Local fishermen have identified about nine crab species, but target only three species commercially: shore crab, swimmer crab and mangrove mud crab (Tana, 1997 as referenced in DOF, 2001). Local fishermen complain about stocks of all crab species being depleted as a result of mangrove degradation and pollution from shrimp farms (DOF, 2001). Marine Conservation Cambodia has photographically documented at least 39 different crab species, which are listed in **Table 3-13**.

Table 3-13: Species of Crabs Identified in Cambodia

Scientific name	
1. *Arcania erinacea*	20. *Galene bispinosa*
2. *Arcania undecimspinosa*	21. *Halimede ochtodes*
3. *Atergatis integerrimus*	22. *Hyastenus pleione*
4. *Calappa lophos*	23. *Ixa cylindricus*
5. *Calappa philargius*	24. *Lauridromia indica*
6. *Carcinoscorpius rotundicauda*	25. *Leucosia rhomboidalis*
7. *Charybdis anisodon*	26. *Matuta victor*
8. *Charybdis feriatus*	27. *Myra fugax*
9. *Charybdis natator*	28. *Ozius guttatus*
10. *Cryptopodia fornicate*	29. *Parthenope longimanus*
11. *Dardanus lagopodes*	30. *Parthenope longispinis*
12. *Dardanus megistos*	31. *Podophthalmus vigil*
13. *Doclea ovis*	32. *Portunus pelagicus*
14. *Doclea tetraptera*	33. *Portunus sanguinolentus*
15. *Dorippe frascome*	34. *Scalopidia spinosipes*
16. *Dorippe granulate*	35. *Scylla serrata*
17. *Episesarma singaporense*	36. *Tachhypleus gigas*
18. *Episesarma versicolor*	37. *Thalamita crenata*
19. *Eucrate alcocki*	38. *Zebrida adamsii*

Source: Marine Conservation Cambodia, 2011

3.4.1.9 Bivalves

In the coastal waters of Cambodia 24 species of marine bivalves have been reported (FAO, 2007). Economically significant species in the Cambodian coastal waters are green mussel (*Perna viridis*), oysters, and blood cockle (*Anadara granosa*). Cambodia produced 400-590 metric ton of bivalves during 2002-2006 (Southeast Asian Fisheries Development Center (SEAFDEC, 2009).

3.4.1.10 Reptiles

Five species of marine turtles have been reportedly seen in Cambodia's waters in the past. These include the Hawksbill (*Eretmochelys imbricata*), Green (*Chelonia mydas*), Olive Ridley (*Lepodochelys olivacea*), Loggerhead (*Caretta caretta*) and Leatherback (*Dermochelys coriacia*) turtles (Bunthang, 2004). All of these species are considered endangered according to International Union for Conservation of Nature (IUCN, 2011).

The Green and Hawksbill's turtles are the most common species found in the Gulf. Green turtles frequent shallow seas with abundant sea grasses, a key component of their diet (Texas Parks &

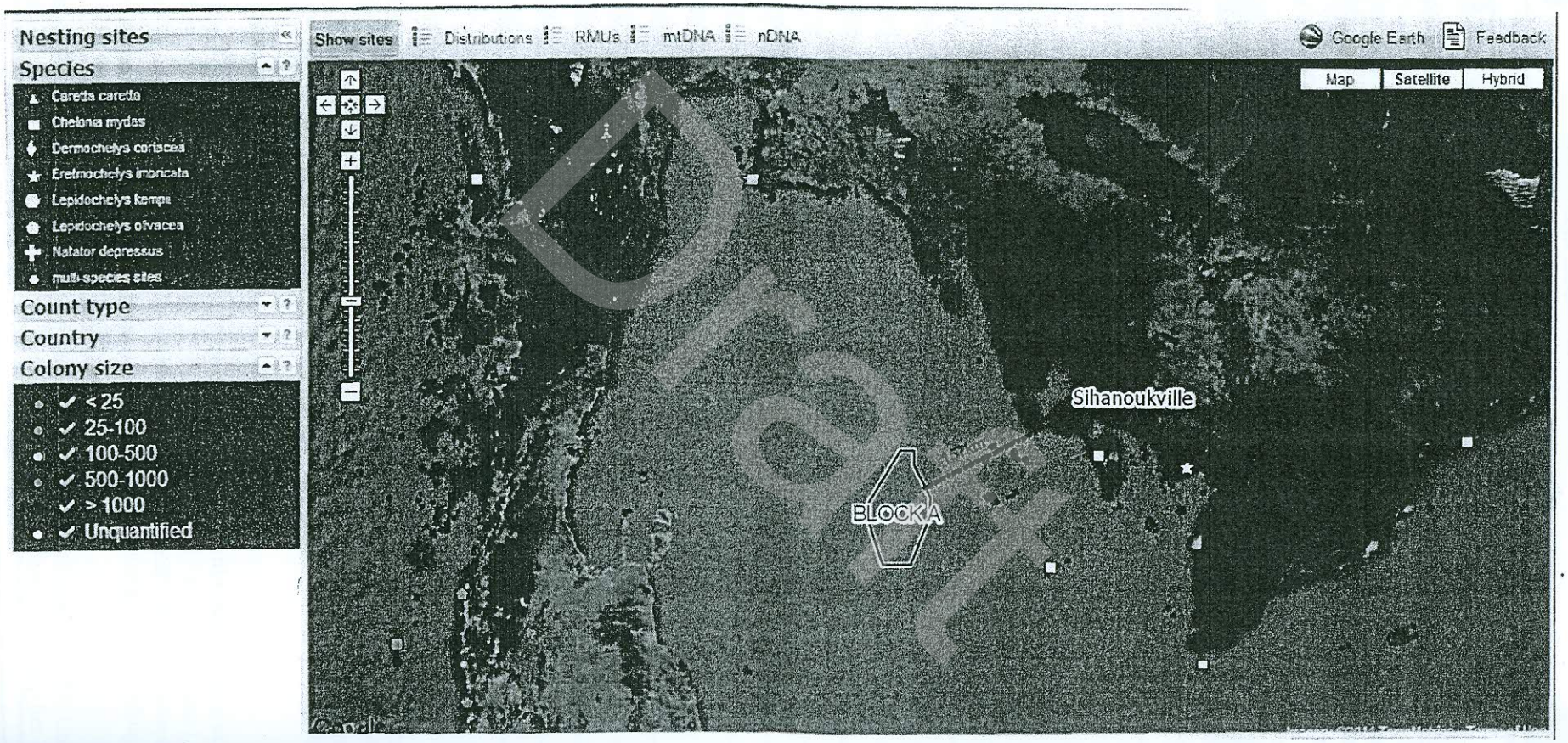
Wildlife, 2011). The Green turtle can migrate from rookeries to feeding grounds thousands of kilometers away.

In Cambodia, sea turtles lay eggs from September to April. Several nesting areas have been identified by local authorities and fishermen: 9 islands/beaches in Sihanoukville Municipality, 3 islands/beaches in Kampot Province, and 4 islands/beaches in Koh Kong Province (DOF, 2004; **Figure 3-33**).

Marine turtles live mostly in the open sea, except when they lay eggs on the same sandy beaches from which they originated.

Fishermen have reportedly sighted crocodiles, probably Saltwater Crocodiles (Crocodylus porosus), in Koh Kong estuaries and Prek Toek Sap (UP-MSI, ABC, ARCBC, DENR, ASEAN, 2002).

Figure 3-33: Map of Sea Turtle Nesting Areas in Gulf of Thailand*



Source: http://seamap.env.duke.edu/swot

* Note: Database for map is not complete for Cambodia

3.4.1.11 Sea and Coastal Birds

Sea and coastal birds in the Gulf are poor in diversity and population; most are winter (non-breeding) visitors. Several species which used to be common are becoming rarer due to egg gathering and development (Lekagul & Round 1991). The following birds are known to inhabit the Gulf of Thailand:

- Gulls and terns are sea birds that occur mostly in coastal waters; most breed colonially. They usually fish by plunge-diving.
- Boobies occur chiefly in offshore areas. They live mainly on fish by plunge diving, often from great heights, which enables them to dive as deep as 10 m underwater. While boobies feed in groups, they may dive simultaneously in order to enhance success. Breeding takes place in colonies along the coast.
- Sooty terns are diurnal pelagic seabirds that forage along seacoasts and far offshore. They feed in flight, picking up fish and squid, chased to the water surface by predatory fish such as tuna. Elsewhere, flocks of sooty terns are found associated with tuna and dolphin-fish as well as dolphins and porpoises. The species is a very rare visitor to the Gulf of Thailand. There are no breeding locations nearby. The nearest known breeding location is in the Spratly Islands, South China Sea.

3.4.1.12 Marine Mammals

Dolphins and Whales

Twenty-one species of dolphins, porpoises and whales have been found in the Gulf of Thailand (Lekagul and McNeely 1988).

Baleen whales are highly migratory; *Balaenoptera borealis* (Sei whale) and *Balaenaptera edini* (Bryde's whale) move to temperate climates in the summer (May to August) and towards tropical areas in the winter (November to March) for calving. Sei whales breed in tropical & subtropical water. Sightings were recorded in 1949; Sei whales have suffered greatly from exploitation and are not common. They live in pods of four or five, and migrate to warmer waters to breed (births occur every second year). *Balaenoptera acutorostrata* (Minke whale) was recorded found in Chumphon and Nakhon Sri Thammarat in Thailand. The Gulf lies outside of the migration routes and feeding grounds for Humpback whales.

