on the distance and altitude of the aircraft from the animals (particularly the angle of incidence of helicopter noise to the water surface) and the prevailing sea conditions.

It is an offence in terms of the Seabirds and Seals Protection Act of 1973 to wilfully disturb seals on the coast or on offshore islands. In terms of the Marine Living Resources Act (No 18 of 1998) it is illegal for any vessel, including aircraft, to approach to within 300 m of whales within South African waters. However, indiscriminate or direct flying over seabird or seal colonies (or flying low level parallel to the coast) could have a significant disturbance impact on breeding success or mortalities of juveniles. Although such impacts would be local in the area of the colony, they may have wider ramifications over the range of affected species and are deemed to range from low to high intensity. The significance of impact is considered to range from **low to medium** (see Table 5.8).

Mitigation measures

- Flight paths must be pre-planned to ensure that no flying occurs over seal and seabird colonies, coastal reserves, marine islands or estuarine systems;
- Extensive coastal flights (parallel to the coast within 1 nautical mile of the shore) should also be avoided. There is a restriction of coastal flights (parallel to the coast within 1 nautical mile of the shore) on the south coast between the months of June and November to avoid Southern Right whale breeding areas;
- The operator must comply with the Seabirds and Seals Protection Act, 1973, which prohibits the wilful disturbance of seals on the coast or on offshore islands;
- Aircraft may not approach to within 300 m of whales in terms of the Marine Living Resources Act, 1998; and
- The contractor should comply fully with all aviation and authority guidelines and rules.

If the suggested mitigation measures are implemented, this impact is expected to be **VERY LOW** (see Table 5.8).

Table 5.8: Impact of noise from helicopter operations.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Without mitigation	Local	Short-term	Low to High	Probable	**Low to Medium**	Medium
With mitigation	Local	Short-term	Low	Improbable	**VERY LOW**	Medium
Degree to which impact can be reversed					Fully reversible	
Degree to which impact may cause irreplaceable loss of resources					N/A	
Degree to which impact can be mitigated					Low to Medium	

5.2 IMPACT OF WELL DRILLING ON MARINE FAUNA

5.2.1 PHYSICAL DAMAGE AND SEDIMENT DISTURBANCE

Description of impact

Physical damage to the seabed and sediment disturbance could result from a number of activities, including:

- Anchoring of drilling unit and support vessels (e.g. impact depressions, scars, mounds and displacement from anchor deployment, tensioning, dragging or retrieval of anchors);
- Drilling activities (e.g. very localised excavation and smothering); and
- Placement of wellheads and guide bases on seafloor.

Physical damage and disturbance has the potential to affect relatively immobile or sedentary benthic species directly and indirectly (e.g. loss of benthic prey items for bottom feeding species).

Assessment

A maximum of 14 wells would be drilled to a depth of between 3 750 m and 5 850 m below the seafloor over the duration of the project. It is anticipated that it would take in the order of 100 to 240 days to drill a well depending on the type of well (see Table 3.5).

Key factors influencing the intensity of the impact include:

- Substrate type: The sediment type within the F-O Gas Field is largely sandy unconsolidated sediments with several isolated rocky outcrops. The unconsolidated sediments appear to support rich infaunal communities. The combination of habitat types (soft sediments and rocky formations) results in a highly diverse benthic environment in the study area;
- Conservation value / status: The limited information available does not indicate specific areas of high conservation value or the occurrence of red listed species;
- Degree of mobility of the organisms: Sedentary or relatively immobile species may be physically damaged during the physical disturbance or resulting smothering. The hard ground rocky outcrops support a diverse range of biota characteristic of reef structures (e.g. gorgonians, bryozoans and sponges);
- Life-history: Several of the species occurring in the area are known to be long-lived and slow growing, rendering them vulnerable to disturbance; and
- Vessel type: PetroSA has indicated that well drilling would involve the use of an anchored semi-submersible drilling unit. PetroSA has indicated that it is not technically feasible to use a dynamically positioned vessel due to the shallow water depth and associated drilling angle. In terms of the impact on the benthic environment, the use of an anchored vessel would have an impact on the benthic environment at the point at which the anchors are deployed. The use of anchors (eight) is unlikely to significantly increase the area of affected environment.

The cumulative physical area affected by 14 wells is estimated to be up to 3.5 km^2 (assuming an average maximum impact area of 500 m x 500 m per well inclusive of discharges). This represents a very small percentage (0.012 %) of the Agulhas Bioregion (28 889 km^2).

Impacts on the offshore benthos as a result of physical damage and sediment disturbance are considered to be of medium intensity at a local scale (i.e. drilling locations and their immediate surroundings). Recovery rates, which are species dependant, are expected to be between 2 to 10 years (i.e. medium-term). Therefore, this impact is assessed to be of **LOW** significance with and without mitigation (see Table 5.9).

Mitigation

Drill sites and anchoring should, where possible, avoid any known sensitive habitats, such as rocky outcrops and any other structural habitat feature, determined during the seabed survey.

Table 5.9: Assessment of impact of physical disturbance on offshore benthic communities.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Without mitigation	Local	Medium-term	Medium	Highly probable	**Low**	High
With mitigation	Local	Medium-term	Medium	Highly probable	**LOW**	High
Degree to which impact can be reversed					Fully reversible	
Degree to which impact may cause irreplaceable loss of resources					N/A	
Degree to which impact can be mitigated					Very Low	

5.2.2 IMPACTS RELATED TO THE DISCHARGE OF CUTTINGS AND DRILLING FLUID

5.2.2.1 Smothering by cuttings and drilling fluid and plume turbidity

Description of impact

The primary impact of discharged cuttings and drilling fluid (or mud) is smothering of relatively immobile or sedentary benthic species. The smothering effect of cuttings and drilling fluid released during drilling can either occur as direct or indirect (from winnowing of disturbed material) smothering.

Smothering and sediment plumes have the potential to affect relatively immobile or sedentary benthic species directly (e.g. mortality, clogging of feeding mechanisms and gills, temporarily altering the nature of the seabed sediments and reduction of light for photosynthesis) and indirectly (e.g. loss of benthic prey items for bottom feeding species, disturbance of migration routes and impact on those species that spawn on the seabed or have a benthic juvenile development stage).

In addition, a decrease in phytoplankton productivity could be expected within the surface plume, although this may be balanced to a certain extent by increased productivity resulting from nutrient availability (through re-suspension of nutrients and limited decomposition of re-suspended organic matter). The release of particulate organic matter into the water column can result in local organic enrichment and consequent oxygen depletion through decomposition. While zooplankton would be exposed for the duration of their passage through the plume, more mobile nekton species are expected to avoid the plume.

Assessment

The factors determining the fate of drilling derived cuttings include particulate size distribution, initial plume dynamics, passive current transport, water depths, chemical weathering, bioturbation, burial and biological uptake.

Initial drilling of the 36" hole and 26" hole would result in the direct discharge of approximately 300 m^3 of drilling cuttings. It is expected that these deposits would be approximately 1.6 m thick immediately adjacent to the well bore and quickly reduce to a thickness of less than 0.1 m within 30 m radius from the wellbore. The total area of deposition is expected to be 0.1 ha. Once the marine riser is connected, the drilling fluid and cuttings are circulated up to the drilling unit where the mud is cleaned and the cuttings discharged into the sea. Surface released cuttings would be dispersed by the current and settle to the bottom. The total amount of surface released cuttings would approximately 550 m^3 for each well. Finer mud particles washing out during the sinking process form a sediment plume. A typical sediment plume can extend 30 to 40 m vertically, 40 to 60 m wide and range between 100 and 4 000 m from the discharge point. Currents flowing along the Agulhas Bank would disperse the cuttings over a wider area, as well as dilute the plume rapidly. The deposition of cuttings and the sediment plumes would have a smothering effect on benthic organisms, estimated to be approximately 500 to 800 m from the discharge point depending on the current strength and particle size (CCA & CMS 2001; Morant, 1999). These sediments are expected to form a thin layer between 130 mm and 1 mm thickness.

Cement and cement additives are not typically discharged to sea during drilling operations, however, some excess volumes of cement are likely to flow out of the well bore, and are usually dispersed by the currents before they are able to set. The volume of discharged cement does not usually exceed 10 m^3 (CCA & CMS, 2001).

At the end of the drilling operation, the WBF not left in the well (approximately 300 m^3) would be discharged into the sea. Where NADF is used, the drill cuttings would be treated to reduce their oil content to less than 5% by weight before discharge into the sea. NADF remaining at the end of the well drilling programme would be shipped to onshore facilities for re-use by PetroSA on future projects, sold for re-use or disposed of through an approved waste disposal company.

There is potential for impacts of medium intensity on longer-lived, slow growing benthic species. However, the affected benthic communities are expected to recover rapidly and full recovery would take place within two to ten years. This impact is considered to be localised, in the medium-term and of medium intensity. The significance of this impact is assessed to be **LOW** with and without mitigation (see Table 5.10).

Mitigation

It is recommended that, where feasible, WBF should be used for drilling operations rather than NADF.

Table 5.10: Impact on benthic communities as a result of smothering and plume turbidity.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Without mitigation	Local	Medium-term	Medium	Highly Probable	**Low**	High
With mitigation	Local	Medium-term	Medium	Highly Probable	**LOW**	High
Degree to which impact can be reversed					Fully reversible	
Degree to which impact may cause irreplaceable loss of resources					N/A	
Degree to which impact can be mitigated					Very Low	

5.2.2.2 Biochemical effects of discharged drilling fluid and contaminated cuttings

Description of impact

Potential effects of discharged drilling fluid and contaminated cuttings include direct toxicity, organic enrichment, contaminant bioaccumulation and dissolution of particulates and precipitates. The effects may be of significance in terms of:

- Chronic accumulation of persistent contaminants in the marine environment;
- Acute or chronic effects on biota, including effects on productivity, within the human food-chain (i.e. indirect effects on human health and commercial interests); and
- Acute or chronic effects on other biota (i.e. indirect effects on biodiversity).

All these potential effects combined are considered as 'biochemical effects' on benthic communities.

Assessment

Cuttings are separated from the drilling fluid and discharged overboard. The drilling fluid is generally re-used, however, approximately 10% of drilling fluid remains adhered to the cuttings and are disposed of along with the cuttings. The estimated total amount of drilling fluid discharged with cuttings during the drilling of a standard well (3 500 to 4 000 m below the seabed) is approximately 107 m^3 (Morant 1999).

Biochemical effects caused by discharged drilling fluid and cuttings depend on the kind of drilling fluid used, the toxicity of the fluid additives and the dilution following discharge. PetroSA has indicated that they propose to use both a WBF and a Group III NADF as part of the proposed drilling procedure (see Section 3.4.4.3). The biochemical effects of WBF are often subtle and undetectable as they consist predominantly of polymeric organic substances and inorganic salts with low toxicity and bioaccumulation potential. NADF are largely compiled of an invert emulsion of a refined mineral oil with saturated brine water and chemical additives (CCA & CMS 2001) making the solutions mildly toxic to marine organisms.

In addition to the discharge of drilling fluid and cuttings, hydraulic fluid would also be vented onto the seafloor during routine opening and closing of subsea BOP units. It has been estimated that approximately 12 240 litres of oil-based hydraulic fluid can be released during the drilling of one well (Morant 1999, CCA & CMS 2001). Concentrated BOP hydraulic fluid is considered to be mildly toxic to marine organisms, however, during drilling operations they are usually diluted 1:50-100 with freshwater. BOP fluids are reported to be biodegradable in seawater within 28 days (Morant 1999, CCA & CMS 1999).

The biochemical effects caused by the discharge of WBF and cuttings is considered to result in a medium intensity impact due to the limited number of wells proposed (up to 14) and the tremendous dilution capacity of the water column. A recent study undertaken in Block 9 (Sink *et al.*, 2010) found a change in the benthic faunal assemblages within 250 m of a wellhead where a WBF had been used. Therefore, the extent of the impact would be localised. It is estimated that recovery would commence directly after the drilling operation and full recovery could be expected within 5 years (medium-term). The overall biochemical impact from the use of a WBF would, therefore, be of **LOW** significance with and without mitigation (see Table 5.11).

When a Group III NADF is used, the drill cuttings would be treated to reduce their oil content (< 5% by weight) before discharge into the sea. Therefore, only small volumes of NADF would enter the marine environment. NADF remaining at the end of the well drilling programme would be shipped to the proposed onshore facilities at the Mossel Bay Harbour for re-use by PetroSA on future projects, sold for re-use or disposed of through an approved waste disposal company. The overall biochemical impact from the use of a NADF is also considered to be of **LOW** significance with and without mitigation (see Table 5.11).

Mitigation

It is recommended that WBF should wherever possible be used for drilling operations rather than NADF. Where it is necessary to use a NADF, the following mitigation measures should be implemented:

- NADF should not be used in the upper part of a well (with the exception in cases of geological or safety reasons) as specified by the OSPAR Convention;
- Only a Group III NADF with a PAH content of less than 0.001% and a total aromatic content of less than 0.5% should be used; and
- NADF cuttings should be treated to reduce the oil content (< 5% by weight) before discharge. No bulk discharge of untreated NADF cuttings should be allowed.

Table 5.11: The assessment of biochemical effects on benthic communities using WBF and NADF.

	Extent	Duration	Intensity	Probability	Significance	Confidence
WBF cuttings						
Without mitigation	Local	Medium-term	Medium	Highly Probable	**Low**	High
With mitigation	Local	Medium-term	Medium	Highly Probable	**LOW**	High
Degree to which impact can be reversed					Fully reversible	
Degree to which impact may cause irreplaceable loss of resources					N/A	
Degree to which impact can be mitigated					Very Low	
NADF cuttings						
Without mitigation	Local	Medium-term	Medium	Highly Probable	**Low**	Low to Medium
With mitigation	Local	Medium-term	Medium	Highly Probable	**LOW**	Low to Medium
Degree to which impact can be reversed					Fully reversible	
Degree to which impact may cause irreplaceable loss of resources					N/A	
Degree to which impact can be mitigated					Very Low	

5.2.3 DRILLING NOISE

Description of impact

Although faunal attraction to drilling infrastructure in all likelihood overrides avoidance effects from drilling noise for most species, avoidance by some species has been identified.

Assessment

Impacts of drilling noise are considered similar to noise from shipping traffic. A maximum of 14 wells would be drilled to a depth of between 3 750 m and 5 850 m below the seafloor over the duration of the project. It is anticipated that it would take in the order of 100 to 240 days to drill a well depending on the type of well (see Table 3.5).The drilling noise is local in extent and is likely to be low intensity. The significance of impact is consequently **VERY LOW** with or without mitigation (see Table 5.12).

Mitigation

No mitigation measures are considered necessary.

Table 5.12: Impact of drilling noise.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Without mitigation	Local	Short-term	Low	Probable	**Very Low**	High
With mitigation	Local	Short-term	Low	Probable	**VERY LOW**	High
Degree to which impact can be reversed					Fully reversible	
Degree to which impact may cause irreplaceable loss of resources					N/A	
Degree to which impact can be mitigated					None	

5.2.4 FAUNAL ATTRACTION TO DRILLING UNITS

Description of impact

Marine fauna may be attracted to a drilling unit for a number of reasons, including structural stimuli, protection, illumination (operating lights & flaring) and food availability. The attraction of fauna may impact species through both the ingestion of oil or contaminants from the sea surface or within prey tissues and nocturnal kills from birds flying into flares or lighting structures.

Assessment

Seabirds, fish, cephalopods (squids), seals and cetaceans may be attracted to the strong operating lights required during drilling activities and to flaring during any flow testing. Potential attraction may increase during fog when greater illumination is caused by refraction of light by moisture droplets.