Irrawaddy Dolphins (*Orcaella brevirostris*), considered endangered by IUCN, are a freshwater mammal, but have been reported in many places within the Cambodian coastal zone. The IUCN lists five of the seven subpopulations as critically endangered. Other cetacean species known to occur in the country's coastal zone are Indo-Pacific Humpback Dolphin (*Sousa chinensis*), Common Dolphin (*Dephinus delphis*), Bottle-nosed Dolphin (*Tursiops truncatus*), Spinner Dolphin (*Stenela logirostris*), and Finless Porpoise (*Neophocaena phocaenoides*) (Vathana and Vibol, 2002).

Table 3-14: Species of Dolphins and Whales Identified in Cambodia

Common name	Scientific name	IUCN Status
Indo-Pacific Humpback Dolphin	*Sousa chinensis*	Near threatened
Common Dolphin	*Dephinus delphis*	Least concern
Bottlenose Dolphin	*Tursiops truncatus*	Least concern
Spinner Dolphin	*Stenela logirostris*	Data deficient
Finless Porpoise	*Neophocaena phocaenoides*	Vulnerable

Source: Vathana and Vibol, 2002

Dugongs

The endangered dugong (*Dugong dugon*) (CITES, 2011) has been sighted in parts of the coast especially near Pre Ksach in Koh Kong District, and in Kampot Bay (UP-MSI, ABC, ARCBC, DENR, ASEAN, 2002).

Dugongs inhabit the shallow sea where the sea grass is abundant. In the Gulf, they have been found in the coast off Rayong, Chumphon and Surat Thani Province in Thailand (Chatrapornsyl and Adulyanukosol, 1994). Dugong lives in pods of many families. However, the dugong populations have been reduced and the size of pods has become smaller. Single dugongs have been observed in some areas. The decline in dugong populations is reported to be mainly caused by hunting and entanglement in the fishing gear. Moreover, marine pollution along the coastline has resulted in the degradation of sea grass, which is the important feeding area of dugong (Adulyanukosol, 2002).

Adulyanukosol (2002) conducted a small survey of 20 persons regarding the sightings of Dugongs and their primary habitat, seagrass, in Kampot and Kep villages in Cambodia. Most of the interviewed persons knew little about the number of species of seagrass, but were aware that seagrass is good habitat for dugongs. The survey found that trawlers operating in the seagrass areas were primarily responsible for destroying seagrass, and many dugongs die from enganglement in the nets operating in seagrass areas. The survey also found that some people kept certain body parts of dugong for medicinal, spiritual, and aesthetic reasons, such as skin, penis, skull, teeth, and rib cages. All interviewees agreed that the abundance of dugong along the Cambodian coast has been decreasing.

The estimated population of the dugong in the Gulf has been reduced to about 35 individuals in recent year (Adulyanukosol and Mananunsap, 2010).

3.4.1.13 Summary of Threatened/Endangered Marine Species in Cambodia

Table 3-15 shows a summary of information for threatened or endangered marine animal species in Cambodia, according to IUCN (IUCN, 2011)), Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (CITES, 2011)) and Marine Conservation Cambodia (Marine Conservation, 2010). According to these sources, of the documented marine species in Cambodia, there are at least 11 species that are listed as 'Endangered' or 'Critically Endangered'. All IUCN endangered species are protected under Cambodian law.

Table 3-15: Threatened/Endangered Marine Animals in Cambodia

Common Name	Scientific Name	IUCN Status	CITES Appendix	Notes
Estuarine crocodile	*Crododylus porosus*	Lower Risk/least concern	Appendix I	Previously endangered according to IUCN. Possibly extinct in neighboring Thailand.
Dugong	*Dugong dugong*	Vulnerable	Appendix I	
Humphead wrasse	*Cheilinus undulatus*	Endangered	Appendix II	
False killer whale	*Pseudorca crassidens*	Data Deficient	Appendix II	
Short-finned pilot whale	*Glbicephala macrorhynchus*	Data Deficient	Appendix II	
Indo-Pacific bottlenose dolphin	*Tursiops aduncus*	Data Deficient	Appendix II	
Common bottlenose dolphin	*Tursiops truncates*	Least Concern	Appendix II	

Common Name	Scientific Name	IUCN Status	CITES Appendix	Notes
horseshoe crab	*gigas*			
Mangrove horseshoe crab	*Carcinoscorpius rotundicauda*	Data Deficient	Appendix II	
Whale shark	*Rhincodon typus*	Vulnerable	Appendix II	According to IUCN, Populations appear to have been depleted by harpoon fisheries in Southeast Asia.
Hairy-nosed Otter	*Lutra sumatrana*	Endangered	Appendix II	
Black-faced Spoonbill	*Platalea minor*	Endangered	Appendix I	Regionally extinct in Cambodia according to IUCN
Largetooth Sawfish	*Pristis microdon*	Critically Endangered	Appendix I	
Narrowsnout Sawfish	*Pristis zijsron*	Critically Endangered	Appendix I	
Great Hammerhead	*Sphyrna mokarran*	Endangered	Appendix II	
Spotted Greenshank	*Tringa guttifer*	Endangered	Appendix I	

Source: IUCN (http://www.iucnredlist.org), CITES (http://www.cites.org/), Marine Conservation Cambodia (http://www.marineconservationcambodia.org), Accessed July 2011

3.4.2 Sensitive Ecosystems

3.4.2.1 Seagrass Beds

Seagrass beds occur throughout the coastal zone of Cambodia in shallow waters. They are most extensive in Kampot province, Prek Kompong Bay Delta and Kep municipality. There are two types of seagrass habitats:

- extensive seagrass meadows along the mainland, and
- patches of seagrass intermingled with corals around the islands (ASEAN, 2002).

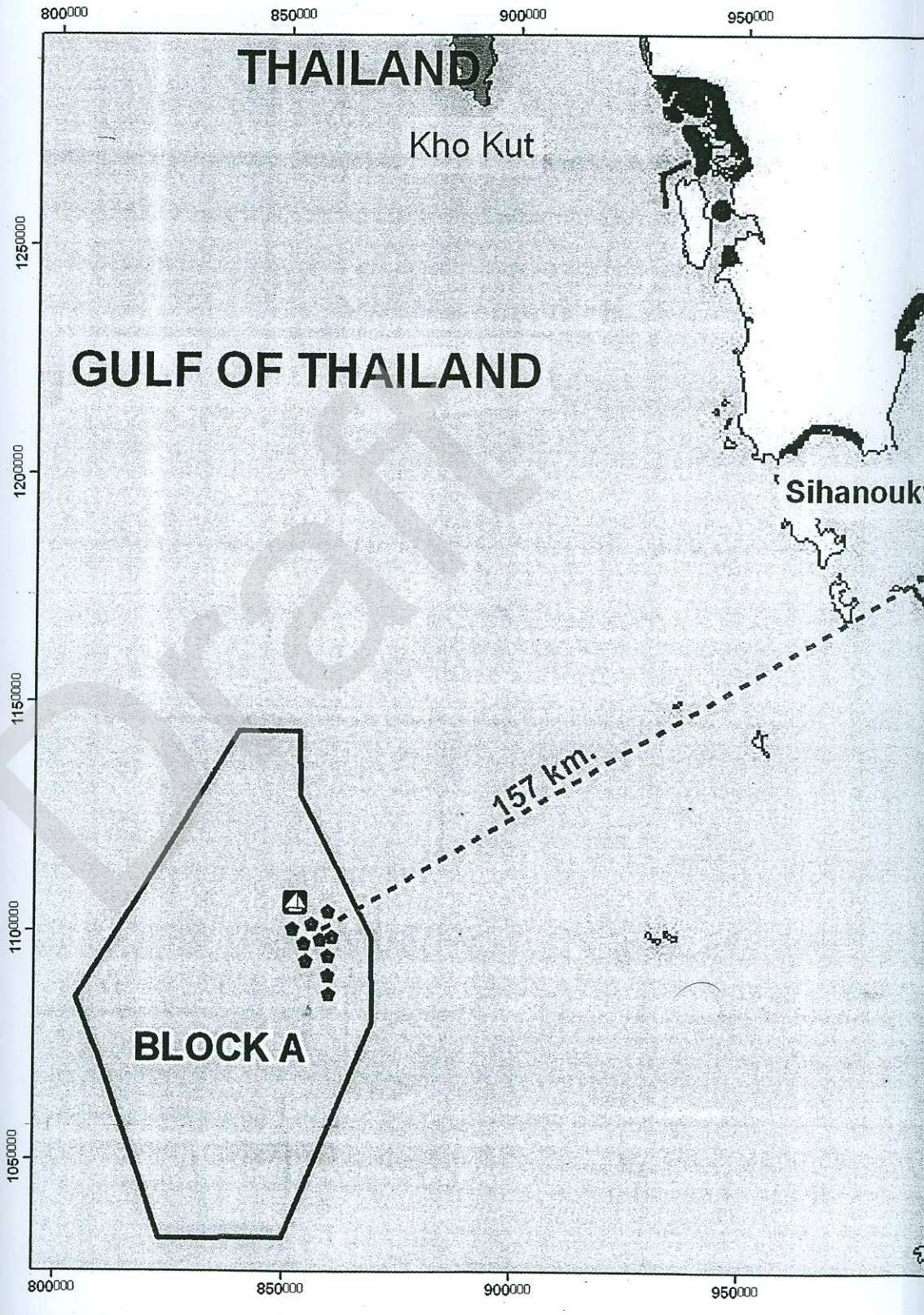
Seagrass beds are known to be an important habitat for dugongs, sea turtles, juvenile shrimp, crabs and fishes. Important species of sea grasses identified in the Cambodian coastal zone are (MOE 2002):

- Thalassia hemprichii
- Halodule uninervis
- Enhalus acoroides
- Halophila decipiens
- Cymodocea serrulata
- Halodule pinifolia
- Cymodecea rotundata
- Syringodium isoetifolium
- Halophila ovalis

Seagrass beds can be found in most shallow water areas of the Cambodian coastal zone. Most of the seagrass beds are multispecies, located in enclosed or semi-enclosed embayments from the intertidal area to 5m in depth (Seagrass-Watch, 2010). Significant locations are shown in **Figure 3-34** and **Figure 3-35**. A lack of comprehensive systematic research however means that local seagrass condition and species composition are not well known, particularly around islands.

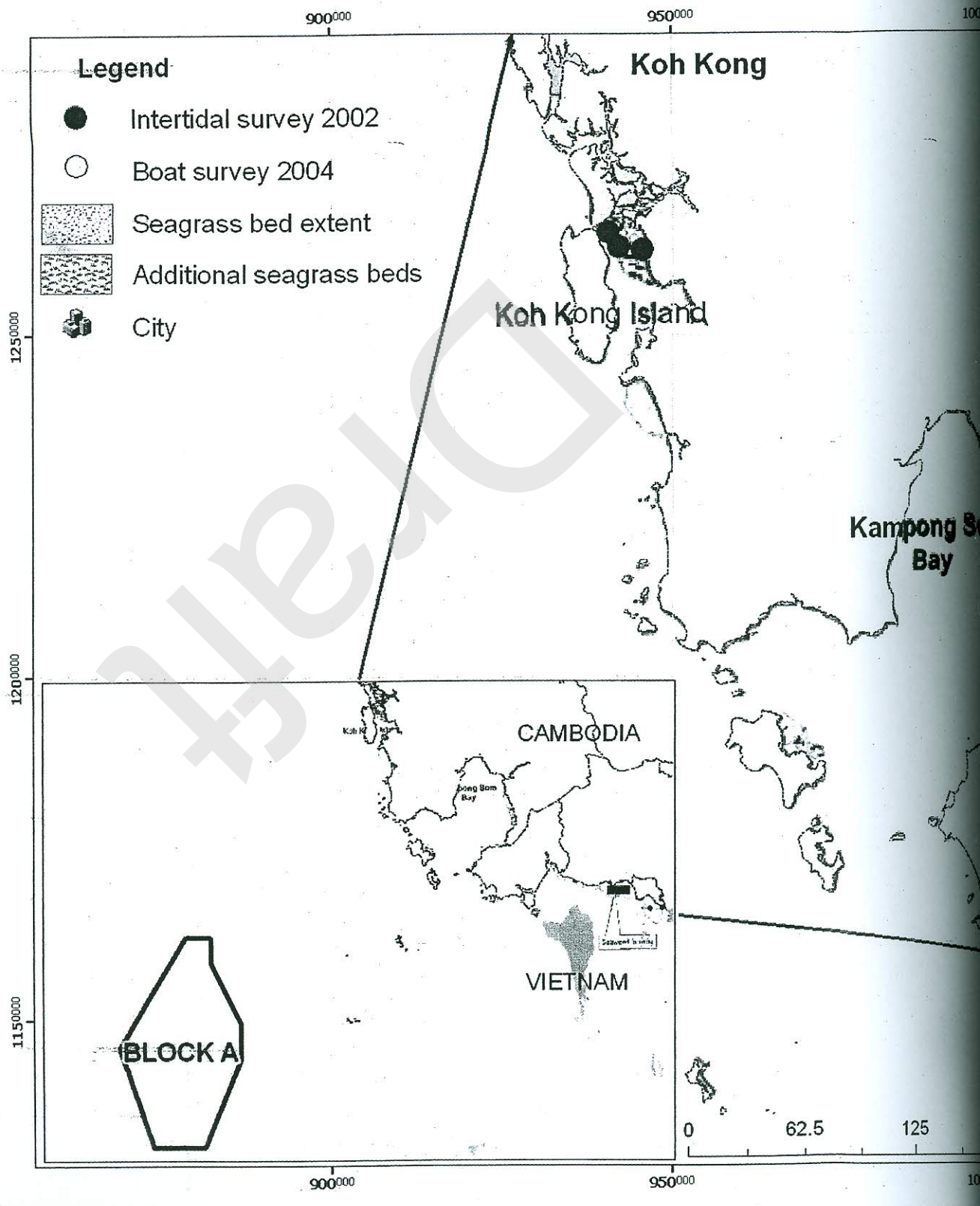
There are no seagrass beds within Block A.

Figure 3-34: Ecological Resourc



GIS information from MoE (2002)

Figure 3-35: Map of Seagrass Distribution in Ca



Source: Hines et al, 2008 - Seagrass areas as originally mapped by the Cambodian Department of Fisheries (seagrass bed extent), as augmented by aerial surveys, inter
Cambodia

3.4.2.2 Mangrove Forests

The 435 km coastline comprises about 60,000 ha of 30 species of mangroves. The most pristine area can be found in Koh Kong Province (Kosal, 2004). Mangroves are found around Veal Renh and Kompong Som Bays and north of Kas Kong up to the border with Thailand. The main species are as follows (FAO, 2004):

- *Rhizophora conjugate*
- *R. mucronata*
- *Bruguiera gymnorhiza*
- *B. sexangula*
- *Ceriops tagal*
- *C. decandra*
- *Sonneratia alba*
- *Lumnitzera littorea*
- *L. racemosa*
- *Xylocarpus obovata (*syn *Carapa obovata)*

Four vegetation zones can be found in the Cambodian mangrove and rear mangrove forests. From seaward to landward edge species in these vegetation zones are: (1) *Avicennia-Sonneratia* zone; (2) *Rhiziphoria* zone, (3) *Brugieiria-Kandelia-Ceriops* zone; and (4) *Limnitzera-Xylocarpus/Brugieiria* zone (Water Environment Partnership in Asia, 2011).

Mangrove forests, established in silty seashores and brackish swamps, play an important ecological role and have significant human use value. The mangrove forests in Cambodia are scattered, as seen in **Figure 3-34**.

Table 3-16 provides approximate mangrove area coverage in coastal areas. Many mangrove forests are in decline because of pressure from firewood collection, charcoal production, salt farming and aquaculture (MoE and Danida, 2006). Forestry statistics from 1973 and 1993 indicate an annual mangrove loss of 0.5% in Cambodia (94,600 ha and 85,100 ha in 1973 and 1993, respectively; (Ma, 1999)). Between 1993 and 2002 the mangrove forest saw an additional 12,000 ha lost to clearance. In relation to the period in the early 1990s, 17% of mangroves in the coastal areas was lost during this period (MoE, 2005).

There are no mangroves within Block A.

Table 3-16: Mangrove Coverage in Coastal Provinces and Municipalities

Location	Period	Mangrove Area (Hectares)
Kampot Province	1992/93	7,900
	2006	5,803
Koh Kong Province	1996/97	57,582
	2006	49,914
Sihanoukville Municipality	1992/93	13,500
	2006	8,110
Kep Municipality	2002	1,000
	2006	1,114

Sources: State of the Environment Reports: Kampot Province, Koh Kong Province, Sihanoukeville Municipality and Kep Municipality. Environmental Management in Coastal Zone, Cambodia Ministry of the Environment, April 2002. Data Book Report from National Committee for Sub-National Democratic Development (NCDD)-Ministry of Interior, 2009 (GIS data, Land Used 2006, MLMUPC)

3.4.2.3 Wetlands

Mudflats and estuaries are important wetland environments. Major estuaries and mudflats are found in Koh Kong and Kampot Provinces. The estuaries of two rivers (Stung Koh Pao and Stung Kep, Koh Kong Province) are recognized as internationally important wetlands (Kosal, 2004).

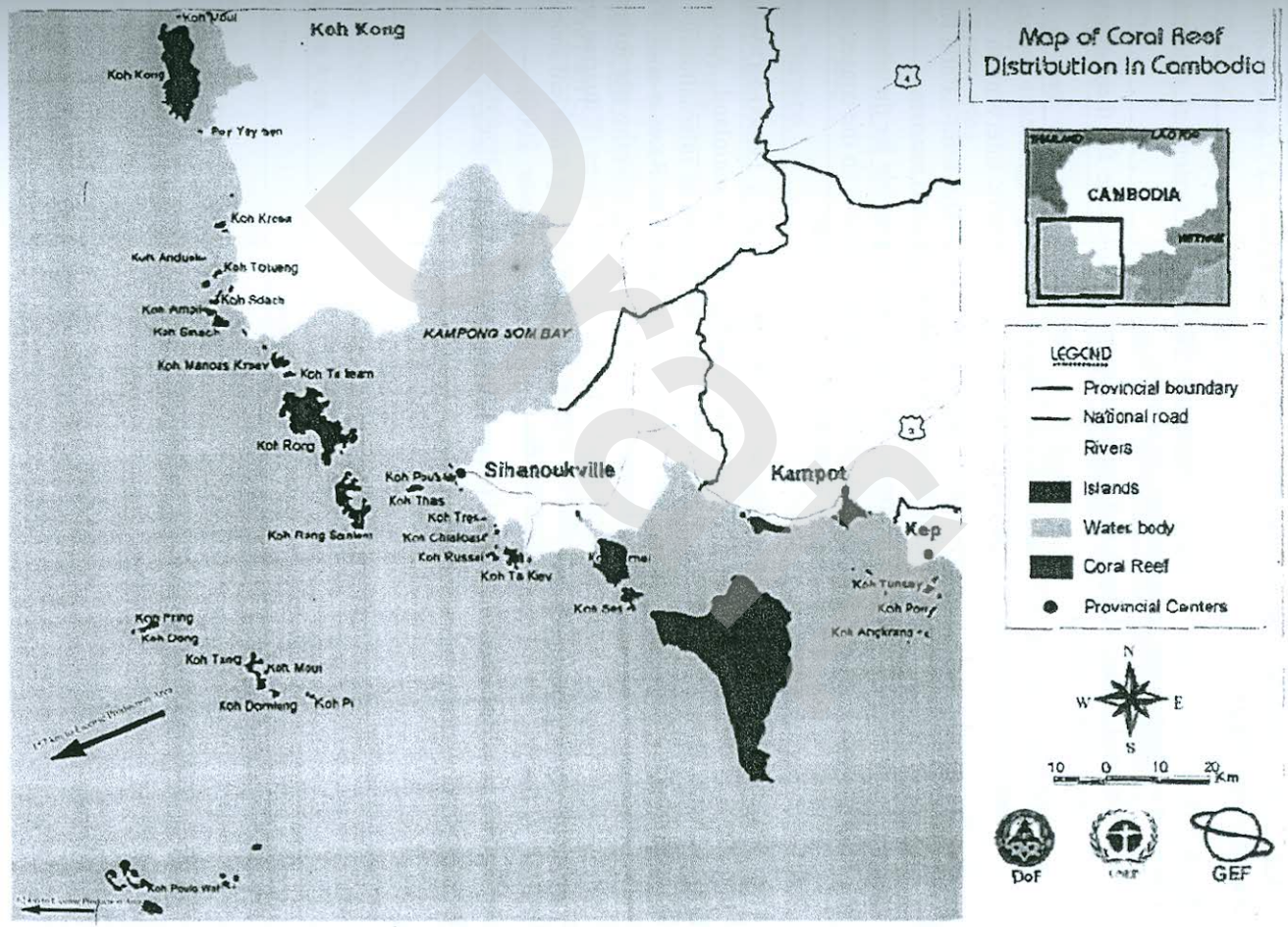
There are no wetlands within Block A.