Attraction to food supply may result from both the disposal of human wastes (leading to both an extreme local increased productivity or a direct supply of food), the drilling unit acting as a local reef (enhancing food supply) and through indirect attraction of prey species. Many seabird species forage at night on bioluminescent plankton prey and any light would result in obvious attraction.

The extent of impact is likely to be limited to the visual stimulus of the drilling unit, while the duration would be limited to maximum of 240 days per well. Although the intensity of impact is likely to range from low (altered distribution and behaviour) to high (mortality) for individuals, the intensity of the impact on the population is expected to be low. The significance of impact is deemed **very low** with or without mitigation (see Table 5.13).

Table 5.13: Impact of faunal attraction to drilling unit.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Without mitigation	Local	Short-term	Low	Probable	**Very Low**	Medium to High
With mitigation	Local	Short-term	Low	Probable	**VERY LOW**	Medium to High
Degree to which impact can be reversed					Fully reversible	
Degree to which impact may cause irreplaceable loss of resources					N/A	
Degree to which impact can be mitigated					Very Low	

Mitigation

The following mitigation are recommended to mitigate the impacts of faunal (particularly seabird) attraction:

- Non-essential lighting should be minimised on all platforms to reduce nocturnal attraction. However, such measure should not undermine work safety aspects or concerns; and
- Discharging of waste material should be minimised if obvious attraction of fauna is observed.

5.2.5 INTRODUCTION OF NON-INDIGENOUS INVASIVE MARINE SPECIES THROUGH VESSELS AND EQUIPMENT TRANSFER AND BALLAST WATER DISCHARGE

Description of impact

Larvae, cysts, eggs and adult marine organisms are frequently firmly attached to artificial structures such as vessel hulls and infrastructure that have been in the sea for any length of time. Vessels and the transportation of infrastructure from one place to another in the ocean provide the potential for translocation of introduced or alien species. In addition, the discharge of ballast water also provides the potential for translocation of introduced or alien species.

The relocated organism may be able to thrive and out compete local species naturally occurring in the region, resulting in a loss of overall regional biodiversity and, in extreme cases, an invasion of the foreign species.

Assessment

Currently three marine species are known to be invasive in South African waters. However, the difficulty in detection, identification and the cryptic nature of some species potentially makes this number an underestimate. Underwater footage of existing petroleum infrastructure on the Agulhas Bank has shown evidence of invasion by two foreign anemone species (*Metridium senile* and *Sagartia elegans*) (Sink *et al.*, 2010), which occur in abundance on pipelines and other hard, artificial structures. These species of anemone are not endemic to South Africa and were most likely introduced from the North West Atlantic region. Even the transport of species from the South Coast to the West Coast can result in the introduction of an invasive species, although this is usually less likely than invasive species being introduced from foreign countries. Furthermore, the Sink *et al.* (2010) found two species of introduced ascidians and the highly invasive European mussel (*Mytilus galloprovincialis*) also occurring on oil and gas infrastructure in Block 9.

Although no infrastructure would be towed to site, which would reduce the risk of non-indigenous species translocation, it is most likely that the drill unit (and support vessels) contracted for the proposed well drilling campaign would have spent time outside of South Africa's EEZ during the past 12 months. This recent exposure to foreign water bodies increases the risk of introducing invasive or non-indigenous species. In addition, the slow speed at which drill units are towed through water bodies further facilitates the accumulation of fouling species (Hewitt *et al.* 2009). The risk of this impact is, however, reduced by the highly dynamic, wave-exposed coastline of South Africa, which contributes to minimising the establishment of non-indigenous invasive species resulting in comparatively low numbers of such species in the region.

The potential impact related to the introduction of alien invasive marine species is considered to be of medium intensity in the long-term and is expected to have an extent ranging from regional to national. The significance of impact is consequently deemed **HIGH TO VERY HIGH** with and without mitigation (see Table 5.14). The degree of confidence in this prediction is low. Mitigation would only serve to reduce the probability of occurrence to "improbable".

It should be noted that this impact is not unique to the proposed project, but rather a threat common to the South African offshore environment from the numerous vessels that pass through South African coastal waters daily.

Mitigation

DEA (Directorate: Pollution & Waste Management) has indicated that a policy on Ballast Water Management is currently being drafted, which will dictate how ballast water must be managed in South African waters. However, until such time as this policy is finalised and enforced environmental best practice is encouraged. In this regard, it is recommended that the guidelines for management of ballast water provided by the International Maritime Organisation (IMO) (Guideline A.868(20)) should be adhered to. These include:

- Ensuring the drilling unit has a ballast water management plan in place in order to ensure safe and effective ballast water management;
- Reducing the risk of transfer of harmful aquatic organisms by onboard ballast water treatment or exchange[5]. The following is applicable to ballast water exchange:
  - ⇒ Vessels using ballast water exchange should whenever possible, conduct such exchange at least 200 nautical miles from the nearest land and in water at least 200 m in depth. Where this is not feasible, the exchange should be as far from the nearest land as possible, and in all cases a minimum of 50 nautical miles from the nearest land and preferably in water at least 200 m in depth;
  - ⇒ Ballast water exchange should be conducted in a manner consistent with the IMO Guidelines and one of the three approved ballast water exchange methods. These include:
    - > Sequential method: This method entails emptying at least 95% or more of the volume of ballast tanks and refilling with replacement ballast water (open-ocean). However, the emptying of certain tanks may lead to significantly reduced stability, higher stresses, high sloshing pressures, and/or reduced forward drafts. A secondary effect of reduced forward draft would be an increased probability of bow slamming;
    - > Flow through method: This method involves pumping open-ocean water into a full ballast tank. Ballast equal to approximately three times the tank capacity must be pumped through the tank to achieve 95% effectiveness in eliminating aquatic organisms. Applying the flow through method does not alter the stability, stress and ship attitude; and
    - > Dilution method: This method involves the pumping the replacement ballast water through the top of the ballast tank or hold intended for the carriage of water ballast with simultaneous discharge from the bottom at the same flow rate and maintaining a constant level in the tank or hold. At least three times the tank or hold volume should be pumped through the tank or hold.
  - ⇒ When exchanging ballast at sea, guidance on safety aspects of ballast water exchange as set out in Appendix 2 of the IMO Guidelines should be taken into account. When these requirements cannot be met, ballast water exchange should be undertaken in designated ballast water exchange areas, as determined with the relevant authority (e.g. DEA: Directorate Pollution & Waste Management or Transnet National Ports Authority).
- Where practicable, routine cleaning of the ballast tank to remove sediments should be carried out in mid-ocean or under controlled arrangements in port or dry dock, in accordance with the provisions of the ship's ballast water management.

It is further recommended that no infrastructure (e.g. wellheads, BOPs and guide bases) should be deployed that has been used in other regions, unless thoroughly cleaned. In addition, an appropriate monitoring and control programme should be developed, which should, at a minimum, take the following into consideration during the production phase:

- All underwater inspections of infrastructure (ROV and SAT diver) should be used as opportunities to acquire footage (close-ups and stills) of marine life associated with the infrastructure;

[5] The ballast water exchange methods will be phased out as an acceptable method of complying with the Convention. In the time period 2009 to 2016 depending on ballast capacity and date of keel lay only ballast water treatment will be acceptable. After this period all merchant ships will have to use ballast water treatment to comply with the Convention.
(ref: http://www.skuld.com/templates/newspage.aspx?id=1101).

- Any visual footage of marine growth / features on infrastructure should be distributed to relevant marine ecologists to investigate the presence of potential invasive species; and
- Should species of concern be detected, the spread thereof should be monitored over time.

Table 5.14: Assessment of impact related to the potential introduction of alien/invasive marine species through equipment transfer and ballast water discharge.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Without mitigation	Regional - National	Long-term	Medium	Probable	**High to Very High**	Low
With mitigation	Regional - National	Long-term	Medium	Improbable	**HIGH TO VERY HIGH**	Low
Degree to which impact can be reversed					Partially reversible to irreversible	
Degree to which impact may cause irreplaceable loss of resources					Medium	
Degree to which impact can be mitigated					Very Low	

5.2.6 CUMULATIVE IMPACT

The total area impacted as a result of the existing PetroSA oil and gas infrastructure in the area is approximately 0.18 km^2, which represents approximately 0.0006 % of the Agulhas Bioregion[6] (Quick and Sink, 2005). The proposed well drilling programme (specifically the discharge of cuttings) would impact an additional approximately 3.5 km^2 representing 0.012 % of the Agulhas Bioregion. Combined, the area affected by the developments would be approximately 3.68 km^2 representing 0.013 % of the Agulhas Bank resource, which is considered to be negligible. Therefore, considering the total development in the area, the small area directly affected and the recovery rates (i.e. full recovery would take place within two to ten years), the cumulative impact is considered to be of **LOW** significance.

5.3 IMPACT ON CULTURAL HERITAGE MATERIAL

Description of impact

Drilling activities and the installation of subsea infrastructure could disturb cultural heritage material on the seabed, particularly historical shipwrecks.

Assessment

The likelihood of disturbing a shipwreck is expected to be very small considering the vast size of the South African offshore area. In addition, previous exploration work undertaken it the project area has not indicated the presence of any heritage material on the seabed. The likelihood of impact is further reduced by the fact that PetroSA would undertake a site survey in order to assess the seabed condition and identify potential obstacles on the seafloor at the selected drill sites.

Without mitigation the significance of this impact on any cultural heritage material is expected to be **medium** (see Table 5.15).

[6] (Note: this area excludes the area impacted by the deposition of drill cuttings as these areas are expected to have recovered).

Mitigation

- The final positioning of the wells should avoid any cultural heritage material identified during the site survey; and
- If any cultural heritage material is found during drilling the South African Heritage Resources Agency (SAHRA) should be notified immediately. If any material older than sixty years is to be disturbed a permit would be required from SAHRA.

With mitigation, the significance of this impact is assessed to be **INSIGNIFICANT** (see Table 5.15).

Table 5.15: The assessment of the potential impact of drilling activities on heritage material.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Without mitigation	Local	Permanent	Medium	Improbable	**Medium**	High
With mitigation	Local	Permanent	Zero	Improbable	**INSIGNIFICANT**	High
Degree to which impact can be reversed					Irreversible	
Degree to which impact may cause irreplaceable loss of resources					High	
Degree to which impact can be mitigated					Medium	

5.4 IMPACT ON OTHER USERS OF THE SEA

5.4.1 POTENTIAL IMPACT ON MARINE TRANSPORT ROUTES

Description of impact

The presence of the drilling unit with the associated 500 m safety zone could interfere with shipping in the area.

Assessment

The safety zone around the drilling unit would be relatively small (0.8 km^2) and all vessels would be prohibited from entering this area. The F-O Gas Field area is located to the south of the eastbound shipping traffic lane (see Figure 4.22). Support vessels would, however, cross the east- and westbound shipping traffic lanes during well drilling operations. Thus, interference with shipping would occur in the short-term, during the construction phase. The impact on shipping traffic is considered to be localised, of medium intensity in the short-term. The significance of this impact is therefore assessed to be **low** (Table 5.16).

Mitigation

- Prior to the commencement of activities, the operator and its contractors must consult with relevant bodies including DEA (Branch Oceans and Coats), PASA, South African Maritime Safety Authority (SAMSA), the South African Navy (SAN) Hydrographic Office, relevant Port Captains and Department of Agriculture, Forestry and Fisheries (DAFF). These bodies must be notified of the navigational co-ordinates of any location prior to commencement of such activities.
- A Notice to Mariners must be released prior to well drilling. The notice should provide: the co-ordinates of the well drilling activity; an indication of the well drilling timeframes; location reports of the drilling unit; an indication of the 500 m safety zone; and a special note on any hazard posed by the anchor chains and anchors.
- The drilling unit and support vessels must be certified for seaworthiness through an appropriate internationally recognised marine certification programme (e.g. Lloyds Register, Det Norske Veritas). The certification, as well as existing safety standards, requires that safety precautions would be taken

to minimise the possibility of an offshore accident. Collision prevention equipment should include radar, multi-frequency radio, foghorns, etc. Additional precautions include: the support / chase vessel, the existence of an internationally agreed 500 m safety zone around the drilling unit, cautionary notices to mariners, and access to current weather service information. The drilling unit and support vessels must be fully illuminated during twilight and night. The law also requires equipment and training to ensure the safety and survival of the crew in the event of an accident; and

- A Notice to Mariners must be released at the end of drilling informing all key stakeholders that the drilling unit is off location.

Provided normal rules of the sea are observed the interference of the project vessels with shipping traffic could be mitigated. If the suggested mitigation measures are implemented this impact is assessed to be of **VERY LOW** significance (see Table 5.16).

Table 5.16: Assessment of interference with marine transport routes.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Without mitigation	Local	Short-term	Medium	Probable	**Low**	High
With mitigation	Local	Short-term	Low	Improbable	**VERY LOW**	High
Degree to which impact can be reversed					Fully reversible	
Degree to which impact may cause irreplaceable loss of resources					N/A	
Degree to which impact can be mitigated					Low	

5.4.2 POTENTIAL IMPACT ON FISHING

Description of impact

Well drilling could impact the fishing industry as a result of the 500 m safety zone around the drilling unit. This could potentially increase fishing effort and disrupt fishing activities due to the reduction in the length of trawls and time lost hauling and setting gear, as fishermen would have to lift their gear when they traverse a safety zone. In addition, the proposed safety zone would result in the loss-of-access to fishing grounds and associated loss of catch from these areas.

Assessment

Although the fishing industry would be excluded from the immediate area with the commencement of drilling, the safety zone would remain after well drilling until decommissioning, as PetroSA would also be seeking to establish a 500 m safety zone around the entire subsea system. Therefore, these impacts (including the cumulative impact) have been assessed together with the proposed development of the F-O Gas Field (see Section 6.2.1.2 in Chapter 6).

5.5 RISK ASSOCIATED WITH THE PROPOSED ONSHORE DRILLING AND COMPLETION FLUIDS PLANT

Description of impact

The main risk relating to the proposed drilling and completion fluids plant and the materials to be stored on site relates to the unlikely event of a tank or bund fire. A tank or bund fire could result in a large volume of flammable material at atmospheric pressure burning in an open space. During combustion heat would be released in the form of thermal radiation. Any plant, building or persons close to the fire or within the intolerable zone would experience burn damage with the severity depending on the distance from the fire and the time exposed to the heat of the fire.

Assessment

Of all the material stored on site, the base fluid (MOSSPAR H) is the only material with the potential to ignite and cause a tank of bund fire. The base fluid would be stored in four tanks with secondary containment. The thermal radiation of a large base fluid bund fire at the proposed drilling and completion fluids plant is shown in Figure 5.1. A large loss of containment of the base fluid within the bunded area followed by an ignition could result in a fire that would have an impact that would not extend beyond Pier 9.

The physical and consequence modelling, as presented in Figure 5.1, merely illustrates the extent and potential consequence of a pool and bund fire. However, this does not take into account the probability of occurrence. Risk is defined as the product of consequence and probability (including loss of containment and ignition). MOSSPAR H has a high flash point (> 90 °C) and as a result the probability of ignition from a loss of containment is sufficiently low to deem it zero. As the probability of ignition is extremely low, the risks of a fire at the proposed plant would be less than $1x10^{-10}$ fatalities per person per year, resulting in the individual and societal risks being classified as trivial (i.e. an acceptable risk). Provided no other hazardous materials are stored or produced at the drilling and completion fluids plant, it would not be classified as a Major Hazardous Installation (MHI).