3.4.2.4 Coral Communities

Coral communities are ecologically and economically important as they provide a suitable habitat for high biodiversity and productivity of marine biota. Their aesthetic value plays an important role in the tourism industry, particularly for diving. Many species of coral have been identified in Cambodian coastal waters (MOE, 2002). Seventy species of hard coral have been found belonging to 33 genera and 11 families. *Acropora* and *Montipora* are the two most common genera (Kosal, 2004). The total area of reefs in Cambodia has been estimated as 28.065 km^2, although average live coral cover for the whole coastline was estimated to be 23% to 58% (UNEP/GEF, 2008). There is approximately 953 ha of coral reefs in Kampot, 602 ha in Koh Kong, 1198 ha in Sihanoukville, and 52.5 ha in Kep (MoE, 2005). Main continuing threats to the coral reef habitats are reported to be, amongst others, over-fishing and use of dynamite and other illegal fishing practices, harvest of coral reefs for trade, and degradation of water quality.

All significant sites of coral reefs may not have been fully identified, but several known locations are shown in **Figure 3-36**. Coral generally occurs around inshore islands and rocky areas. There are no coral reefs within the Block A area.

Figure 3-36: Map of Coral Reef Distribution in Cambodia



Source: FiA, (2004a), updated with information from http://reefgis.reefbase.org

3.4.3 Protected Areas

The Royal Government of Cambodia has designated national protected areas for the conservation and protection of biodiversity. A Royal Decree, signed November 1, 1993, established 23 areas as national parks, wildlife sanctuaries, protected landscapes and multiple-use areas. The Protected Areas Law (2008) defines the framework of development, management and conservation of protected areas (OGEL, 2008). A list of all protected areas is shown in **Table 3-17**. Several of these are located in the coastal zone (**Figure 3-37**).

According to the Protected Areas Designation (2003), the system of protected areas includes the following categories and management objectives:

- National Parks: Natural and scenic areas of significance for their scientific, educational and recreational values.
- Wildlife Sanctuaries: Natural areas where nationally significant species of flora and fauna, natural communities, or physical features require specific intervention for their perpetuation.
- Protected Landscapes: Nationally significant natural and semi-natural landscapes which must be maintained to provide opportunities for recreation and tourism.
- Multiple-use Management Areas: The areas which provide for the sustainable use of water resources, timber, wildlife, fish, pasture and recreation with the conservation of nature primarily oriented to support these economic activities.

The Peam Krasoap Wildlife Sanctuary in Koh Kong includes a 12,000 ha Wetland of International Significance located on alluvial islands immediately off the mainland. According to the Ramsar Convention, "Koh Kapik and Associated Islets" are designated as internationally important under the Convention on Wetlands (Ramsar, 1971), commonly known as Ramsar sites. **Figure 3-38** shows a map of this area. Two major rivers flowing into the area bring a freshwater influence and create sand flats in some places. The site is classified into two wetland types (Estuarine waters, and Intertidal mud, sand, or salt flats). The area plays a critical role in providing a nutrient source supporting coastal fishery in the near-shore and offshore waters of Cambodia (Ramsar, 2000).

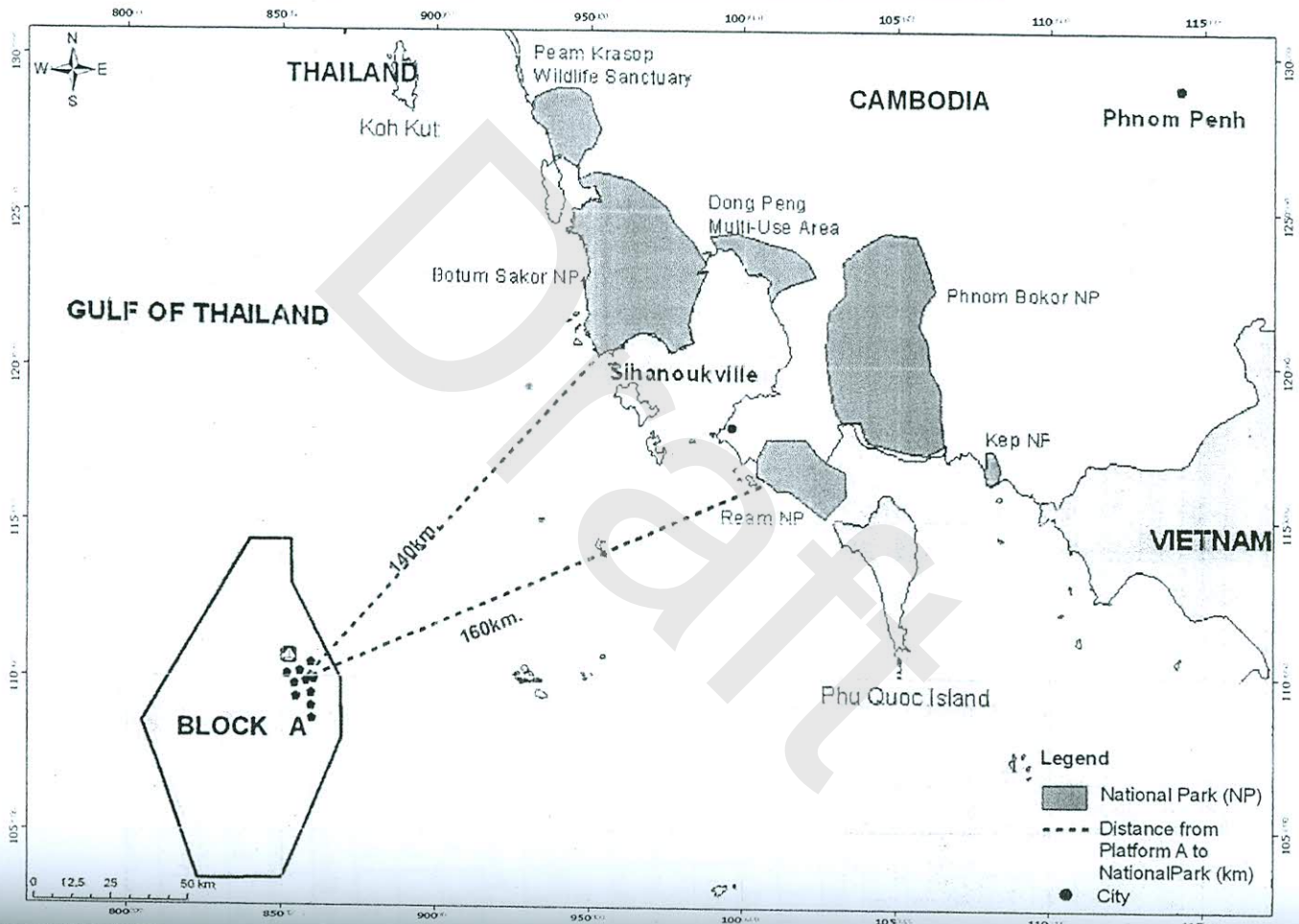
None of the protectd areas are located in or near Block A; however, several protected areas are located near the shore base in Sihanoukville.