The potential impact associated with a tank or bund fire is considered to be localised, of low intensity in the short-term. The significance of this improbable impact is, therefore, assessed to be of **VERY LOW** significance with and without mitigation (see Table 5.17).

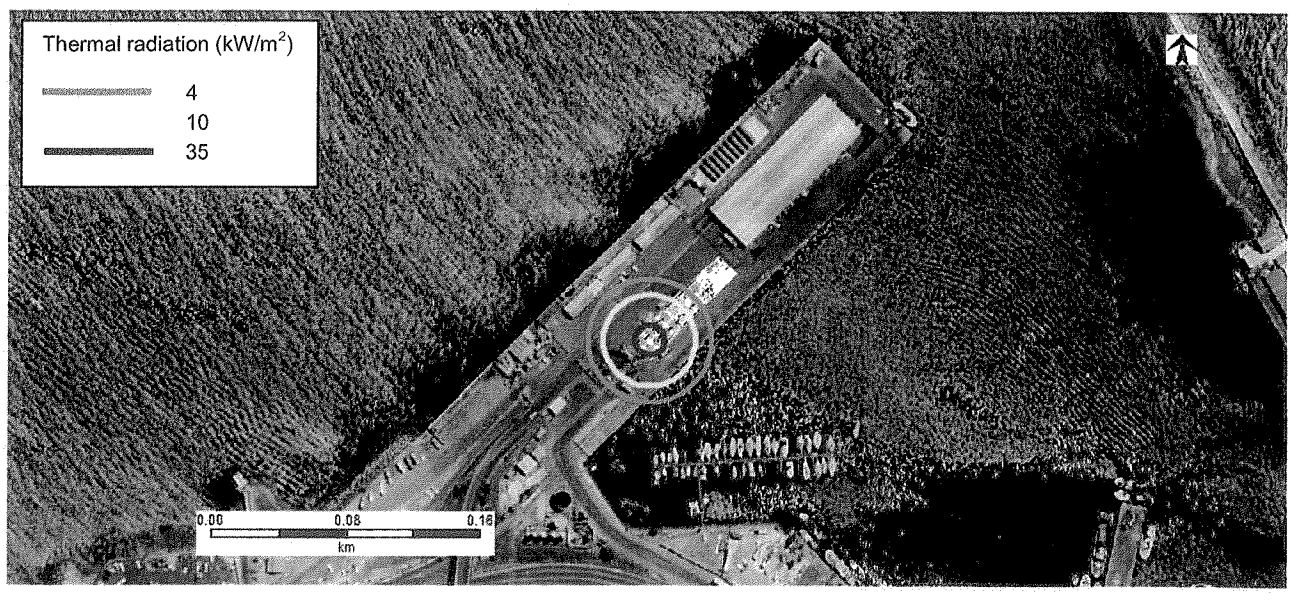


Figure 5.1: Thermal radiation isopleths from a large bund fire on Pier 9.

Mitigation

Although no mitigation is considered necessary, the following is recommended:

- The final design of the proposed drilling and completion fluids plant should comply with applicable SANS codes (including SANS 10089-1, SANS 10131, SANS 10108, etc.) and guidelines or equivalent internationally recognised codes of good design and practice;
- A review of the final designs and materials should be undertaken by an Approved Inspection Authority. This should include a recognised process hazard analysis (Hazard and Operatibility Study (HAZOP), Failure Mode Effects Analysis (FMEA), etc.);
- An emergency preparedness and response document for onsite incidents must be completed prior to construction; and
- No significant increase to the product list or product inventories should be permitted without reassessing the associated risk.

Table 5.17: Summary of impact for pool or bund fires.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Without mitigation	Local	Short-term	Low	Improbable	**Very Low**	High
With mitigation	Local	Short-term	Low	Improbable	**VERY LOW**	High
Degree to which impact can be reversed					Fully reversible	
Degree to which impact may cause irreplaceable loss of resources					N/A	
Degree to which impact can be mitigated					Very Low	

5.6 ACCIDENTAL RELEASE OF GAS OR HYDROCARBONS

This section considers the various sources and environmental effects of an accidental gas and hydrocarbon release.

5.6.1 ACCIDENTAL RELEASE OF GAS

5.6.1.1 Introduction

Natural gas accumulates at various depths in suitable geological formations that act as traps. Essentially gas accumulates in porous rock or sand beneath an impervious cap. Such accumulations of gas are contained under pressure, which needs to be managed carefully during drilling operations in order to prevent an uncontrolled release. During drilling, gas is most likely to be encountered at the level of the targeted reservoir. It may, however, be intersected at shallower levels.

5.6.1.2 Shallow gas

Pockets of shallow gas often are not detected by deep-focused seismic surveys and thus may be encountered without warning when drilling. The risk is particularly severe if encountered at shallow depths before the marine riser is connected. However, it should be noted that shallow gas has not been encountered in South African waters during any drilling campaigns to date.

5.6.1.3 Deep gas

Possible release paths

In the event of a blow out, gas may travel to the surface either through the well bore, i.e. through the cased hole and the drill pipe, or around the outside of the casing through fractures in the overburden formations up to the seafloor. The first can be controlled by BOPs installed on the well. The situation where gas escapes around the outside of the casing is more difficult to bring under control. However, this situation is avoided by running and cementing casings in the hole at various depths and pressure testing the wellbore to ensure it can withstand the higher pressures of well fluids expected deeper in the well. In the event of a gas blow out it may be necessary to plug the well with cement and cap the well permanently and drill a new well into the reservoir from where the gas originates close to the penetration of the original well. This would allow the well to be killed by pumping large amounts of heavy fluids into the original well bore.

Fate of releases
If gas escapes outside the well casing it would form a jet through the water column to the surface where it may ignite spontaneously. Drilling fluid and cuttings would be forced into the water column and disperse with the currents. Heavy particles (i.e. rock chips and fragments) would settle to the bottom near the wellbore whereas the fine material may drift some distance before settling.

In the event of loss of hydrostatic head (i.e. the loss of the drilling fluid content from the hole) gas may be released up the well casing to reach the drilling unit. The loss of hydrostatic head would be prevented by closing the BOP stack and circulating the drilling fluid to re-establish the hydrostatic head. At the unit the opportunity remains to separate the gas from the drilling fluid in the mud degasser and dissipate the gas up the flare stack. The quantity of gas separated from the mud is normally too small to flare, but in some circumstances it might be flared. The de-gassed drilling fluid is recycled through the mud circulating system on board. If during such an emergency there was BOP failure, a last resort would be to release the drilling unit from the well, by disconnecting at the lower end of the riser system and selectively releasing the mooring lines.

5.6.1.4 Potential impacts of an uncontrolled release of natural gas

Impact on water column and sea bottom
Description of impact
If gas escapes from a shallow gas release or a gas blow-out (if gas escapes around the well casing), it would be forced into the water column and disperse with the currents and could have an impact on marine organisms.

In the case of a blow-out, drilling fluid and cuttings would be forced into the water column and disperse with the currents. Heavy particles i.e. rock chips and fragments would settle to the bottom near the well bore whereas the fine material may drift some distance before settling. This could have an impact on benthic communities.

Assessment
Methane is almost insoluble in the water column (natural concentrations in seawater are in the range of 10-100 µg/l) and would bubble to the surface and enter the atmosphere. Methane is not toxic and does not have any long-term physiological effects. However, it is possible that the methane may suffocate poorly mobile organisms, e.g. plankton, fish eggs and larvae. The impact of released gas (methane) on the pelagic marine organisms would be local (restricted to the environments of the well or leak) and could be of medium to high intensity. The significance of this impact is considered to be **LOW** with and without mitigation (see Table 5.18).

Drilling fluid and cuttings forced out of the well by a blow-out would disperse in the water column according to the size and density of the particles and to the strength and direction of currents. Large heavy particles would settle near the wellhead whereas fine material would form a relatively extensive "footprint". The significance of the impact of the release of drilling fluid and cuttings on benthic biota, which is similarly applicable for normal drilling operations, is assessed in Section 5.2.3.

Mitigation
As accidents generally arise from human error, construction defects (including age and corrosion) or natural events, safety measures that could limit accidents include:

- Implement monitoring and management measures in accordance with normal well control practise to assist in the detection and control of uncontrolled releases;
- The BOP installed on the well during drilling must be "fit for purpose" (i.e. appropriate for intended use, dependable and effective when required and able to perform as intended); and

- Adequate training of all personnel in both accident prevention and immediate response.

If the suggested mitigation measures are implemented, the impact would remain of similar significance, but the probability of the impact would be reduced (see Table 5.18).

Table 5.18: Assessment of impact of gas release on water column and sea bottom.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Without mitigation	Local	Short-term	Medium to High	Improbable	**Low**	Medium
With mitigation	Local	Short-term	Medium to High	Improbable	**LOW**	Medium
Degree to which impact can be reversed					Fully reversible	
Degree to which impact may cause irreplaceable loss of resources					N/A	
Degree to which impact can be mitigated					Very Low	

Impact on the atmosphere

Description of impact

In the event of a blow-out, methane gas, which is considered to be a 'greenhouse gas' could be released to the atmosphere. Methane is implicated in global warming i.e. it acts by storing heat in the atmosphere. Methane (15%) is second only to carbon dioxide (50%) in contributing to global warming (WMO 1992).

Assessment

While any unnecessary addition of greenhouse gases to the atmosphere is undesirable, the volume of an accidental release from an exploration well is insignificant in terms of the total volume of greenhouse gases released daily into the global atmosphere. Considering the improbability of such an uncontrolled release of gas, the significance of the impact is assessed to be **VERY LOW** with and without mitigation (see Table 5.19).

Mitigation

Mitigation measures would ensure that the volume of gas released to the atmosphere is reduced. Mitigation includes:

- Implement monitoring and management measures in accordance with normal well control practise to assist in the detection and control of uncontrolled releases; and
- A BOP must be installed during drilling operations.

Table 5.19: Assessment of the impact of an accidental gas release of the atmosphere.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Without mitigation	Local	Short-term	Low	Improbable	**Very Low**	High
With mitigation	Local	Short-term	Low	Improbable	**VERY LOW**	High
Degree to which impact can be reversed					Fully reversible	
Degree to which impact may cause irreplaceable loss of resources					N/A	
Degree to which impact can be mitigated					Very Low	

5.6.2 ACCIDENTAL HYDROCARBON SPILL

5.6.2.1 Introduction

This scenario assumes that an accidental spillage of hydrocarbons (including oil, condensate or diesel) would occur. Although the probability of an uncontrolled release of hydrocarbons (blow-out) is extremely low, it nonetheless provides the greatest environmental concern in exploratory drilling. Previous studies (Crowther Campbell & Associates and CSIR 1999; CSIR 1995a; CSIR 1995b; and CSIR 1999) have assessed the impact of oil spills under two spill volume scenarios as indicated below:

- *Small spill* – 150 to 700 barrels of oil or diesel. This scenario was chosen to assess the effect of an accident involving the supply vessels or during the transfer of diesel fuel to the drilling unit.
- *Large spill* – 5 000 to 30 000 barrels of oil. This spill scenario was selected to investigate the consequences of a major spill arising from a well blow-out or loss of well control.

Spill simulations were performed with OILMAP, a numerical oil spill trajectory model. The main input data for the simulation studies consisted of known wind and current data. The spill trajectories are governed by the current velocity field and to a lesser extent by the wind field. A summary of the simulations for the work undertaken in License Area 2814A (Namibia), Block 9 and Blocks 17/18, representing scenarios for the West, South and East coasts respectively, is shown in Table 5.20. The results shown here are for the worst-case scenario at the offshore distances indicated. No account is taken of any intervention in the transport and fate of the spilled oil. For the Block 9 example, a large spill could reach the shore within 21 hours under a constant southerly wind of 72 km/hr. However, it was indicated that the probability of such conditions occurring is extremely remote. This is the most likely scenario for the F-O Gas Field.

The section below assesses the impact of the two oil spill scenarios.

Table 5.20: Results of previous oil spill simulation studies.

Simulation type	Spill size	2814A Namibia 70 km offshore	Block 9 50 km offshore	Block 17/18 40 km offshore
Minimum time to shore wind speed of 72 km/hr	Small	Would not reach shore	Would not reach the shore	12 hrs with a continual south-east wind blowing
	Large	24 hrs with a continual south-west wind of 90 km/hr	21 hrs with a continual southerly wind blowing	15 hrs with a continual south-east wind blowing
Probability of shoreline oiling and travel time	Small	As for large spill but will disappear in 2 to 3 days	40 % Less than 5 days	50 % Less than 2 to 3 days
	Large	70 to 90% probability of spill moving away from shore	50 % Less than 3 days	70 % Less than 3 days
Volume of oil reaching the shore	Small	Would disappear before reaching the shore	Would disappear before reaching the shore	Less than 30 %
	Large	Would disappear before reaching the shore	Less than 30 % during spring	Less than 30 % during summer

5.6.2.2 Potential impacts of an accidental condensate or hydrocarbon spill

Description of impact

In the event of a blow-out, condensate[6] would be released from the well, which could have an impact on marine fauna and associated environs (offshore, nearshore and shoreline), as well as the fishing industry.

[6] It should be noted that appraisal well drilling has shown there to be no oil in the F-O Gas Field.

Similarly, an accident involving supply vessels or during the transfer of diesel fuel to the drilling unit could result in a small hydrocarbon spill.

Assessment

Although it is impossible to quantify the volume of condensate that would result from a blow-out, appraisal well drilling has shown there to be very little condensate at ambient pressure and temperature in the F-O Gas Field. Therefore, no large spills can be expected to occur. A small condensate or hydrocarbon spill would more than likely disappear before reaching the shore.

The impact of a small spill on marine fauna, fishing (commercial and recreation) and coastal environments is expected to be of local extent of medium intensity and short-term duration. The significance is thus expected to be **VERY LOW** (see Table 5.21).

Mitigation

Mitigation includes the following:

- Prior to the commencement of the drilling programme, PetroSA and the selected Contractor must ensure that there is an Oil Spill Response Plan in place to deal with accidental hydrocarbon spills. In this regard, a bridging document is required between PetroSA's current procedures, *Oil Spill Contingency and Response Plan* (EP/SHE/PR/001) and *General Onshore Plan for Offshore Emergencies* (EP/SHE/PR/006), and the emergency response procedures and plans of the selected Contractor; and
- PetroSA and / or the selected Contractor would also require adequate protection and indemnity insurance cover for pollution incidents.

Table 5.21: Assessment of impact related to a small accidental condensate or hydrocarbon spill.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Without mitigation	Local	Short-term	Low to medium	Improbable	**Very Low**	Low
With mitigation	Local	Short-term	Low to medium	Improbable	**VERY LOW**	Low
Degree to which impact can be reversed					Fully reversible	
Degree to which impact may cause irreplaceable loss of resources					N/A	
Degree to which impact can be mitigated					Very Low	

6. F-O GAS FIELD DEVELOPMENT: IMPACT DESCRIPTION AND ASSESSMENT

This chapter describes and assesses the significance of potential impacts related to the development of the F-O Gas Field components after the well drilling programme is complete.

All impacts are systematically assessed and presented according to predefined rating scales (see Appendix 3). Mitigation measures are proposed which could ameliorate the negative impacts or enhance potential benefits. The status of all impacts should be considered to be negative unless otherwise indicated. The significance of impacts with and without mitigation is also assessed.

Specialists were appointed by CCA to address the two key issues raised during the Scoping Study, namely the effect on the fishing industry (see Appendix 4) and effects on marine benthic fauna (see Appendix 5). In addition, this EIA used as a basis the issues identified during previous oil and gas development projects in the area, notably the development of the Sable Field, Oribi/Oryx Oil Field and the South Coast Gas project. The project team have assessed the relevance of these issues to this project.