Table 3-17: Protected Areas of Cambodia

No	Protected Area 's Name	Area (ha)	Location
A. National Parks			
1	Kirirom	35,000	Kampong Speu and Koh Kong
2	Phnom Bokor	140,000	Kampot
3	Kep	5,000	Ket
4	Ream	15,000	Kampong Som (Preachsihanouk)
5	Botum Sakor	171,250	Kampong Som and Koh Kong
6	Phnom Kulen	37,500	Siem Reap
7	Virachey	332,500	Rattanakiri and Stung Treng
B. Wildlife Sanctuaries			
8	Aural	253,750	Koh Kong, Pursat, Kamp Chhnang and Kamg Speu
9	Boeung Per	242,500	Kampong Thom and Preach Vihear
10	Peam Krasop	23,750	Koh Kong
11	Phnom Samkos	333,750	Koh Kong
12	Roniem Daun Sam	178,750	Battambang
13	Kulen Promtep	402,500	Siem Reap and Preah Vihaer
14	Lomphat	250,000	Rattanakiri and Mondolkiri
15	Phnom Prich	222,500	Mondolkiri
16	Phnom Nam Lyr	47,500	Mondolkiri
17	Snuol	75,000	Kratie and Mondolkiri
C. Protected Landscapes			
18	Angkor	10,800	Siem Reap
19	Banteay Chhmar	81,200	Banteay meanchey
20	Preah Vihear	5,000	Preach Vihear
D. Muliple Use Area			
21	Dong Peng	27,700	Koh Kong
22	Samlaut	60,000	Battambang and Pailin
23	Tonle Sap	316,250	Kamp.Chhnang, Kamp.Thom, Siem Reap, Battambang, and Pursat

Source: Creation and Designation of Protected Areas, (Kret No. 1993).

Figure 3-37: Map of Protected Areas in Cambodia's Coastal Zone

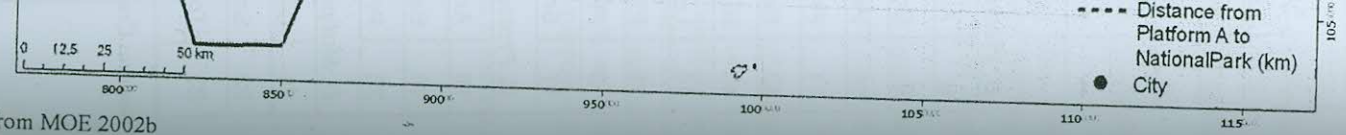


Source: GIS information from MOE 2002b

Cambodia Block A Development
Environmental Impact Assessment

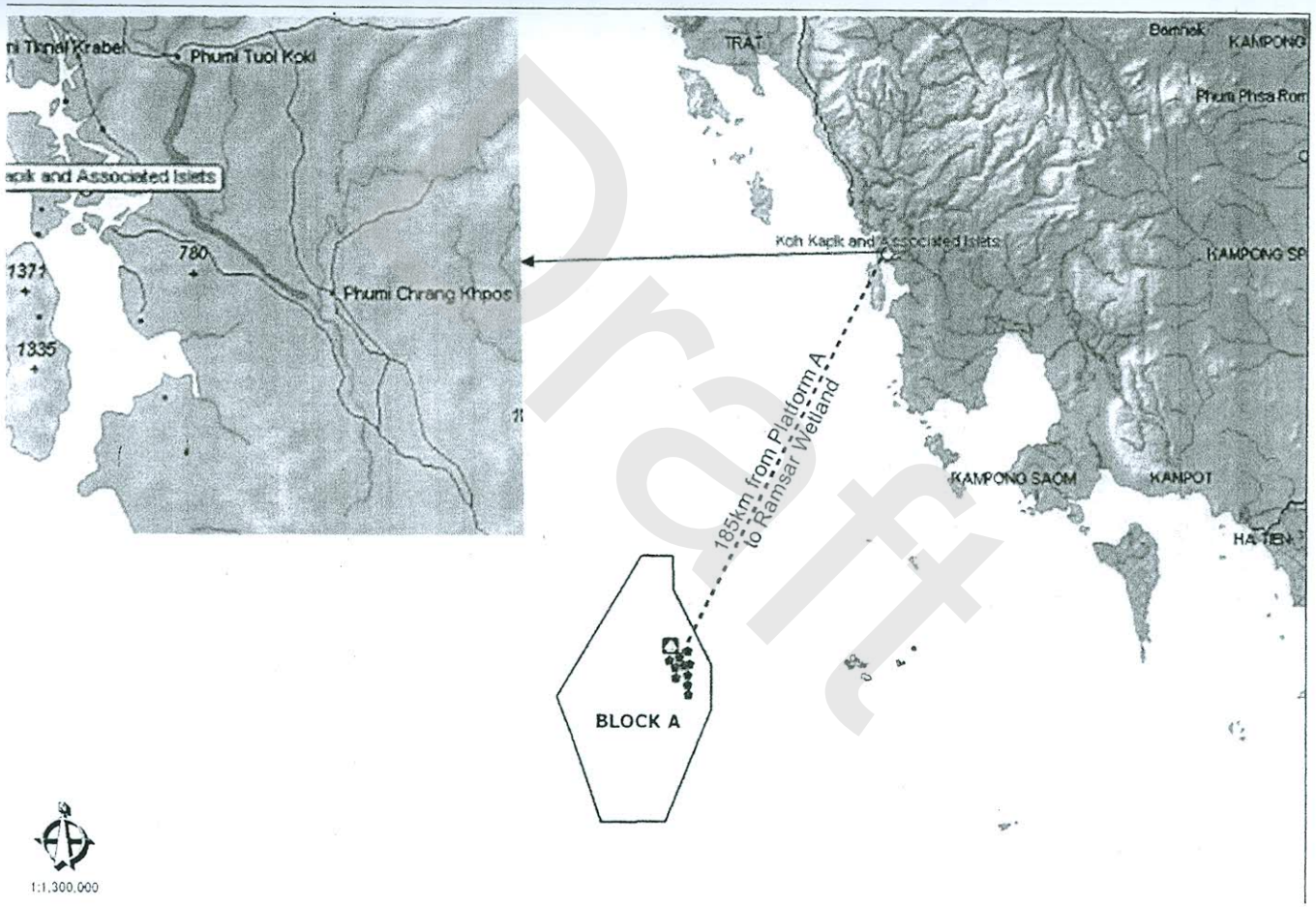
3. Environmental Setting

Figure 3-38: Koh Kapik and Associated Islets (Ramsar Wetland)



Source: GIS information from MOE 2002b

Figure 3-38: Koh Kapik and Associated Islets (Ramsar Wetland)



Source: http://ramsar.wetlands.org/

3.4.4 Historical/Archaeological Resources

To date, surveys performed in Block A did not find historical or archaeological resources in Block A.

In Kampot Province there are three archaelogical sites: Phnom Chngok, Phnom Khchang Temple and Wat Phnom Sor. Phnom Chngok, a cave that houses a 6th century Hindu Temple, is located 12 km north-east of Kampot. Phnom Khchang Temple, an Hindu Temple which has been influenced by Angkor Borey Temple, is at 42 km east from Kampot. Wat Phnon Sor, this temple with Buddha statues representing Preah Kor and Preah Keo, is located at 8 km north-west from Kampot (Kampot Provincial Government, 2011). None of the sites are on the coast or in the water.

3.5 Human-Use Values

3.5.1 Fisheries

In Cambodia, fisheries are one of the most important sectors, playing an important role in the daily food production and contributing to the national economy. Marine fishery and the aquaculture sector are small compared to the inland fishery (FAO,2011).

The average catch per unit is low compared to Thailand and Vietnam due to less fishing effort and less advanced fishing technology (FAO, 2011).

The classification of fishing activities in the Cambodian Economic Exclusive Zone (EEZ) comprises two main groups; coastal and commercial fisheries.

- The coastal fishery is characterized by small family-scale fishing operating in the area extending from the coast to a depth of 20 m. Boats used are without engines or with engines of less than 50 hp.
- The commercial fishery is characterized by large-scale fishing from 20 m depth to the limit of the EEZ.

Commercial boats, in general, use engines of more than 50 hp. They use various kinds of fishing gears including single trawling.

Key commercial pelagic species in the Gulf of Thailand are Indo-Pacific mackerel, Indian mackerel, Spanish mackerel, scad or carangids, long tail tuna, sardines and anchovies. Demersal species are economically less important than pelagic fish (FAO, 1996). In Cambodian fishing grounds, the main commercial species consist of mackerels, scads, anchovies and snappers, penaeid and metapenaeid shrimps, blue swimming crabs, cuttlefish, squid, green mussels, oysters and blood cockles (FAO, 2011).

The total quantity of fish catches in 2006 was reported to be around 60,000 tons in the coastal area (FiA, 2007).

Fish breeding grounds have been identified in Cambodian coastal waters in Kampot and Koh Kong Provinces, and in Sihanoukville and Kep Municipalities (MOE, 2002).

The Department of Fishery distinguished nine groups of marine fisheries wich are shown in Table **3-18**.