Section 6.1 assess impacts related to the proposed project during the installation and decommissioning phases, while Section 6.2 assesses impacts related to the production phase. The implications of not going ahead with the proposed development of the F-O Gas Field (i.e. the No-Go option) are assessed in Section 6.3.

6.1 CONSTRUCTION AND DECOMMISSIONING PHASES

It should be noted that many of the impacts relating to construction and decommissioning are similar to those experienced during well drilling, e.g. emissions to the atmosphere, discharges to the sea, and impact to fauna, heritage and shipping. These have been repeated in this section.

6.1.1 EMISSIONS TO ATMOSPHERE

Description of effect

The installation and support vessels would use diesel as fuel for generators and motors during infrastructure installation operations and decommissioning. Diesel exhaust gases comprise SO_2, CO, CO_2 and soot ("carbon-black"). Burning of waste, e.g. domestic packaging materials, aboard can release soot as well as CO, CO_2 and possibly dioxins depending upon the composition of the materials to be burned.

During operation flaring of gas would release CO_2, CO, NO_x and (unburned) hydrocarbons at the F-A Platform and GTL refinery.

These compounds are known to contribute to atmospheric problems such as the greenhouse effect, ozone depletion, etc. In addition, there is some concern that soot is carcinogenic.

Assessment

The atmospheric emissions from vessels are expected to be similar to those from similar diesel-powered vessel of comparable tonnage (i.e. an average consumption of 27.4 m^3/day or 27 400 L/d). Based on the relatively short construction phase (i.e. six months), levels of air pollution are expected to be in the order of 5 000 m^3. It is not expected that such emissions would have a direct effect on any other activity and as such, the impact of such emissions on a wider atmospheric scale is considered to be of **VERY LOW** significance with and without mitigation (Table 6.1).

Mitigation

Diesel motors and generators must be adequately maintained so that the exhaust gases contain the minimum of soot and unburned diesel.

Table 6.1: Assessment of impact relating to emissions to air during construction and decommissioning.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Without mitigation	Local	Short-term	Low	Definite	**Very Low**	High
With mitigation	Local	Short-term	Low	Definite	**VERY LOW**	High
Degree to which impact can be reversed					Fully reversible	
Degree to which impact may cause irreplaceable loss of resources					N/A	
Degree to which impact can be mitigated					Very Low	

6.1.2 DISCHARGES/DISPOSAL TO THE SEA

Discharges to the marine environment of deck drainage, machinery space drainage, sewage, galley wastes and solid wastes from installation and support vessels.

6.1.2.1 Deck drainage

Description of effect

Water washing off the deck areas of the various project vessels could contain small amounts of oils, solvents and cleaners, which are potentially toxic to marine organisms.

Assessment

Oils, solvents and cleaners could be introduced into the marine environment in small volumes through spillage and drainage of deck areas during pipeline installation and decommissioning. This impact would be very localised, of low intensity and only occur in the short-term. The significance of this impact is therefore assessed to be **VERY LOW** with and without mitigation (Table 6.2).

Table 6.2: Assessment of impact of deck drainage on the marine environment during construction and decommissioning.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Without mitigation	Local	Short-term	Low	Highly Probable	**Very Low**	High
With mitigation	Local	Short-term	Low	Highly Probable	**VERY LOW**	High
Degree to which impact can be reversed					Fully reversible	
Degree to which impact may cause irreplaceable loss of resources					N/A	
Degree to which impact can be mitigated					Very Low	

Mitigation

The following measures are recommended for mitigation of deck drainage discharges from vessels:

- Deck drainage should be collected in oily water catchment systems. Discharged water must meet MARPOL standards;
- Training and awareness of crew in spill management could minimise contamination;
- Low-toxicity biodegradable detergents should be used in cleaning of all deck spillage; and
- All hydraulic systems should be adequately maintained and hydraulic hoses should be frequently inspected.

6.1.2.2 Machinery space drainage

Description of effect

Small quantities of oil, such as diesel fuel from engines, lubricants, grease, etc. used aboard the various project vessels could enter the marine environment during infrastructure installation and decommissioning.

Assessment

All operations would comply fully with international agreed standards regulated under MARPOL 73/78. All machinery space drainage would pass through an oil/water filter to reduce the oil in water concentration to 15 mg/l, in accordance with MARPOL 73/78 requirements.

Concentrations of oil reaching the marine environment through drainage of machinery spaces are therefore expected to be low. In addition, the oceanic environment off the South Coast would ensure rapid dispersion and oxidation of any residual oil in the discharged water. The potential impact of such low concentrations would be of low intensity and very localised in extent over the short-term. The potential impact of machinery space drainage on the marine environment is therefore considered to be of **VERY LOW** significance (see Table 6.3).

Mitigation

No mitigation measures are deemed necessary (assuming compliance with the MARPOL 73/78 standards).

Table 6.3: Impact related to machinery space drainage during construction and decommissioning.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Without mitigation	Local	Short-term	Low	Highly Probable	**Very Low**	High
With mitigation	Local	Short-term	Low	Highly Probable	**VERY LOW**	High
Degree to which impact can be reversed					Fully reversible	
Degree to which impact may cause irreplaceable loss of resources					N/A	
Degree to which impact can be mitigated					Very Low	

6.1.2.3 Sewage disposal

Description of effect

Treated sewage would be discharged from the project vessels during construction operations and decommissioning. Sewage poses an organic and bacterial load on the natural degradation processes of the sea. Many marine micro-organisms (such as bacteria) metabolise sewage, resulting in rapid biodegradation.

The availability of raw sewage as a food source can lead to a rise in bacterial levels in the water and an increased demand for oxygen. Treated sewage also poses an increased biological oxygen demand (BOD).

Assessment
The volume of sewage waste released from vessels would be small and comparable to volumes produced by vessels of similar crew compliment. All sewage would be treated to the required MARPOL 73/78 standard prior to release into the marine environment, where the high wind and wave energy is expected to result in rapid dispersal. It is unlikely that treated sewage discharged will have a BOD that results in a significant effect on the flora and fauna. The impact would be of low intensity and very localised as a result of the large dilution capacity of the seawater relative to the small volume of effluent and the distance offshore (100 km).

The potential impact of sewage on the marine environment is therefore considered to be of **VERY LOW** significance (Table 6.4).

Mitigation
No mitigation measures are recommended (assuming sewage discharges are in compliance with the MARPOL 73/78 standards).

Table 6.4: Assessment of impact of sewage disposal on the marine environment during construction and decommissioning.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Without mitigation	Local	Short-term	Low	Highly Probable	**Very Low**	High
With mitigation	Local	Short-term	Low	Highly Probable	**VERY LOW**	High
Degree to which impact can be reversed					Fully reversible	
Degree to which impact may cause irreplaceable loss of resources					N/A	
Degree to which impact can be mitigated					Very Low	

6.1.2.4 Disposal of galley wastes

Description of effect
Galley waste (comprised mostly of biodegradable food waste) would be discharged from project vessels during construction operations and decommissioning, which can pose an organic and bacterial load on the sea. Untreated galley waste can attract large numbers of seabirds (gulls), which may become a hazard to helicopter operations.

Assessment
The volume of galley waste from the drilling unit would be small and comparable to wastes form any vessel of a similar crew compliment. The daily volume of discharge of galley waste is expected to be less than 0.2 m^3 per vessel. Discharges of galley wastes, according to MARPOL 73/78 standards, would be comminuted to particle sizes smaller than 25 mm prior to disposal to the marine environment if less than 12 nautical miles (± 22 km) from the coast and no disposal within 3 nautical miles (± 5.5 km) of the coast.

These small volumes would be quickly dispersed by the strong Agulhas current. This impact would therefore be localised, of low intensity and in the short-term. The significance of this impact is considered to be **VERY LOW** (Table 6.5).

Mitigation

No mitigation measures are deemed necessary (assuming discharge is in compliance with the MARPOL 73/78 standards).

Table 6.5: Assessment of impact of disposal of galley waste during construction and decommissioning.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Without mitigation	Local	Short-term	Low	Highly Probable	Very Low	High
With mitigation	Local	Short-term	Low	Highly Probable	VERY LOW	High
Degree to which impact can be reversed					Fully reversible	
Degree to which impact may cause irreplaceable loss of resources					N/A	
Degree to which impact can be mitigated					Very Low	

6.1.2.5 Solid waste

Description of effect

The disposal of solid waste comprising non-biodegradable domestic waste, packaging and operational industrial waste into the sea could pose a hazard to marine fauna, may contain contaminant chemicals and could end up as visual pollution at sea, on the seashore or on the seabed.

Assessment

The solid waste generated onboard the project vessels would be stored on the respective vessels for later disposal at an onshore licensed landfill site. No solid waste would be disposed of into the sea. However, a spill may result in a small amount of waste entering the marine environment (e.g. blown by wind, spill during transfer to workboat, etc.). The potential impact of the disposal of solid waste on the marine environment is therefore **INSIGNIFICANT** (see Table 6.6).

Mitigation

The following measures are recommended for mitigation of solid waste:

- Secure on board storage and safe transfer of solid waste;
- Initiate a waste minimisation system on board; and
- Ensure that contractors co-operate with the relevant local authority to ensure that solid and hazardous waste disposal is carried out in accordance with the appropriate laws and ordinances.

Table 6.6: Assessment of impact of solid waste on the marine environment during construction and decommissioning.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Without mitigation	Local	Short-term	Zero	Improbable	**Insignificant**	Medium
With mitigation	Local	Short-term	Zero	Improbable	**INSIGNIFICANT**	Medium
Degree to which impact can be reversed					N/A	
Degree to which impact may cause irreplaceable loss of resources					N/A	
Degree to which impact can be mitigated					Very Low	

6.1.3 IMPACT ON MARINE FAUNA

6.1.3.1 Physical damage on marine benthic fauna

Description of impact

Physical damage to the seabed and disturbance of the benthic communities could result from the placement of physical structures on the benthos (such as pipelines, wellhead structures, control umbilicals, TIFs, etc.) and the removal of this infrastructure during decommissioning. In addition, anchor deployments, tensioning or dragging of anchors and attached cables during installation and decommissioning could result in the temporary disturbance of the benthos.

Generally, the impacts accruing to these activities include the displacement of materials and the creation of impact depressions, scars and spoil mounds. Physical damage has the potential to affect relatively immobile or sedentary benthic species. There may also be an associated loss of benthic prey items that could negatively affect predator / prey relationships as the number of available prey organisms decrease.

Assessment

The benthic environment within the vicinity of the proposed F-O Gas Field Gas development is largely sandy unconsolidated sediments with several isolated rocky outcrops. The unconsolidated sediments appear to support rich infaunal communities. The combination of habitat types (soft sediments and rocky formations) results in a highly diverse benthic environment in the study area.

The final number of wells is dependant on the success of the initial five wells and production experience gained during the initial field operation. The subsea facilities have thus been designed to be expandable by the addition of further tie-in facilities adjacent to those proposed for the initial four wells. Thus the exact details of the subsea facilities are not presently known.

A conservative estimate of the area affected by both phases of the proposed gas field development is approximately 0.05 km^2, which represents 0.0002 % of the Agulhas Bioregion (28 889 km^2). The extent of the impact during construction would be limited to the site and the immediate surroundings. The extent of the impact during decommissioning would be less than during installation, as some infrastructure would be abandoned on the seafloor (e.g. production pipeline). However, if the production pipeline was retrieved it would impact an additional 20 000 m^2, which is negligible considering the total area of the Agulhas Bioregion.

Key factors influencing the intensity of the impact include:

- Substrate type: The sediment type within the F-O Gas Field is largely sandy unconsolidated sediments with several isolated rocky outcrops. The unconsolidated sediments appear to support rich infaunal communities. The combination of habitat types (soft sediments and rocky formations) results in a highly diverse benthic environment in the study area.
- Conservation value / status: The limited information available does not indicate specific areas of high conservation value or the occurrence of red listed species.
- Degree of mobility of the organisms: Sedentary or relatively immobile species may be physically damaged during the physical disturbance or resulting smothering. The hard ground rocky outcrops support a diverse range of biota characteristic of reef structures (e.g. gorgonians, bryozoans and sponges).
- Life-history: Several of the species occurring in the area are known to be long-lived and slow growing, rendering them vulnerable to disturbance.
- Vessel type: Installation and decommissioning would most likely involve the use of either an anchored or dynamically positioned vessel. In terms of the impact on the benthic environment, the use of an anchored vessel would have an impact on the benthic environment at the point at which the anchors are deployed. There is currently no information pertaining to the number of anchor deployments or

potential drag on the anchor lines and thus it is not possible to quantify the area of benthos that would be affected by the use of anchors. Nevertheless, in terms of the proposed development as a whole, the use of anchors is unlikely to significantly increase the area of affected environment.

With respect to intensity, it is reasonable to suggest that while the benthic fauna would be affected in the immediate environs of the proposed development, populations are likely to regenerate, and thus the intensity is considered to be medium during construction and low during decommissioning.

Past studies investigating the duration of these types of impacts on the benthic fauna suggest that recovery rates, while clearly dependent upon species, are in the region of 2 to 10 years. Taking this into consideration, the duration of the impact is considered to be medium-term.

The impact on the marine benthic environment is therefore considered to be **LOW** with and without mitigation during construction regardless of the subsea infrastructural layout configuration and selected vessel type (see Table 6.7). During decommissioning the impact on the marine benthic environment is considered to be **VERY LOW** with and without mitigation regardless of whether or not the production pipeline is retrieved or abandoned (see Table 6.7).

Mitigation

- If feasible, PetroSA should consider using dynamically positioned rather than anchored vessels; and
- If anchoring vessels are used anchoring should, where possible, be avoided on or adjacent to known sensitive habitat types, such as rocky outcrops and any other structural habitat features. Sensitive areas must be identified during the pipeline route / seabed survey.

Table 6.7: The assessment of the potential impact of physical disturbance on benthic communities during construction and decommissioning.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Construction Phase						
Without mitigation	Local	Medium-term	Medium	Highly probable	**Low**	High
With mitigation	Local	Medium-term	Medium	Highly probable	**LOW**	High
Degree to which impact can be reversed					Fully reversible	
Degree to which impact may cause irreplaceable loss of resources					N/A	
Degree to which impact can be mitigated					Very Low	
Decommissioning Phase						
Without mitigation	Local	Medium-term	Low	Probable	**Very Low**	Medium
With mitigation	Local	Medium-term	Low	Probable	**VERY LOW**	Medium
Degree to which impact can be reversed					Fully reversible	
Degree to which impact may cause irreplaceable loss of resources					N/A	
Degree to which impact can be mitigated					Very Low	

6.1.3.2 Disturbance of fauna by helicopter operations

Description of effect

Helicopters would be used for crew changes between the offshore vessels and George Airport. Such flights could disturb bird colonies and breeding whales.

Assessment

Flying over bird colonies at low altitude can cause disturbances leading to mortalities of the young of these animals. Birds may abandon their nests temporarily thereby exposing the eggs and chicks to predation. Flying over seal colonies at low altitude can cause stampedes of seals to the sea resulting in deaths of juveniles or of nesting birds within the seal colony. The disturbance of whales by helicopters would largely depend on the altitude and distance of the aircraft from the animals and the prevailing sea conditions. The operation of helicopters within authority aviation guidelines and regulations would largely mitigate effects of helicopter noise.

There are a number of protected and sensitive areas along the South Coast (see Table 4.19 and 4.20). The impact of helicopter flights could be of **low to medium** significance, if helicopter flight paths cross any of these areas at an altitude of less than 2 500 feet (see Table 6.8).