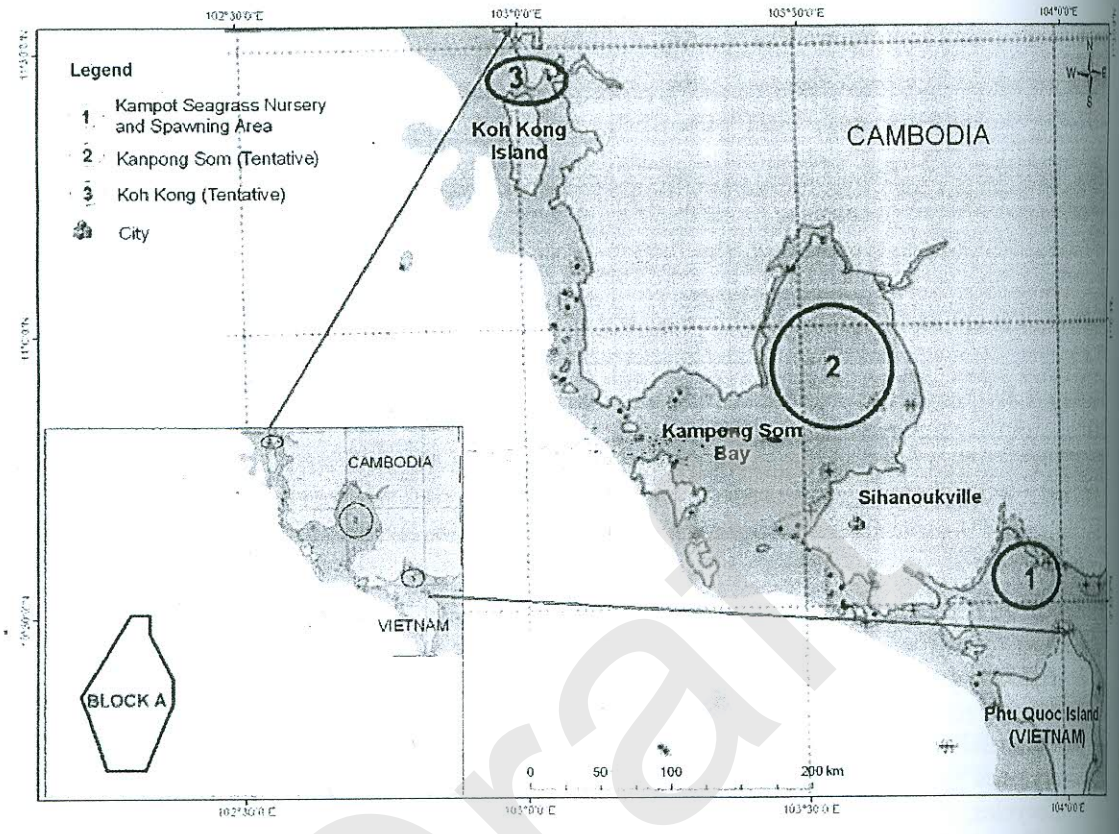
Table 3-18: Marine Fishery Landings

	Kampot	Sihanoukville	Koh Kong	Kep	Total
Fish	2703	6943	7104	123	16873
Trash Fish	1786	4287	4764	10	10847
Shrimp	284	1730	1606	42	3662
Ray	165	0	42	2	209
Cephalopod	247	1496	604	8	2355
Slipper Lobster	0	40	0	0	40
Crab	870	897	1410	285	3462
Snail	176	1236	1082	0	2494
Blood Cockle	199	226	762	0	1187
Sea Cucumber	0	210	0	470	680
Krill	0	0	26	123	149
Total	**6430**	**17065**	**17400**	**1063**	**41958**

Source: DoF, 2001

The South China Sea Project's Regional Working Group on Fisheries (2002-2008) has established a regional system of fisheries *refuges(refugia)* in the South China Sea and Gulf of Thailand. The fisheries refuges are a mechanism for integrating fisheries and habitat management and are defined as "a spacially and geographically defined, marine or coastal area in which specific management measures are applied to sustain important species [fisheries resources] during critical stages of their lifecycles, for their sustainable use" (UNEP/GEF, 2008). This initiative is aimed at building the resilience of Southeast Asian fisheries. Three sites in Cambodia have been identified as potential sites for inclusion in the system of fisheries refugia (**Figure 3-37**). The site at Kampot has been studied extensively. The Kampot seagrass demonstration site is important as a nursery area and feeding area for greasy grouper, mangrove red snapper, Malabar grouper, threadfin breams, leopard coarl grouper, lizardfish, brownstripe red snapper and sixbar grouper. It also is an important feeding site for several species of spinefoot (goldenspotted, whitespotted, streaked), grouper (humphack, longfin, orangespotted, blacktip) and bluespot grey mullet, lined silver grunt, wrasse and harrowed sole (UNEP/GEF/SCS, 2006).

Figure 3-39: Cambodia Sites Selected for Inclusion as Fisheries Refugia



Source: http://refugia.unepscs.org/index.php?option=com_content&task=view&id=18&Itemid=57, Accessed August 2011

3.5.1.1 *Fisheries - Marine Capture/Catches*

The quantities of marine resources production in Cambodia from 1990-2010 are shown in Table 3-19. The composition of the catch includes approximately 100 finfish species, predominated by mackerel and scad species (World Fish Centre, 1999). According to FiA statistics (2007), most fish are brought to shore in Sihanoukville (22, 000t) and Koh Kong (35, 600t) (FAO, 2011).

Southeast Asian Fisheries Development Center (SEAFDEC) marine fishery statistics for Cambodia records a total catch of "other prawns" as 12,600 metric tonnes in 2004 and 13,500 metric tonnes in 2005 (UNU, 2007). Catch statistics of shrimps and prawns in Cambodian waters increased from 2,905 tonnes in 2000 to 4,778 tonnes in 2006 (UNU, 2007). Catch statistics of crabs in Cambodian waters from 2000-2006 ranged from 3,458 tonnes in 2004 to 4,301 tonnes in 2005. Catches of lobster during this period are generally small but variable: between 40-169 tonnes from 2000 - 2004, but 1,233 tonnes in 2005 (UNU, 2007). Catch statistics of squid and cuttlefish in Cambodian waters from 2000-2006 ranged from 2,355 tonnes in 2001 to 3,723 tonnes in 2005 (UNU, 2007).

Table 3-19: Fisheries Marine Catch in Cambodia from 1990 - 2010

Year	Marine Resources Caught (T)
1990	39,900
1991	36,400
1992	33,700
1993	33,100
1994	30,000
1995	30,500
1996	31,200
1997	29,800
1998	32,200
1999	38,100
2000	36,000
2001	42,000
2002	45,850
2003	54,750
2004	55,800
2005	60,000
2006	60,500
2007	63,500
2008	66,000
2009	75,000
2010	85,711

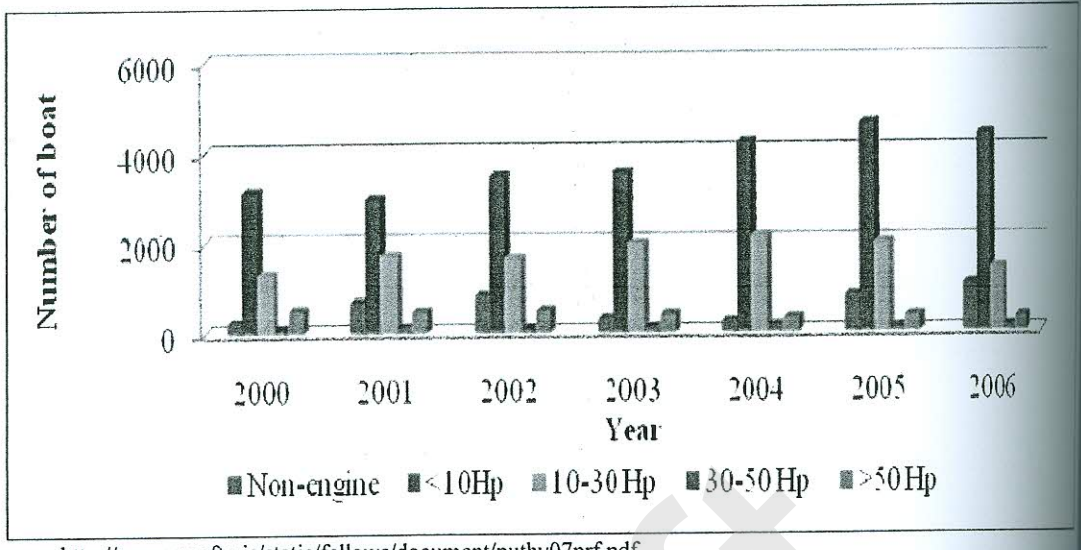
Source: Ministry of Agriculture Forest and Fishery (MAFF), Fishery Administration (FA), December, 2010

Fishing Gear

There were approximately 4,200 motorized fishing boats in Cambodia in 2000 (MOE, 2002b). In 2006 this number had grown to over 6000 (**Figure 3-40**). **Table 3-20** shows the number of motorized boats operating in the coastal zones in 2002. **Table 3-21** shows the gear used and species targeted in marine fisheries in Cambodia. Additional data from Koh Kong province show that approximately 10% fishing boats are small non-motorized canoes (World Fish Centre, 1999). In offshore areas, fishing boats tend to be larger (>50hp) purse seines, gill netters and trawlers. Inshore fisheries are dominated by smaller gill nets, traps, push nets and long lines.

Approximately 43,000 people are directly employed in capture fisheries in coastal Cambodia, or 5% of the population of the coastal provinces (MAFF, 2003).

Figure 3-40: Number of Marine Fishing Vessels Operating in Cambodia, from 2000 – 2006 (FiA, 2007)



Source: http://www.unuftp.is/static/fellows/document/puthy07prf.pdf

Table 3-20: Number of Motorized Boats in Coastal Cambodia

Location	# Motorized Boats			
Kampot, Koh Kong & Kep	<10 HP	10-30 HP	30-50 HP	>50 HP
	2321	571	32	152
Sihanoukville	11-30 HP		>30 HP	
	838		282	