Mitigation

- Flight paths must be pre-planned to ensure that no flying occurs over seal and seabird colonies, coastal reserves, marine islands or estuarine systems;
- Extensive coastal flights (parallel to the coast within 1 nautical mile of the shore) should also be avoided. There is a restriction of coastal flights (parallel to the coast within 1 nautical mile of the shore) on the south coast between the months of June and November to avoid Southern Right whale breeding areas;
- The operator must comply with the Seabirds and Seals Protection Act, 1973, which prohibits the wilful disturbance of seals on the coast or on offshore islands;
- Aircraft may not approach to within 300 m of whales in terms of the Marine Living Resources Act, 1998; and
- The contractor should comply fully with all aviation and authority guidelines and rules.

If the suggested mitigation measures are implemented, this impact is expected to be of **VERY LOW** significance (see Table 6.8).

Table 6.8: Assessment of disturbance of fauna by helicopter operations during construction and decommissioning.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Without mitigation	Local	Short-term	Low to High	Probable	**Low to Medium**	Medium
With mitigation	Local	Short-term	Low	Improbable	**VERY LOW**	Medium
Degree to which impact can be reversed					Fully reversible	
Degree to which impact may cause irreplaceable loss of resources					N/A	
Degree to which impact can be mitigated					Low to Medium	

6.1.4 IMPACT ON CULTURAL HERITAGE MATERIAL

Description of impact
The installation of subsea infrastructure could disturb cultural heritage material on the seabed (e.g. historical shipwrecks).

Assessment
The likelihood of disturbing a shipwreck is expected to be very small considering the vast size of the South African offshore area. A route survey (side-scan survey) of the pipeline corridor has been undertaken, which did not indicate the presence of any heritage material on the seabed. The likelihood of impact is further reduced by the fact that a further route survey of the pipeline alignment would be undertaken during pipeline installation using a ROV. Although this impact is considered unlikely, any impact on material of cultural heritage significance could be permanent and of medium intensity. Without mitigation the significance of this unlikely impact on any cultural heritage material is expected to be **medium** (see Table 6.9).

Mitigation
- The final positioning of the pipelines and associated subsea infrastructure should avoid any known cultural heritage material; and
- If any cultural heritage material is found during development SAHRA should be notified immediately. If any material older than sixty years is to be disturbed a permit would be required from SAHRA.

With mitigation, the significance of this impact is assessed to be **INSIGNIFICANT** (see Table 6.9).

Table 6.9: The assessment of the potential impact of subsea infrastructure installation on heritage material.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Without mitigation	Local	Permanent	Medium	Improbable	**Medium**	High
With mitigation	Local	Permanent	Zero	Improbable	**INSIGNIFICANT**	High
Degree to which impact can be reversed					Irreversible	
Degree to which impact may cause irreplaceable loss of resources					High	
Degree to which impact can be mitigated					Medium	

6.1.5 INTERFERENCE WITH SHIPPING

Description of impact:
The presence of the installation and support vessels in waters used by shipping could result in interference with shipping in the area of the F-O Gas Field and the bay of Mossel Bay during installation and decommissioning.

Assessment:
The F-O Gas Field area is located to the south of the eastbound shipping traffic lane. However, the proposed production pipeline from the F-A Platform to the central manifold located centrally on the seabed within the F-O Gas Field would traverse the eastbound shipping traffic lane (see Figure 4.22). Installation and support vessels (see Plates 3.3. to 3.6) would regularly cross the east- and westbound shipping traffic lanes during infrastructure installation operations. Thus, interference with shipping would occur in the short-term, during the construction phase. The current project schedule is based on installing the pipelines during the drilling of

the first development well (February 2012 to August 2012) with the remainder of the subsea infrastructure (umbilicals, platform risers, TIFs, etc.) being installed during the drilling of the second well (October 2012 to January 2013).

This interference is expected to be localised and of medium intensity. Without mitigation this impact is therefore assessed to be of **low** significance (see Table 6.10).

Mitigation

- Prior to the commencement of activities, the operator and its contractors must consult with relevant authorities and key stakeholders including DEA (Branch Oceans and Coasts), PASA, SAMSA, the SAN Hydrographic Office, relevant Port Captains and DAFF. They must be notified of the navigational co-ordinates of any location prior to commencement of such activities;
- A Notice to Mariners must be released prior to installation and decommissioning. The Notice to Mariners should give notice of the infrastructure locations, an indication of the construction and decommissioning timeframes, location reports of the installation vessels, an indication of the 500 m safety zone around the installation vessel and subsea infrastructure, and a special note of any hazard posed by the anchor chains and anchors;
- The Installation and supply vessels that would be used must be certified for seaworthiness through an appropriate internationally recognised marine certification programme (e.g. Lloyds Register, Det Norske Veritas). The certification, as well as existing safety standards, requires that safety precautions would be taken to minimise the possibility of an offshore accident. Collision prevention equipment would include radar, multi-frequency radio, foghorns, etc. Additional precautions include: the existing 24-hour surveillance in the F-A Platform control room, the existence of an internationally agreed 500 m radius activity safety zone around the installation vessel, cautionary notices to mariners and access to current weather service information. Installation and supply vessels must be fully illuminated during twilight and night. The law also requires equipment and training to ensure the safety and survival of the crew in the event of an accident;
- A Notice to Mariners must be released at the end of the construction and decommissioning phases informing all key stakeholders that the vessels are off location; and
- The SAN Hydrographer should be notified regarding the positions of any abandoned infrastructure after decommissioning in order to inform the fishing industry of such obstructions through Navigation Warnings.

Provided normal rules of the sea are observed the interference of the project vessels with shipping traffic could be mitigated. If the suggested mitigation measures are implemented this impact is assessed to be of **VERY LOW** significance (see Table 6.10).

Table 6.10: Impact table relating to the interference of project vessels with shipping traffic during installation and decommissioning.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Without mitigation	Local	Short-term	Medium	Probable	**Low**	High
With mitigation	Local	Short-term	Low	Improbable	**VERY LOW**	High
Degree to which impact can be reversed					Fully reversible	
Degree to which impact may cause irreplaceable loss of resources					N/A	
Degree to which impact can be mitigated					Low	

6.2 PRODUCTION PHASE

Section 6.2.1 assumes a normal operations scenario, where it is assumed that operations proceed smoothly and without any major incidents (i.e. no major gas leak). For the proposed development of the F-O Gas Field, there would be no risk of an oil spill, as only gas and a small percentage of condensate would be produced. However, leaks could occur and thus the potential impacts of an accidental gas release are assessed in Section 6.2.2.

6.2.1 NORMAL OPERATIONS

6.2.1.1 Impact on marine benthic fauna

6.2.1.1.1 Physical presence of infrastructure

Description of impact

There are two areas of potential impact, the first relates to the potential increase in hard substrate habitat available for colonisation by benthic organisms, which may increase biodiversity and biomass in the vicinity of physical structures on the seabed (i.e. pipelines, umbilicals, wellheads, TIFs, etc.). The second relates to a possible restriction or alteration in the migration routes of benthic species.

Assessment

Effects on biodiversity and biomass:

Physical structures on the seabed would effectively increase the amount of hard substrate that is available for the colonisation of benthic organisms, which may result in an increase in biodiversity and biomass in the vicinity of physical structures. Certain fish species, such as kingklip (*Genypterus capensis*) and jacopever (*Helicolenus dactylopterus*) frequently opt to reside close to structural features on the seafloor. Although this impact was previously considered to be positive, a study conducted by Sink *et al.* (2010) in petroleum exclusion zones on the Agulhas Bank revealed very limited benefits to fish species as a result of infrastructure presence. Furthermore, they detected several non-indigenous and invasive species colonising infrastructure, suggesting that the additional hard substrate is most likely not beneficial to natural biodiversity.

The increase of surface area afforded by the proposed infrastructure would be small and as a result the impact on biodiversity and biomass can be expected to be highly localised and of low intensity. The duration of the impact would be long-term, as PetroSA propose to abandon the production pipeline on the seafloor. If the production pipeline were retrieved the duration would be medium-term. The significance of this impact is assessed to be **LOW** with and without mitigation if the pipeline is abandoned on the seafloor and **VERY LOW** with and without mitigation if the pipeline is retrieved during decommissioning (see Table 6.11).

Effects on migrating benthic species:

The South Coast rock lobster (*Palunirus gilchristii*), which occurs in the area at depths between 55 and 360 m, is known to migrate across the benthic environment in the F-O Gas Field area and could potentially be affected by infrastructure such as the production pipeline and flowlines. This could conceivably restrict or alter their natural migration routes, potentially altering lobster behaviour, reduce spawning success and/or survival rates.

Since the production pipeline and flowlines would only be approximately 32 cm and 20 cm in diameter, respectively, it is reasonable to suggest that adult lobsters would be able to move over the production pipeline. In addition, the pipes are likely to settle into the substrate in some areas and lift above it in others, thereby reducing the potential to restrict the movement of the lobsters. Therefore, the impact is considered to be highly localised and of low intensity. The duration of the impact would be long-term, as PetroSA propose to abandon the production pipeline on the seafloor. If the production pipeline were retrieved the duration

would be medium-term. The significance of this impact is assessed to be **MEDIUM** if the pipeline is abandoned on the seafloor and **LOW** if the pipeline is retrieved during decommissioning (see Table 6.12).

Mitigation

An appropriate monitoring and control programme should be developed for non-indigenous invasive marine species. The programme should, at a minimum, take the following into consideration during the production phase:

- All underwater inspections of infrastructure (ROV and SAT diver) should be used as opportunities to acquire footage (close-ups and stills) of marine life associated with the infrastructure;
- Any visual footage of marine growth / features on infrastructure should be distributed to relevant marine ecologists to investigate the presence of potential invasive species; and
- Should species of concern be detected, the spread thereof should be monitored over time.

Table 6.11: Assessment of impact on biodiversity and biomass due to the physical presence of infrastructure.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Production pipeline abandonment during decommissioning						
Without mitigation	Local	Long-term	Low	Highly probable	Low	High
With mitigation	Local	Long-term	Low	Highly probable	LOW	High
Degree to which impact can be reversed					Irreversible	
Degree to which impact may cause irreplaceable loss of resources					Very Low	
Degree to which impact can be mitigated					Very Low	
Production pipeline retrieval during decommissioning						
Without mitigation	Local	Medium-term	Low	Highly probable	Very Low	High
With mitigation	Local	Medium-term	Low	Highly probable	VERY LOW	High
Degree to which impact can be reversed					Fully reversible	
Degree to which impact may cause irreplaceable loss of resources					Very Low	
Degree to which impact can be mitigated					Very Low	

Table 6.12: Assessment of impact on migrating benthic species due to the physical presence of infrastructure.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Production pipeline abandonment during decommissioning						
Without mitigation	Local	Long-term	Medium	Probable	Medium	Medium
With mitigation	Local	Long-term	Medium	Probable	MEDIUM	Medium
Degree to which impact can be reversed					Partially-reversible	
Degree to which impact may cause irreplaceable loss of resources					N/A	
Degree to which impact can be mitigated					Very Low	

	Extent	Duration	Intensity	Probability	Significance	Confidence
Production pipeline retrieval during decommissioning						
Without mitigation	Local	Medium-term	Medium	Probable	Low	Medium
With mitigation	Local	Medium-term	Medium	Probable	LOW	Medium
Degree to which impact can be reversed					Fully reversible	
Degree to which impact may cause irreplaceable loss of resources					N/A	
Degree to which impact can be mitigated					Very Low	

6.2.1.1.2 Cumulative impact on the benthic environment

The cumulative impact considered here relates to the presence of the infrastructure (existing and proposed) on the environment. The total area impacted as a result of the existing PetroSA oil and gas infrastructure in the area is approximately 0.18 km^2, which represents approximately 0.0006 % of the Agulhas Bioregion (Quick and Sink, 2005). Both phases of the proposed gas field development would impact an additional approximately 0.05 km^2 representing 0.0002 % of the Agulhas Bioregion. Combined, the area affected by the developments would be approximately 0.0008 % of the Agulhas Bank resource, which is considered to be negligible. Therefore, it is reasonable to suggest that considering the current status of the developments in the area, the cumulative impact associated with the proposed development of the F-O Gas Field is considered to be of **LOW** significance.

It should also be noted that at the end of the F-O Gas Field's economic life, as well as that of other gas (South Coast Gas, E-M and F-A) and oil (Oribi/Oryx and Sable) fields, infrastructure would be removed during decommissioning, which would mitigate this impact to a certain extent.

6.2.1.2 Potential impact on fishing

6.2.1.2.1 Increased fishing effort and loss of catch as a result of the proposed safety zone around subsea infrastructure

Description of impact

In order to protect the subsea infrastructure (e.g. production pipeline, wellheads, Xmas trees, TIFs, umbilicals, flow lines, etc.), PetroSA would establish a 500 m safety zone around the subsea infrastructure as defined in the Marine Traffic Act (No. 2 of 1981). This could potentially increase fishing effort and disrupt fishing activities due to the reduction in the length of trawls and time lost hauling and setting gear, as fishermen would have to lift their gear when they traverse a safety zone. In addition, the proposed safety zone would result in the loss-of-access to fishing grounds and associated loss of catch from these areas.

Assessment

The only two fishing sectors that could potentially be impacted by the proposed safety zone are demersal longlining and South Coast Rock Lobster longlining. However, if the demersal trawling and midwater trawling move into the area in future there could be an impact on these sectors as well. There would be no anticipated impact on the pelagic longline fishery.

It is estimated that the proposed project would extend the operational life of the GTL refinery to at least 2020. Therefore, production or operational impacts are generally considered to take place over the medium-term within the project area (i.e. localised). However, if new gas reserves are identified then infrastructure could remain for a longer period thereby extending the duration of the impact on fishing.

Demersal longline

The proposed F-O Gas Field development area coincides with the western extent of heavily longlined grounds (see Figure 4.16). Commercial catch records show that 26 longlines were set directly across the proposed safety zone between 2002 and 2008. Together these lines yielded an average annual catch of approximately 7.2 t of hake (i.e. approximately 0.09% of Total Allowable Catch). Based on the average Cost of Insurance and Freight price in 2010 this equates to a value of € 31,766 per year (i.e. R 295,900 at the exchange rate of 12 Oct 2010).

The impact on the demersal longline sector is considered to be localised and of medium intensity. The duration of the impact would be medium-term for both decommissioning alternatives (i.e. production pipeline abandonment or retrieval), as this fishery would be able to set their lines over the abandoned pipeline. The significance of this impact is assessed to be **LOW** regardless of the subsea layout configuration and decommissioning alternative (see Table 6.13).

South Coast Rock Lobster longline

The main fishing grounds lie to the south-west and north / north-east of the proposed F-O Gas Field Development area and there is no evidence of fishing activity in the vicinity of the proposed F-O Production right area (see Figure 4.20). However, the proposed production pipeline from the F-A Platform to the F-O Gas Field intersects Grid No. 195, which yielded approximately 5 t of lobster tail in 1999. The effective safety area surrounding the section of pipeline within this grid would be 7.3 km^2 and assuming that fishing effort is distributed evenly over the entire area of Grid No. 195 this constitutes a 2.6 % reduction in fishable area. The delivery price (May 2008) of exported frozen tails ranges from $63.80/kg to $44.00/kg (dependent on, for example, quality and tail size). Assuming that fishing takes place uniformly over the entire area of Grid No. 195, the safety zone surrounding the installation of a pipeline from the F-A Platform to the F-O Gas Field could result in a loss of 134 kg of landed frozen tail (i.e. approximately 0.03% of Total Allowable Catch) at a value of between $5,896 (R 45,554) and $8,549 (R 66,052) in any given year[1].

The impact on the South Coast Rock Lobster longline sector is considered to be localised and of low intensity. The duration of the impact would be medium-term for both decommissioning alternatives (i.e. production pipeline abandonment or retrieval), as this fishery would be able to set their lines over the abandoned pipeline. The significance of this impact is assessed to be **VERY LOW** regardless of the subsea layout configuration and decommissioning alternative (see Table 6.13).

Demersal trawl

There is no anticipated impact on the demersal trawl fishery as the closest trawling grounds are located approximately 30 km to the south-east of the proposed F-O wells (see Figure 4.12). However, in the unlikely event that trawling was to move into the area in future there could be a disruption to trawling activities and associated loss of catch.

The impact on the demersal trawl sector is considered to be localised and of low intensity regardless of the subsea layout configuration. The duration of the impact would be long-term, as PetroSA propose to abandon the production pipeline on the seafloor. If the production pipeline were retrieved the duration would be medium-term. This improbable impact is assessed to be **LOW** significance for pipeline abandonment and of **VERY LOW** significance for pipeline retrieval (see Table 6.13). No mitigation is considered necessary.

Midwater trawl

Although there is evidence of activity in the south-eastern area of the proposed F-O Production Right area, the proposed safety zone does not coincide with the trawled grounds (see Figure 4.14). However, in the unlikely event that trawling was to move into the area in future there would be a risk of gear fouling since midwater gear occasionally touches the seafloor. This could result in a disruption to trawling activities and associated loss of catch.

[1] This value was calculated from the maximum recorded annual catch over the period 1997 to 2006.

The impact on the midwater trawl sector is considered to be localised and of low intensity regardless of the subsea layout configuration. The duration of the impact would be long-term, as PetroSA propose to abandon the production pipeline on the seafloor. If the production pipeline were retrieved the duration would be medium-term. This improbable impact is assessed to be **LOW** significance for pipeline abandonment and of **VERY LOW** significance for pipeline retrieval (see Table 6.13). No mitigation is considered necessary.

Mitigation

The alternative of retrieving the production pipeline, although not proposed, would mitigate the impact on demersal trawling and mid-water trawling in the long-term from **LOW** to **VERY LOW** significance.

Proposed mitigation includes:

- Notify the fishing industry prior to construction regarding timing, safety zone and subsea infrastructure (e.g. production pipeline, TIFs, flowlines, wellheads, etc.) positions. The channel of communication should be through established industrial bodies, particularly for longlining and trawling; and
- The SAN Hydrographer should be notified regarding the positions of any abandoned infrastructure in order to inform the fishing industry of such obstructions through Navigation Warnings.

Table 6.13: Assessment of the potential impact relating to increased fishing effort and loss of catch.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Demersal longline: Production pipeline abandonment during decommissioning						
Without mitigation	Local	Medium-term	Medium	Highly probable	Low	High
With mitigation	Local	Medium-term	Medium	Highly probable	LOW	High
Degree to which impact can be reversed					Fully reversible	
Degree to which impact may cause irreplaceable loss of resources					N/A	
Degree to which impact can be mitigated					Very Low	
Demersal longline: Production pipeline retrieval during decommissioning						
Without mitigation	Local	Medium-term	Medium	Highly probable	Low	High
With mitigation	Local	Medium-term	Medium	Highly probable	LOW	High
Degree to which impact can be reversed					Fully reversible	
Degree to which impact may cause irreplaceable loss of resources					N/A	
Degree to which impact can be mitigated					Very Low	
South Coast Rock Lobster Longline: Production pipeline abandonment during decommissioning						
Without mitigation	Local	Medium-term	Medium	Probable	Low	High
With mitigation	Local	Medium-term	Medium	Probable	LOW	High
Degree to which impact can be reversed					Fully reversible	
Degree to which impact may cause irreplaceable loss of resources					N/A	
Degree to which impact can be mitigated					Very Low	

	Extent	Duration	Intensity	Probability	Significance	Confidence
South Coast Rock Lobster Longline: Production pipeline retrieval during decommissioning						
Without mitigation	Local	Medium-term	Medium	Probable	Low	High
With mitigation	Local	Medium-term	Medium	Probable	LOW	High
Degree to which impact can be reversed					Fully reversible	
Degree to which impact may cause irreplaceable loss of resources					N/A	
Degree to which impact can be mitigated					Very Low	
Demersal trawl: Production pipeline abandonment during decommissioning						
Without mitigation	Local	Long-term	Low	Improbable	Low	High
With mitigation	Local	Long-term	Low	Improbable	LOW	High
Degree to which impact can be reversed					Partially reversible	
Degree to which impact may cause irreplaceable loss of resources					N/A	
Degree to which impact can be mitigated					Very Low	
Demersal trawl: Production pipeline retrieval during decommissioning						
Without mitigation	Local	Medium-term	Low	Improbable	Very Low	High
With mitigation	Local	Medium-term	Low	Improbable	VERY LOW	High
Degree to which impact can be reversed					Fully reversible	
Degree to which impact may cause irreplaceable loss of resources					N/A	
Degree to which impact can be mitigated					Very Low	
Midwater trawl: Production pipeline abandonment during decommissioning						
Without mitigation	Local	Long-term	Low	Improbable	Low	High
With mitigation	Local	Long-term	Low	Improbable	LOW	High
Degree to which impact can be reversed					Partially reversible	
Degree to which impact may cause irreplaceable loss of resources					N/A	
Degree to which impact can be mitigated					Very Low	
Midwater trawl: Production pipeline retrieval during decommissioning						
Without mitigation	Local	Medium-term	Low	Improbable	Very Low	High
With mitigation	Local	Medium-term	Low	Improbable	VERY LOW	High
Degree to which impact can be reversed					Fully reversible	
Degree to which impact may cause irreplaceable loss of resources					N/A	
Degree to which impact can be mitigated					Very Low	

6.2.1.2.2 Cumulative impact on fishing activities

Description of impact

Existing exclusion zones, safety areas and infrastructure in Petroleum Licence Block 9 (including Oribi/Oryx Field, Sable Field, F-A Platform, F-A pipelines to shore, E-M pipeline, South Coast Gas Field and 50 existing wells) have reduced fishing grounds of the various fishing sectors in the South Coast offshore region (see Table 6.14). The proposed development of the F-O Gas Field and associated safety zone would further reduce some of these fishing grounds.

The reduction in fishing grounds has increased fishing effort due to the reduction in the length of trawls and time lost due to hauling and setting gear. In addition, safety zones have resulted in the loss-of-access to portions of fishing grounds and associated loss of catch from these areas.

Assessment

The main impact from historic oil and gas development in the South Coast offshore region has been on the trawling fishery, specifically within and around the Blues trawling ground. To date there has been an approximately 108 km^2 reduction in trawling grounds on the South Coast amounting to a loss of 0.34% of the trawlable area (see Table 6.14). Although the proposed F-O Gas Field development project is located to the east of the Blues trawling ground and away from the high intensity trawling grounds, there could be an impact on the demersal and midwater trawling sectors if trawling moves into the area in future. The likely future cumulative impact of the proposed project on the trawling fishery is considered to range from **LOW** (midwater trawl) to **MEDIUM** (demersal trawl) significance.

The two fishing sectors that could potentially be directly impacted by the proposed safety zone associated with the F-O Gas Field development include demersal longlining and South Coast Rock Lobster longlining sectors. To date there has been no reduction to the demersal longline sector on the South Coast, while the South Coast Rock Lobster longlining sector has been reduced by approximately 7 km^2 by existing oil and gas development (i.e. 0.014% reduction). The proposed development of the F-O Gas Field would reduce the demersal longlining sector by approximately 53 km^2 (0.27 %) and would further reduce the South Coast Rock Lobster longlining by an approximately 7 km^2 resulting in a total loss of 0.03% (see Table 6.14). The cumulative impact on the demersal longline and South Coast Rock Lobster longline sectors is considered to be of **LOW** significance.

It should be noted that the significance of the cumulative impact would decrease when the proposed project is decommissioned and when the economical life of the existing fields (e.g. South Coast Gas, E-M, F-A, Sable and Oribi/Oryx) have been reached and PetroSA commences with decommissioning activities.

Table 6.14: Percentage reduction to fishing areas in the South Coast offshore region.

Fishing Sector	Existing area of fishing ground on South Coast (East of 20°E)	Existing area of exclusion on the South Coast (East of 20°E)	Additional area of exclusion related to the F-O Gas Field	Total area of exclusion on the South Coast (East of 20°E)	Total % reduction of sector on the South Coast (East of 20°E)
Demersal trawl	31 736.2 km^2	108.2 km^2	0	108.2 km^2	0.34 %
Midwater trawl	11 625.1 km^2	0	0	0	0 %
Demersal longline	19 613.3 km^2	0	53.21 km^2	53.21 km^2	0.27 %
South Coast Rock Lobster	49 938.8 km^2 *	6.9 km^2	7.3 km^2	14.2 km^2	0.03 %

* Fine-scale data not available (area possibly over-estimated)

6.2.1.3 Other production-related impacts

Description of effect

The proposed development of the F-O Gas Field could have a number of impacts, both positive and negative, associated with the production phase, e.g. emissions, discharges, employment, household income, GDP, government revenue, etc.

Assessment

Although the proposed development of the F-O Gas Field would increase the gas resource, the throughput of gas at the F-A Platform would be kept constant at around 200 MMscf per day. Gas and condensate production is separated at the F-A Platform and then transported to the GTL refinery through the existing subsea pipelines. A few modifications to the F-A Platform systems would be necessary to accommodate the proposed F-O development. PetroSA would continue to operate as at present under their existing emission permits and licenses.

All operations and identified impacts at the F-A Platform and associated F-O subsea infrastructure would be managed and monitored in accordance with existing methodologies set out in PetroSA's existing integrated SHEQ system and EMP for the FA-EM production area. The production-related aspects of the FA-EM production area EMP have been included in the EMP prepared for the F-O production area (see Appendix 8).

Essentially, there would be no change to the existing situation, other than extending the operation of the GTL refinery past 2013/2014, and the proposed operation of the F-O Gas Field would result in **no additional production-related impacts**. The No-Go Alternative is assessed in Section 6.3.

6.2.2 ACCIDENTAL RELEASE OF GAS

6.2.2.1 Introduction

The causes of pipeline damage can differ widely. In general, they range from material defects and pipe corrosion to ground erosion, tectonic movements on the bottom and impacts from ship anchors and trawling gear. The likelihood of accidents occurring on subsea pipelines is extremely small. According to Patin (1999), the main causes of these accidents are material and welding defects.

A pipeline could be the source of small and long-term leakage or an abrupt blow-out of gas, depending on the nature of the damage (e.g. cracks or ruptures). The dissolution, dilution and transferring of the gaseous products in the marine environment could be accompanied in some cases by ice and gas hydrates formation.

The proposed production pipeline would be located in a 1 km wide safety zone. The design, construction and installation of the pipeline would be in accordance with recognised international standards. Various options for mechanical protection of pipeline and other subsea infrastructure from accidental fishing gear interaction are available and have been evaluated by PetroSA (see Section 3.5.8).

Operational, maintenance and engineering procedures would be put in place for continuous monitoring and regular inspection of the condition of the new pipelines. A programme of routine surveys of the subsea pipeline and wellhead equipment, during their operational life, would be used as a basis for detection of changes to the physical condition along the pipeline route. The programme would comprise regular external pipeline surveys (e.g. with side scan sonar and low penetration echo sounder) for potential problems such as scour, unsupported pipe sections, any anchor damage and debris collection. In addition, corrosion detectors would be installed on the pipelines to continuously monitor the integrity of the pipe wall.

Well-established industry techniques are available for repairing pipeline damage, which does not involve significant environmental disturbance should any damage to the pipeline be detected. Scheduled visual inspection would be undetaken and any leak detection would be handled according to existing standard procedures.

6.2.2.2 Impact on water column and sea bottom

Description of impact

If gas escapes from damaged pipeline infrastructure, it would be forced into the water column and disperse with the currents and could have an impact on marine organisms.

Assessment

Methane (F-O gas is approximately 89% methane) is almost insoluble in the water column (natural concentrations in seawater are in the range of 10-100 µg/l) and would bubble to the surface and enter the atmosphere. Methane is not toxic and does not have any long-term physiological effects. However, it is possible that the methane may suffocate poorly mobile organisms, e.g. plankton, fish eggs and larvae. The impact of released gas (methane) on the pelagic marine organisms would be local (restricted to the environments of the well or leak) and could be of medium intensity. Monitoring would ensure the impact is of short-term duration. The significance of this impact is considered to be **VERY LOW** with and without mitigation (Table 6.15).

Mitigation

Monitoring and management measures should be implemented to assist in the detection of uncontrolled releases and ensure that appropriate actions are taken to bring the release under control. The proposed project should fit into the current inspection schedule for the F-A Platform (including associated infrastructure), as presented in PetroSA's existing EMP for the FA-EM production area[2]. The current inspection schedule includes ROV inspections and / or side scan sonar at least once every five years.

Table 6.15: Assessment of impact of gas release on water column and sea bottom.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Without mitigation	Local	Short- term	Medium	Improbable	Very low	High
With mitigation	Local	Short-term	Low	Improbable	VERY LOW	High
Degree to which impact can be reversed					Fully reversible	
Degree to which impact may cause irreplaceable loss of resources					N/A	
Degree to which impact can be mitigated					Very Low	

6.2.2.3 Impact on the atmosphere

Description of impact

In the event of a gas release, methane gas, which is considered to be a 'greenhouse gas' could be released to the atmosphere. Methane is implicated in global warming i.e. it acts by storing heat in the atmosphere. Methane (15%) is second only to carbon dioxide (50%) in contributing to global warming (WMO, 1992).

[2] The production-related aspects of the FA-EM production area EMP have been included in the EMP prepared for the F-O production area (see Appendix 8).

Assessment

While any unnecessary addition of greenhouse gases to the atmosphere is undesirable, the volume of an accidental release from damaged pipeline infrastructure is insignificant in terms of the total volume of greenhouse gases released daily into the global atmosphere. Considering the improbability of such an uncontrolled release of gas, the significance of the impact is assessed to be **VERY LOW** with and without mitigation (Table 6.16).

Mitigation

Monitoring and management measures should be implemented to assist in the detection of uncontrolled releases and ensure that appropriate actions are taken to bring the release under control. The proposed project should fit into the current inspection schedule for the F-A Platform (including associated infrastructure), as presented in PetroSA's existing EMP for the FA-EM production area. The current inspection schedule includes ROV inspections and / or side scan sonar at least once every five years.

Table 6.16: Assessment of the impact of an accidental gas release of the atmosphere.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Without mitigation	Local	Short-term	Low	Improbable	Very Low	High
With mitigation	Local	Short-term	Low	Improbable	VERY LOW	High
Degree to which impact can be reversed					Fully reversible	
Degree to which impact may cause irreplaceable loss of resources					N/A	
Degree to which impact can be mitigated					Very Low	

6.2.2.4 Conclusion

An accidental release of gas at worst would have a local, short-term impact, which could be mitigated by immediately repairing the pipeline leak.