Source: MOE 2002b

Table 3-21: Gear Used and Species Targeted in Marine Fisheries in Cambodia

Gear	Target species	Secondary 'by-catch'
Purse seiners	Short mackerel (Rastrelligerbrachysoma), Indian mackerel (R. kanagurt), Indian Anchovy (Stolephorus indicus)	Torpedo scad (Megalaspis cordyla), Longtail tuna (Thunnus tonggol), other mackerels, tunas, bonitos (Scombridae)
Shrimp trawls	Shrimp/Penaeidae sp.: Penaeus semisulkatus, P. canaliculatus, P. latisulcatus, P. merguiensis	Black tiger shrimp (Penaeus monodon), P. silasi, Swimming crabs (Portunidae), trash fish
Shrimp gillnets	Penaeus merguiensis, Mantis shrimp (Squillidae)	Trash fish, squid (Loliginidae), Scallops (Pectinidae), Swimming crabs (Portunidae), Scorpion fish (Scorpaenidae), Scallops (Pectinidae)
Crab gillnets	Swimming crabs (Portunidae), Mud crab/Scylla serrata	Sea bass & grouper (Serranidae), Scorpionfish (Scorpaenides), Mantis shrimp (Squillidae), Scallops (Pectinidae)
Fish gillnet	Indo-Pacific king mackerel (S.guttatus), Bluefin tuna (T.thynnus), Sharks, Seacatfish (Ariidae), Jacks (Carangidae), Mullet (Liza argentea), Valamugil seheli, Snapper (Lutjanidae), Short mackerel (R. brachysoma), Indian mackerel (R. kanagurta), Torpedo scad (Megalaspiscordyla), Silver pomfret (Pampusargenteus), Black Pomfret (Formio niger), Stingrays (Dasyatidae) Barramundi (L. calcarifer) Barracuda (Sphyraenidae), Terapons (Terapontidae)	Sea bass & grouper (Serranidae), Snappers (Lutjanidae), Breams (Nemipteridae), Drums & croakers (Sciaenidae), Sicklefish (Drepaneidae), Rabbitfish (Siganidae), Cutlassfish (Trichiuridae) Butterfish (Stromateidae), Wolf herring, (Chirocentridae), Lizardfish (Synodontidae).
Traps	Swimming crab (Portunidae), Mud crab (Scylla serrata), Squid (Loliginidae)	
Fishing weirs	Mixed species	
Hook & line	Nurse shark (Orectolobidae), Requiem shark (Carcharhinidae), Stingray (Dasyatidae), Seabass & grouper (Serranidae), Snapper (Lutjanidae)	
Push & stow nets	Mixed fish species Peregrine shrimp (Metapenaeu), Sepiolid squid (Sepiolidae), Octopus (Octopus sp.), Squid (Loliginidae), Very small shrimp (for shrimp paste)	Multi-species juvenile fish and shrimp
Live coral reef fish and shell fish collection	Grouper (Serranidae), Mixed coral reef fish	Giant clams (Tridacnagigas), Spidershell (Lambis)

Source: Touch & Todd, 2001

3.5.1.2 *Coastal Culture Fishery*

Shrimp, cockle, crab and seaweed aquaculture occurs at various locations all along the coast (MOE, 2002b). Based on 1999 data from DOF, the marine aquaculture accounted for 5% of the commercial fisheries production or 14,205 tons (Sour and Viseth, 2004). The production from specific facilities and the exact number of people they employ is uncertain. A map of marine aquaculture in the Sihanoukville Area is shown in **Figure 3-41**. In 2009, PACT, under funding from COPCL, conducted fishing community mapping of Sihanoukville Province. Across Prey Nub District, Stoeunghav District, and Preah Sihanouk Municipality, nine fishing communities were identified and mapped:

Trapang Lapov, Koh Kchong village, Ream, Otrest, Kam Penh, Tomnop Rolok, Ovietnam, Kam Penh, and Damnak Sdach. **Figure 3-42** shows a map of the community fisheries.

Shrimp Pond Aquaculture

According to information from the Ministry of Agriculture, Forestry and Fishery, shrimp pond aquaculture is presently carried out on a small scale (i.e. by small holders with one or two ponds), with no extensive farms owned by large companies.

Cage Culture

Finfish culture in pens or cages are observed in Koh Kong province and Sihanoukville. Cages for cockles were observed in a number of locations within Kampong Som Bay and are reported in Trapeang Ropov of Kampot bay, while green mussel culture was observed in Koh Kong bay (MoE and Danida, 2006).

Seaweed Culture

The culture of seaweed is an increasingly important aquaculture activity, currently centred in Kampot. The Department of Fisheries in Kampot have identified zones for seaweed culture. Although the MAFF policy is that seaweed farms may not be established over seagrass beds, according to the existing data, the seaweed zones overlap with seagrass areas.

Cambodia Block A Development
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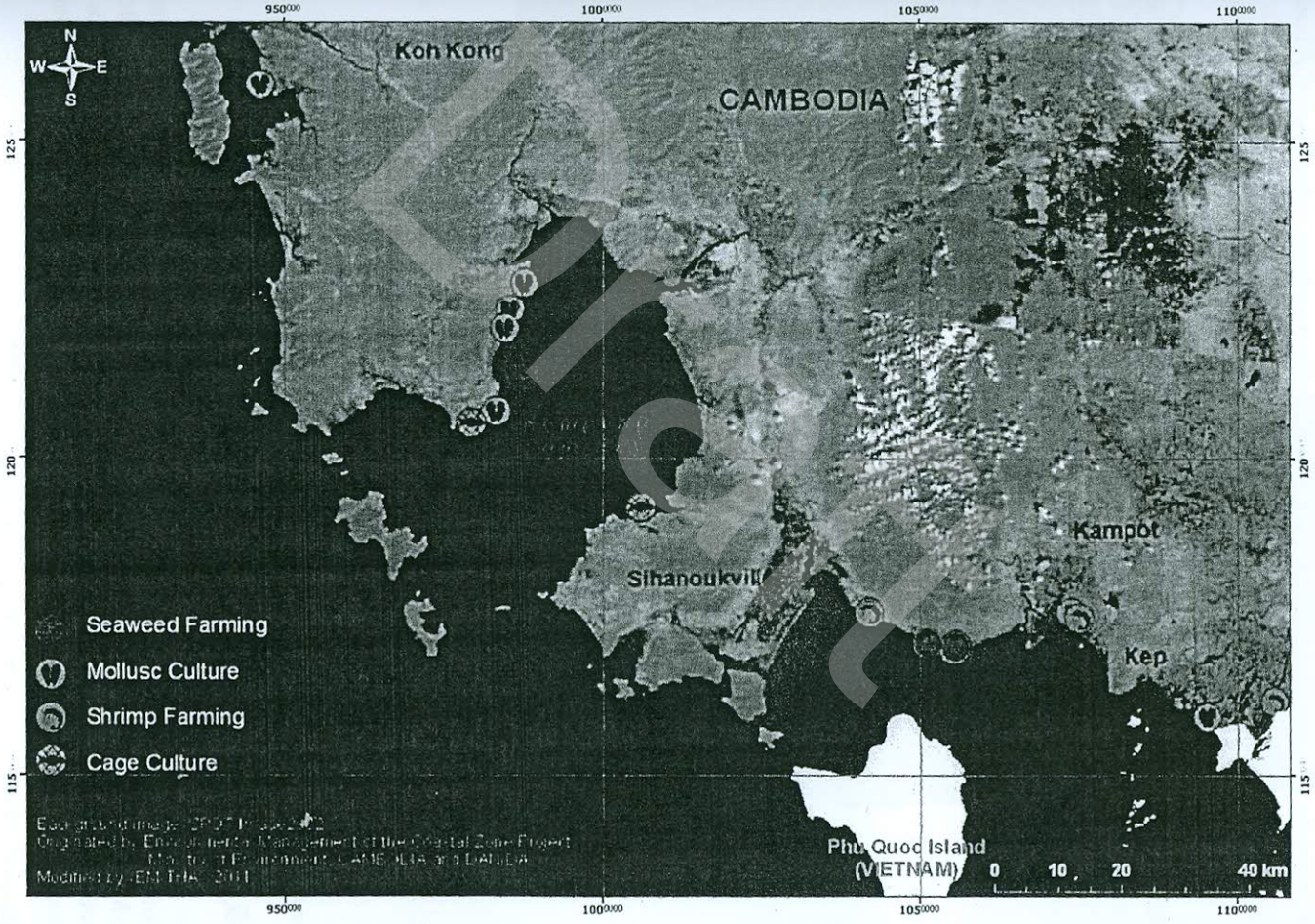
3. Environmental Setting

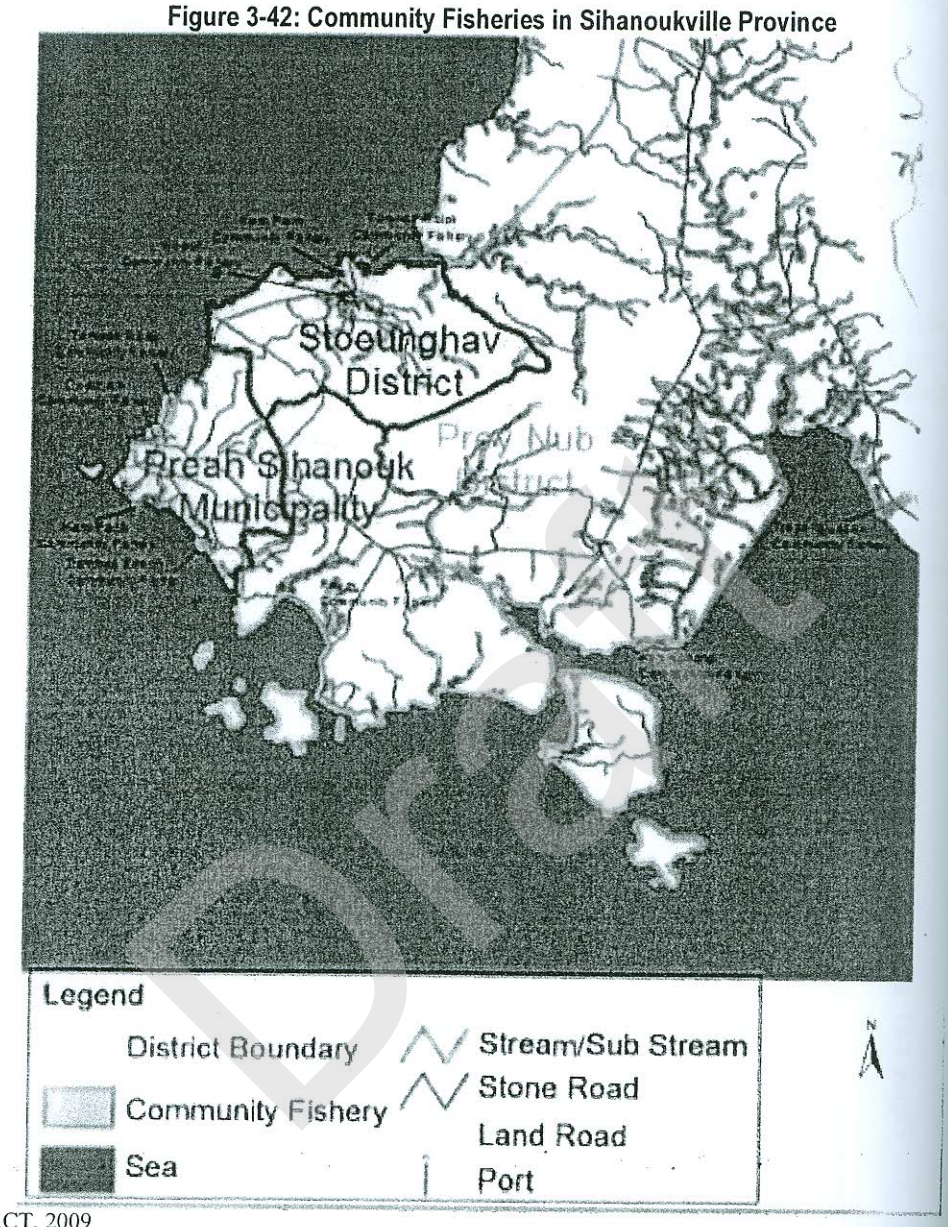
Figure 3-41: Marine Aquaculture in Sihanoukville Area