6.3 NO-GO OPTION

Description of impact

The implications of not going ahead with the proposed development of the F-O Gas Field are as follows:

- South Africa would loose the opportunity to further establish the extent of indigenous gas reserves on the South Coast;
- If economic gas reserves do exist and are not developed, South Africa / PetroSA would loose the opportunity to:
  - ⇒ maximise the use of its own indigenous gas reserves; and
  - ⇒ use the reserves as possible feedstock for the GTL refinery.
- Lost economic opportunities related to sunken costs (i.e. costs already incurred) of exploration in the F-O Gas Field; and
- PetroSA has indicated that if the F-O Gas Field is not developed, the GTL refinery would be abandoned in 2013/2014 (IHS Global Insight Southern Africa, 2010). The impact of abandonment would have an impact on employment, Gross Domestic Product (GDP), household income and government revenue.

Assessment

The implications related to the lost opportunity to further explore and utilise gas reserves on the South Coast and the possible abandonment of the GTL refinery are detailed below (IHS Global Insight Southern Africa, 2010):

- *Employment:* A total of 3 081 and 9 805 employment opportunities are sustained annually by the GTL refinery in the Mossel Bay Local Municipality and Western Cape, respectively. This accounts for approximately 10% of total employment in the Municipality and 3.5% of all employees in the mining and manufacturing sectors in the Western Cape;
- *GDP:* The total contribution to GDP due to the operation of the GTL refinery would amount to an estimated R 1.7 billion annually until abandonment. This is approximately 26.1% of Mossel Bay's economy and 6.1% of the economy of the Eden District Municipality. Currently, the GTL refinery contributes R 4.4 billion and R 6.9 billion annually to the economies of the Western Cape and South Africa, respectively;
- *Household income:* The total contribution to household income in the Western Cape as a result of current operations at the GTL refinery is approximately R 2.9 billion per annum. Of this amount, approximately 16.8% (or R 478.5 million) is destined for low-income households. It is estimated that R 1.2 billion of the total benefit on household income accrue to households in the Mossel Bay Local Municipality; and
- *Government revenue:* It is estimated that National Government is currently earning tax revenue of an estimated R 2.8 billion per annum due to the operation of the GTL refinery.

All of these positive contributions to employment, GDP, household income and government revenue would cease if the GTL refinery was abandoned. The potential impact related to the lost opportunity to further explore and utilise gas reserves on the South Coast and the possible abandonment of the GTL refinery is considered to be of **VERY HIGH** significance (see Table 6.17).

Table 6.17: Assessment of impact related to No-Go alternative.

	Extent	Duration	Intensity	Probability	Significance	Confidence
Without mitigation	National	Permanent	High	Probable	**VERY HIGH**	Medium

7. CONCLUSION AND RECOMMENDATIONS

PetroSA is proposing to develop the F-O Gas Field in Petroleum Licence Block 9 off the South Coast of South Africa in two phases. It is proposed to drill and collect gas from up to fourteen wells via a new approximately 39 km subsea production pipeline that would connect each well and route the gas to the existing F-A Platform for processing. Phase 1 development would consist of five to eight production wells, with an additional four to six wells envisaged as a Phase 2 development. The final number of wells is dependant on the success of the initial five wells and production experience gained during the initial field operation.

CCA was appointed to act as the independent environmental consultant to undertake the necessary Scoping Study and EIA, EMP and associated public consultation process for the proposed project. The EIA process was undertaken so as to comply with the requirements of the EIA Regulations 2006 promulgated in terms of Chapter 5 of NEMA (No. 107 of 1998) and MPRDA (No. 28 of 2002). However, CCA has taken cognisance of the EIA Regulations 2010 and, where necessary, has expanded the EIA process to ensure compliance to the revised regulations.

A public participation process was undertaken as part of the Scoping Study Phase, which resulted in the identification of a number of key issues of concern by I&APs and the EIA team. Three specialist studies were undertaken to address potential impacts relating to fishing and the marine benthic environment, as well as assess the risk associated with the proposed onshore drilling and completion fluids plant. The findings of the specialist studies and other relevant information have been integrated and synthesised into this Draft EIR. The two main objectives of this Draft EIR are, firstly, to assess the environmental significance of impacts resulting from the proposed development of the F-O Gas Field and to suggest ways of mitigating negative impacts and enhancing benefits, and secondly to provide I&APs with an opportunity to comment on the proposed project.

This chapter summarises the key findings of the study and presents the recommendations in terms of mitigation measures that should be implemented if the proposed development goes ahead.

7.1 CONCLUSIONS

7.1.1 F-O WELL DRILLING

A summary of the assessment of potential environmental impacts associated with the proposed well drilling in the F-O Gas Field is provided in Table 7.1.

The majority of the impacts associated with well drilling would occur in the immediate vicinity of each drilling location, would be of short- to medium-term duration (i.e. reversible) and of low to medium intensity, and are considered to be of **VERY LOW** to **LOW** significance after mitigation.

The key impact, although unlikely, associated with drilling operations relates to the introduction of non-indigenous invasive marine species through vessels and equipment transfer and ballast water discharge. The improbable introduction of non-indigenous invasive species (e.g. the anemones, *Metridium senile* and *Sagartia elegans*) due to vessels and equipment transfer and the discharge of ballast water could result in an impact of **high to very high** significance. This impact is not unique to the proposed project, but rather a threat common to the South African offshore environment from the numerous vessels that pass through South African coastal waters daily. Mitigation would only serve to reduce the probability of occurrence. However, if the impact did occur it could remain of **HIGH** to **VERY HIGH** significance.

The main risk relating to the proposed drilling and completion fluids plant, which would be located on Pier 9 in the Mossel Bay Harbour, relates to the unlikely event of a tank or bund fire. Of all the material stored on site, the base fluid (Mosspar H) is the only material with the potential to ignite and cause a tank or bund fire. As the probability of ignition is extremely low, the risks of a fire at the proposed plant would be less than $1x10^{-10}$ fatalities per person per year, resulting in the individual and societal risks being classified as trivial (i.e. an acceptable risk). Provided no other hazardous materials are stored or produced at the drilling and completion fluids plant, it would not be classified as a MHI. The significance of this improbable impact is assessed to be of **VERY LOW** significance with and without mitigation.

Table 7.1: Summary of the significance of the potential impacts associated with the proposed well drilling in the F-O Gas Field.

Potential impact		Significance	
		Without mitigation	With mitigation
1. Normal drilling unit, support vessel and helicopter operation:			
Emissions to the atmosphere		VL	**VL**
Deck drainage into the sea		VL	**VL**
Machinery space drainage into the sea		VL	**VL**
Sewage effluent into the sea		VL	**VL**
Galley waste disposal into the sea		VL	**VL**
Solid waste disposal into the sea		Insig.	**INSIG.**
Noise from drilling unit and support vessel operation		VL	**VL**
Noise from helicopter operation		L-M	**VL**
2. Impact of well drilling on marine fauna:			
Physical damage and sediment disturbance		L	**L**
Smothering by cuttings and drilling fluid and plume turbidity		L	**L**
Biochemical effects of discharged drilling fluid and contaminated cuttings	Water-based fluids	L	**L**
	Non-aqueous drilling fluids	L	**L**
Drilling noise		VL	**VL**
Faunal attraction to drilling units		VL	**VL**
Vessel & equipment transfer and discharge of ballast water		H-VH	**H-VH**
Cumulative impact		L	
3. Impact on cultural heritage material:			
Impact on historical shipwrecks		M	**INSIG.**
4. Impact on other users of the sea:			
Marine transport routes		L	**L**
Fishing industry (including cumulative impact)		See Table 7.2	
5. Risk associated with drilling and completion fluids plant:			
Thermal radiation associated with a tank or bund fire		VL	**VL**
6. Accidental release of gas or hydrocarbons:			
Impact on water column and sea bottom from an uncontrolled release of natural gas		L	**L**
Impact on the atmosphere from an uncontrolled release of natural gas		VL	**VL**
Impact on marine fauna, fishing and coastal environments from a small hydrocarbon spill		VL	**VL**

VH=Very High	H=High	M=Medium	L=Low	VL=Very low	Insig = Insignificant	N/A= Not applicable

7.1.2 F-O GAS FIELD DEVELOPMENT

A summary of the significance of the potential impacts associated with the infrastructure and operational aspects of the proposed F-O Gas Field (excluding well drilling which is assessed above) is presented in Table 7.2.

7.1.2.1 Construction phase

The construction phase would include the installation of the production pipeline between the F-A Platform and the F-O Gas Field and associated infrastructure (e.g. umbilicals, MEG pipeline, SSIV, TIFs, flowlines, tie-in spool pieces, concrete mattresses, etc.) using installation and support vessels. All impacts associated with the construction phase would be short-term and are considered to range from **INSIGNIFICANT** to **LOW** significance with the implementation of mitigation measures regardless of what final subsea infrastructural layout configuration is selected and what type of vessel is used (namely anchored or dynamically positioned).

7.1.2.2 Production

It is estimated that the proposed project would extend the operational life of the GTL refinery to at least 2020. Therefore, production or operational impacts are generally considered to take place over the medium-term within the project area (i.e. localised). However, some impacts are considered to take place over the long-term where these relate to the proposed abandonment of the production pipeline on the seafloor.

The most significant impact relates to the effect on benthic migrating species due to the physical presence and the proposed abandonment of the production pipeline (**MEDIUM** significance with and without mitigation). The alternative of retrieving the production pipeline during decommissioning, which was assessed for comparative purposes, would result in the impact taking place over the medium term, which would lower the significance of the impact to **LOW** with and without mitigation. Although pipeline abandonment would result in a more significant impact on migrating species, it is reasonable to suggest that adult lobsters would be able to move over the production pipeline, which would be only approximately 32 cm in diameter. In addition, the pipeline is likely to settle into the substrate in some areas and lift above it in others, thereby reducing the potential to restrict the movement of this species.

A potentially key concern at the onset of the EIA was the impact of the proposed infrastructure and associated 500 m safety zone on the fishing industry during the production phase in terms of increased fishing effort and loss of catch. The only two fishing sectors that could potentially be impacted by the proposed safety zone around the subsea infrastructure are demersal longlining and South Coast Rock Lobster longlining. The impact on these sectors due to the proposed safety zone is considered to be of **LOW** significance regardless of the decommissioning alternative, as these fisheries would be able to set their lines over the abandoned pipeline. If demersal trawling and midwater trawling move into the area in the future there could be an impact on these sectors as well. The unlikely impact on the demersal trawling and midwater trawling sectors ranges from **LOW** (pipeline abandonment) to **VERY LOW** (pipeline retrieval) significance. Pipeline abandonment would increase the duration of the impact from medium-term to long-term should these fishing sectors move into the area.

Gas from the F-O Gas Field would be routed to the existing F-A Platform for processing. Although the proposed development of the F-O Gas Field would increase the gas resource, the throughput of gas at the F-A Platform would be kept constant at around 200 MMscf per day. PetroSA would continue to operate as at present under their existing emission permits and licenses. All operations and identified impacts at the F-A Platform would be managed and monitored in accordance with existing methodologies set out in PetroSA's integrated SHEQ system and FA-EM production area EMP. The production-related aspects of the FA-EM production area EMP have been included in the EMP prepared for the F-O production area. The proposed development of the F-O Gas Field would not result in any **additional production-related impacts**.

7.1.2.3 Decommissioning

On completion of the economic life of the F-O Gas Field, the wells (including the two appraisal wells, F-O6 and F-O8) and infrastructure installed for the proposed project would be decommissioned. PetroSA propose to remove all SSXT and wellheads from the seafloor. The wells would be plugged with cement and tested for integrity. The SSIV assembly, TIFs, metering skids, flowlines, MEG pipelines and umbilicals would be removed as far as is practicable. Concrete mattresses and concrete blocks (less than 0.5 m high) used to stabilise the pipelines and other overtrawlable structures would be left behind on the seafloor. The production pipeline would be thoroughly flushed, plugged off and left on the seabed.

All impacts associated with the decommissioning phase are considered to be of **VERY LOW** significance with the implementation of mitigation measures regardless of whether or not the production pipeline is retrieved or abandoned.

Table 7.2: Summary of the significance of potential impacts associated with the proposed development of the F-O Gas Field.

Impact			Alternative (where applicable)	Significance	
				Without mitigation	With mitigation
1. Construction					
Emissions to air			-	VL	**VL**
Effluent and waste disposal	*Deck drainage*		-	VL	**VL**
	Machinery space drainage		-	VL	**VL**
	Sewage		-	VL	**VL**
	Galley wastes		-	VL	**VL**
	Solid waste		-	Insig	**INSIG.**
Impact on benthic communities	*Physical damage*		Any subsea infrastructural layout and vessel type	L	**L**
Disturbance of fauna by helicopter operations			-	L-M	**VL**
Interference with shipping			All subsea layouts	L	**VL**
Impact on cultural heritage			All subsea layouts	M	**INSIG.**
2. Production					
2.1 Normal operation					
Impact on benthic communities	*Physical presence of infrastructure*	*Effect on biodiversity and biomass*	Pipeline abandonment	L (+ve)	**L (+ve)**
			Pipeline retrieval	VL (+ve)	**VL (+ve)**
		Effects on migrating species	Pipeline abandonment	M	**M**
			Pipeline retrieval	L	**L**
Impact on fishing	*Increased fishing effort and loss of catch*	*Demersal longline*	All subsea infrastructural layouts and both pipeline decommissioning alts	L	**L**
		South Coast Rock Lobster longline	All subsea infrastructural layouts and both pipeline decommissioning alts	L	**L**
		Demersal trawl	All subsea infrastructural layouts and pipeline abandonment	L	**L**
			All subsea infrastructural layouts and pipeline retrieval	VL	**VL**
		Midwater trawl	All subsea infrastructural layouts and pipeline abandonment	L	**L**
			All subsea infrastructural layouts and pipeline retrieval	VL	**VL**

Impact			Alternative (where applicable)	Significance Without mitigation	Significance With mitigation
2.2 Accidental gas leak					
Impact on water column and sea bottom			-	VL	**VL**
Impact on the atmosphere			-	VL	**VL**
3. Decommissioning					
Emissions to air			-	VL	**VL**
Effluent and waste disposal	*Deck drainage*		-	VL	**VL**
	Machinery space drainage		-	VL	**VL**
	Sewage		-	VL	**VL**
	Galley wastes		-	VL	**VL**
	Solid waste		-	N/A	**N/A**
Impact on benthic communities	*Physical damage*		Both pipeline decommissioning alts and vessel type	VL	**VL**
Disturbance of fauna by helicopter operations			-	L-M	**VL**
Interference with shipping			-	L	**VL**
4. Cumulative Impact					
Impact on benthic communities in Block 9			Both pipeline decommissioning alts and vessel type	L	
Impact on fishing	*Increased fishing effort and loss of catch*	*Demersal longline*		L	
		South Coast Rock Lobster longline		L	
		Demersal trawl		M	
		Midwater trawl		L	
5. No-Go Alternative					
Lost opportunity to further explore and utilise gas reserves on the South Coast and possible abandonment of the GTL plant in Mossel Bay in 2013/2014			-	VH	

VH=Very High	H=High	M=Medium	L=Low	VL=Very low	Insig = Insignificant	N/A= Not applicable

7.1.3 CUMULATIVE IMPACT

The main impact from historic oil and gas development in the South Coast offshore region has been on the trawling fishery, specifically within and around the Blues trawling ground. To date there has been an approximately 108 km^2 reduction in trawling grounds on the South Coast amounting to a loss of 0.34% of the trawlable area. Although the proposed F-O Gas Field development project is located to the east of the Blues trawling ground and away from the high intensity trawling grounds, there could be an impact on the demersal and midwater trawling sectors if trawling moves into the area in future. The likely future cumulative impact of the proposed project on the trawling fishery is considered to range from **LOW** (midwater trawl) to **MEDIUM** (demersal trawl) significance.

The two fishing sectors that could potentially be directly impacted by the proposed safety zone associated with the F-O Gas Field development include demersal longlining and South Coast Rock Lobster longlining sectors. To date there has been no reduction to the demersal longline sector on the South Coast, while the South Coast Rock Lobster longlining sector has been reduced by approximately 7 km^2 by existing oil and gas development (i.e. a 0.014% reduction). The proposed development of the F-O Gas Field would reduce the demersal longlining sector by approximately 53 km^2 (0.27 %) and would further reduce the South Coast Rock Lobster longlining by an approximately 7 km^2 resulting in a total loss of 0.03%. The cumulative impact on both the demersal longline and South Coast Rock Lobster longline sectors is considered to be of **LOW** significance. It should be noted that the significance of the cumulative impact would decrease when the proposed project is decommissioned and when the economical life of the existing fields (e.g. South Coast Gas, E-M, F-A, Sable and Oribi/Oryx) have been reached and PetroSA commence with decommissioning activities.

The cumulative impact on the marine benthic environment relates to both well drilling and the presence of physical infrastructure (existing and proposed). The total area impacted as a result of the existing PetroSA oil and gas infrastructure in the Agulhas Bioregion is approximately 0.18 km^2 representing 0.0006 % of the Agulhas Bioregion (note: this area excludes the area impacted by the deposition of drill cuttings as these areas are expected to have recovered). The proposed well drilling programme (specifically the discharge of cuttings) would impact an additional approximately 3.5 km^2 representing 0.012 % of the Agulhas Bioregion. The proposed subsea infrastructure would impact an additional approximately 0.05 km^2 representing 0.0002 % of the Agulhas Bioregion. Combined, the area affected by the developments (existing and proposed) would be approximately 3.73 km^2 representing 0.013 % of the Agulhas Bank resource, which is considered to be negligible. Therefore, it is reasonable to suggest that considering the current status of the developments in the area, the cumulative impact associated with the proposed development of the F-O Gas Field is considered to be of **LOW** significance. This assessment does not take into consideration the impact caused by demersal trawling on the South Coast, which can cause considerable damage to marine benthic habitat in the estimated 31 736 km^2 trawling grounds and probably has the single most significant impact on the benthic environment on the South Coast.

The impacts relating to emissions to the atmosphere and discharges to the sea during well drilling, construction and decommissioning are considered to be of **VERY LOW** significance. Cumulatively, these are considered to remain of **VERY LOW** significance.

7.1.4 NO-GO ALTERNATIVE

The implications of not going ahead with the proposed development of the F-O Gas Field relate to the lost opportunity to further explore and utilise gas reserves on the South Coast and possible abandonment of the GTL refinery. The possible abandonment of the GTL refinery would have impacts on employment, GDP, household income and government revenue. This potential impact of the No-Go Alternative is considered to be of **VERY HIGH** significance.

7.2 RECOMMENDATIONS

7.2.1 CONSTRUCTION AND DECOMMISSIONING PHASES

The construction phase here is taken to include both well drilling and subsea infrastructure installation.

7.2.1.1 Compliance with Environmental Management Programme and MARPOL 73/78 standards

- The proposed project must comply with the EMP presented in Appendix 8. In addition, the drilling unit and all vessels must ensure compliance with MARPOL 73/78 standards.

7.2.1.2 Notification and communication with key stakeholders

- Prior to the commencement of activities, PetroSA and its contractors must notify relevant authorities and key stakeholders including: DEA (Branch Oceans and Coasts), PASA, SAMSA, the SAN Hydrographic Office, relevant Port Captains and DAFF. They must be notified of the navigational co-ordinates of any location prior to commencement of such activities;
- Communication channels should be set up with the fishing industry operating off the South Coast, particularly for longlining and trawling. This would involve pre-drilling / construction notification and regular updates on the progress via email (see bullet below);
- Appropriate notices should be distributed timeously to mariners. A Notice to Mariners should provide:
    1. the co-ordinates of the well drilling and infrastructure installation activities;
    2. an indication of the construction timeframes;

3. location reports of the drilling unit and installation vessels;
4. an indication of the 500 m safety zone around the drilling unit and installation vessels; and
5. a special note on any hazard posed by the anchor chains and anchors.

- A Notice to Mariners must be released at the end of construction informing all key stakeholders that the drilling unit and installation vessel are off location; and
- The SAN Hydrographer should be notified regarding the positions of any suspended / abandoned infrastructure in order to inform the fishing industry of such obstructions through Navigation Warnings.

7.2.1.3 Discharges, emissions and spills

- Ensure adequate maintenance of diesel motors and generators in order to minimise the volume of soot and unburnt diesel released to the atmosphere;
- Provide training and awareness to crew members of the need for thorough cleaning up of any spillages immediately after they occur in order to minimise the volume of contaminants washing off decks;
- Use low toxicity, biodegradable detergents during deck cleaning to further minimise the potential impact of deck drainage on the marine environment;
- Collect deck drainage in oily water catchment systems. Discharged water must meet MARPOL standards;
- Undertake adequate maintenance of all hydraulic systems and frequent inspection of hydraulic hoses;
- Minimise the discharge of waste material should obvious attraction of marine fauna be observed;
- Secure on board storage and safe transfer of solid waste;
- Initiate a waste minimisation system on board;
- Ensure that contractors co-operate with the relevant local authority to ensure that solid and hazardous waste disposal is carried out in accordance with the appropriate laws and ordinances;
- Adhere to the guidelines for management of ballast water provided by the IMO (Guideline A.868(20)). These include:
  - ⇒ Ensuring the drilling unit and vessels have a ballast water management plan in place.
  - ⇒ Reducing the risk of transfer of harmful aquatic organisms by onboard ballast water treatment or exchange. The following is applicable to ballast water exchange:
    - > Ballast water exchange should whenever possible, be conduct at least 200 nautical miles from the nearest land and in water at least 200 m in depth. Where this is not feasible, the exchange should be as far from the nearest land as possible, and in all cases a minimum of 50 nautical miles from the nearest land and preferably in water at least 200 m in depth;
    - > Ballast water exchange should be conducted in a manner consistent with the IMO Guidelines and one of the three approved ballast water exchange methods (namely sequential, flow through or dilution method); and
    - > When exchanging ballast at sea, guidance on safety aspects of ballast water exchange as set out in Appendix 2 of the IMO Guidelines should be taken into account. When these requirements cannot be met, ballast water exchange should be undertaken in designated ballast water exchange areas, as determined with the relevant authority (e.g. DEA: Directorate Pollution & Waste Management or Transnet National Ports Authority).
  - ⇒ Where practicable, routine cleaning of the ballast tank to remove sediments should be carried out in mid-ocean or under controlled arrangements in port or dry dock, in accordance with the provisions of the ship's ballast water management.
- No infrastructure (e.g. wellheads, BOPs and guide bases) should be deployed that has been used in other regions, unless thoroughly cleaned.

The following is applicable to well drilling only:

- Drilling operations should, where feasible, use WBF rather than NADF. Where it is necessary to use a NADF, the following mitigation measures should be implemented:
  - ⇒ NADF should not be used in the upper part of a well (with the exception in cases of geological or safety reasons) as specified by the OSPAR Convention;
  - ⇒ Only a Group III NADF with a PAH content of less than 0.001% and a total aromatic content of less than 0.5% should be used;
  - ⇒ NADF cuttings should be treated to reduce the oil content (< 5% by weight) before discharge; and
  - ⇒ No bulk discharge of untreated NADF cuttings should be allowed.

7.2.1.4 Anchoring and well position

- The final positioning of the wells and other subsea infrastructure should avoid any known sensitive habitats, such as rocky outcrops and any other structural habitat feature, and any cultural heritage material identified during the seabed survey;
- If feasible, PetroSA should consider using dynamically positioned rather than anchored vessels during construction and decommissioning; and
- If any cultural heritage material is found during drilling and development SAHRA should be notified immediately. If any material older than sixty years is to be disturbed a permit would be required from SAHRA.

7.2.1.5 Vessel seaworthiness and safety

- The drilling unit and support vessels must be certified for seaworthiness through an appropriate internationally recognised marine certification programme (e.g. Lloyds Register, Det Norske Veritas). The certification, as well as existing safety standards, requires that safety precautions would be taken to minimise the possibility of an offshore accident; and
- Vessels should be equipped with collision prevention equipment including radar, multi-frequency radio, foghorns, etc. Additional precautions should include: the support / chase vessel, the existence of an internationally agreed 500 m safety zone around the drilling unit, cautionary notices to mariners, and access to current weather service information. The vessels must be fully illuminated during twilight and night. The law also requires equipment and training to ensure the safety and survival of the crew in the event of an accident.

7.2.1.6 Vessel Lighting

- Minimise non-essential lighting on all platforms to reduce nocturnal faunal attraction. However, such measures should not undermine work safety aspects or concerns.

7.2.1.7 Helicopter operation

- All flight paths must be pre-planned to ensure that no flying occurs over seal and seabird colonies, coastal reserves, marine islands or estuarine systems;
- Extensive coastal flights (parallel to the coast within 1 nautical mile of the shore) should also be avoided. There is a restriction of coastal flights (parallel to the coast within 1 nautical mile of the shore) on the south coast between the months of June and November to avoid Southern Right whale breeding areas;
- The operator must comply with the Seabirds and Seals Protection Act, 1973, which prohibits the wilful disturbance of seals on the coast or on offshore islands;
- Aircraft may not approach to within 300 m of whales in terms of the Marine Living Resources Act, 1998; and
- The contractor should comply fully with all aviation and authority guidelines and rules.

7.2.1.8 Onshore drilling and completion fluids plant

The following is applicable to well drilling only:

- The final design of the proposed drilling and completion fluids plant should comply with applicable SANS codes (including SANS 10089-1, SANS 10131, SANS 10108, etc.) and guidelines or equivalent internationally recognised codes of good design and practice;
- A review of the final designs and materials should be undertaken by an Approved Inspection Authority. This should include a recognised process hazard analysis (HAZOP, FMEA, etc.);
- An emergency preparedness and response document for onsite incidents must be completed prior to construction; and
- No significant increase to the product list or product inventories should be permitted without reassessing the associated risk.

7.2.1.9 Uncontrolled release of natural gas or oil

The following is applicable to well drilling only:

- Implement monitoring and management measures in accordance with normal well control practise to assist in the detection and control of uncontrolled releases;
- The BOP installed on the well during drilling must be "fit for purpose" (i.e. appropriate for intended use, dependable and effective when required and able to perform as intended);
- All personnel should be adequately trained in both accident prevention and immediate response;
- PetroSA and the selected Contractor must ensure that there is an Oil Spill Response Plan in place to deal with accidental hydrocarbon spills prior to the commencement of the drilling programme. In this regard, a bridging document is required between PetroSA's current procedures, *Oil Spill Contingency and Response Plan* (EP/SHE/PR/001) and *General Onshore Plan for Offshore Emergencies* (EP/SHE/PR/006), and the emergency response procedures and plans of the selected Contractor; and
- PetroSA and / or the selected Contractor would also require adequate protection and indemnity insurance cover for pollution incidents.

7.2.2 PRODUCTION PHASE

7.2.2.1 Normal operation

- All operations and identified impacts at the F-A Platform and associated F-O subsea infrastructure would be managed and monitored in accordance with existing methodologies set out in PetroSA's existing integrated SHEQ system and EMP for the FA-EM production area. The production-related aspects of the FA-EM production area EMP have been included in the EMP prepared for the F-O production area (see Appendix 8).
- An appropriate monitoring and control programme should be developed for non-indigenous invasive marine species. The programme should, at a minimum, take the following into consideration during the production phase:
  - ⇒ All underwater inspections of infrastructure (ROV and SAT diver) should be used as opportunities to acquire footage (close-ups and stills) of marine life associated with the infrastructure;
  - ⇒ Any visual footage of marine growth / features on infrastructure should be distributed to relevant marine ecologists to investigate the presence of potential invasive species; and
  - ⇒ Should species of concern be detected, the spread thereof should be monitored over time.

7.2.2.3 Uncontrolled release of natural gas

- Monitoring and management measures should be implemented to assist in the detection of uncontrolled releases and ensure that appropriate actions are taken to bring the release under control. The proposed project should fit into the current inspection schedule for the F-A Platform (including associated infrastructure), as presented in PetroSA's existing EMP for the FA-EM production area. The current inspection schedule includes ROV inspections and / or side scan sonar at least once every five years.

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APPENDIX 1:

DEA AND PASA ACCEPTANCE OF REVISED FSR

5 MAY 2009

environment & tourism

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Reference: 12/12/20/1132
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Fax no: 021 461 1120

PER FACSIMILE / MAIL

Dear Mr Blood

APPLICATION FOR ENVIRONMENTAL AUTHORISATION R. 387: PROPOSED F-O FIELD DEVELOPMENT PROJECT IN PETROLEUM LICENSE BLOCK 9, SOUTH COAST, SOUTH AFRICA, (REFERENCE 12/12/20/1132).

The revised scoping report (SR) and plan of study for environmental impact assessment (POSEIA), dated February 2009, for environmental authorisation of the abovementioned project, refers. You have submitted these documents to fulfil the requirements of the Environmental Impact Assessment Regulations, 2006.

The department has evaluated the revised SR and POSEIA in terms of the requirements of regulation 31(1)(a) and have decided to accept the SR and POSEIA.

You may proceed with the process required in terms of the Regulations, 2006 and submit an environmental impact assessment report to the department for decision-making purposes.

You are hereby reminded that the activity may not commence prior to an environmental authorisation being granted by the Department.

Yours sincerely

Ms Nosiphe Ngcaba
Director General
Department of Environmental Affairs and Tourism
Letter signed by: Dumisane Mthembu
Designation: Director, Environmental Impact Evaluation
Date: 16/04/2009

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24 August 2009

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Dear Sir

RE: SCOPING REPORT AND PLAN OF STUDY FOR EIA FOR THE PROPOSED DEVELOPMENT OF THE F-O GAS FIELD IN PETROLEUM LICENCE BLOCK 9, SOUTH COAST, SOUTH AFRICA

The above matter refers.

The Agency hereby accepts the submitted Revised Scoping Report and the Plan of Study for the Environmental Impact Assessment dated February 2009 in relation to the above proposed development and you are therefore authorized to proceed with the EIA process as per the Plan of Study for EIA; subject to the approval of the Scoping Report and Plan of Study by the Department of Environmental Affairs and Tourism.

When conducting the EIA in preparation for the EIA Report and the Environmental Management Programme (EMPR) for submission to DEAT and the Agency, you are required to take note of the following:

- As it has been identified on the scoping report that there are two prospecting rights granted for glauconite and phosphorite on the South Coast, it must be established if these prospecting areas do not overlap with the proposed development area. In case the granted prospecting permits overlap with the development area, direct consultation with right holders must be undertaken and such results of consultation must be included in the final EMPR. In addition to that, the applicant is encouraged to enter into working agreements with prospecting rights holders addressing concerns relating to environmental risks, liabilities and responsibilities during operations.
- In terms of section 41(1) of the MPRDA, the applicant must before the Minister approves the EMPR in terms of section 39(4) make the prescribed financial provision for the rehabilitation or

management of negative environmental impacts. A quantum of financial provision during premature and on final closure must have a clear breakdown of rehabilitation activities such as the removal of structures (e.g. christmas tree), waste management, rig and vessel hire, etc.

All issues identified above must be undertaken during the EIA process and effected on the EMPR.

Please do not hesitate to contact the aforemention person should you have any queries.

Yours Sincerely

pp (ACTING ENVIRONMENTAL MANAGER)

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APPENDIX 3:

CONVENTION FOR ASSIGNING SIGNIFICANCE RATINGS TO IMPACTS