Figure 3-41: Marine Aquaculture in Sihanoukville Area



Source: Coastal survey from: MoE and Danida, 2006, modified by IEM, 2011

Figure 3-42: Community Fisheries in Sihanoukville Province



Source: PACT, 2009

3.5.2 Shipping

The Gulf of Thailand is traversed by small to medium sized cargo ships but is not regarded as an international shipping lane due to its shallow depth and geographic location away from Singapore and the Malacca Straits. Small cargo boats ply the Gulf but most hug the coastline. Most east-west traffic moves between Hong Kong and Singapore, several hundred kilometers to the south, so large ships move well outside the concession area.

In general, there is no official or well-documented data on shipping lanes off the Cambodian coast. During the IEM 2010 Block A survey, a total of approximately ten vessels, both tankers and container vessels, were observed over a period of seven days traveling through Block A from North to South and visa versa, most likely traveling to and from Bangkok, Laemchabang and/or Rayong ports in Thailand.

During the April 2011 geotechnical site survey conducted by COPCL, only a few large commercial vessels were observed: four vessels were observed in eight days. A similar number of fishing vessels was also observed.

Ports in Cambodia are mostly limited to small vessels. The only international port is at Sihanoukville, with a capacity of 1.2 million tons/year. Further information on vessel capacity of ports is discussed in *Section 3.5.4.3*.

3.5.3 Tourism

Sihanoukville has a large and growing tourism-based service sector. Kep, with good beaches and access to Kep and Phnom Bokor national parks has similar goals for tourism development (MOE, 2002b). Several islands (Koh Rong, Koh Thash and Koh Rongsanlem) are also being developed as nature-oriented resorts (World Fish Centre, 1999). Private resorts are currently in development for the nearyby islands of Koh Puos and Koh Rong.

Tourist infrastructure is poorly developed. Tourist statistics for Cambodia from 1993 – 2010 are shown in **Table 3-22**.

Table 3-22: Tourist Statistics for Cambodia, 1993 -2010

Years	Visitor Arrivals		Average Length of Stay (days)	Hotels Occupancy (%)	Tourism Receipts (million US$)
	Number	Change (%)			
1993	118,183	0.00	N/A	N/A	N/A
1994	176,617	49.44	N/A	N/A	N/A
1995	219,680	24.38	8.00	37.00	100
1996	260,489	18.58	7.50	40.00	118
1997	218,843	-15.99	6.40	30.00	103
1998	289,524	32.30	5.20	40.00	166
1999	367,743	27.02	5.50	44.00	190
2000	466,365	26.82	5.50	45.00	228
2001	604,919	29.71	5.50	48.00	304
2002	786,524	30.02	5.80	50.00	379
2003	701,014	-10.87	5.50	50.00	347
2004	1,055,202	50.53	6.30	52.00	578
2005	1,421,615	34.72	6.30	52.00	832
2006	1,700,041	19.59	6.50	54.79	1,049
2007	2,015,128	18.53	6.50	54.79	1,400
2008	2,125,465	5.48	6.65	62.68	1,595
2009	2,161,577	1.70	6.45	63.57	1,561
2010	2,508,289	16.04	6.45	65.74	1,786

Source: Ministry of Tourism, 2007: Tourism Statistical Report 2007

3.5.4 Infrastructure

3.5.4.1 Roads

National Highway 4 connects Sihanoukville with Phnom Penh via Koh Kong province. This highway is 230 km long and has two lanes. National Highway 3 connects Sihanoukville with Phnom Penh via Kampot Province.

Other roads in the coastal provinces are generally unsealed, with bridges in poor condition (JICA 2002).

The road network for Sihanoukville and for the coastal provinces connecting to Phnom Penh is shown in **Figure 3-43**.

10

ancy (%)	Tourism Receipts (million US$)
	N/A
	N/A
	100
	118
	103
	166
	190
	228
	304
	379
	347
	578
	832
	1,049
	1,400
	1,595
	1,561
	1,786

province. This highway
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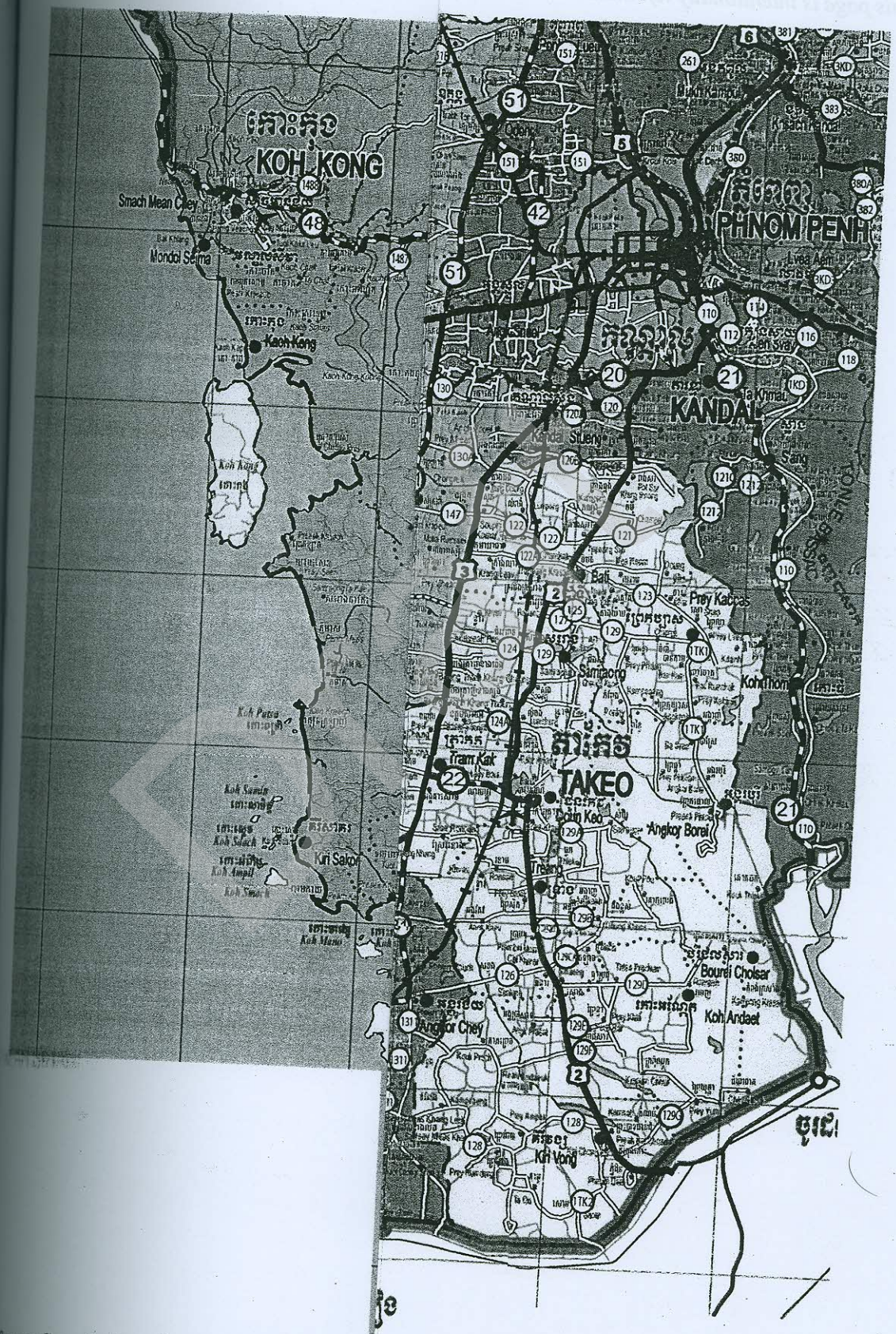


Source: Compilation of maps from http://ww

3.5.4.2 *Air Traffic*

According to The State Secretariat of Civil Aviation (SSCA), there are three international airports (Phnom Penh, Siem Reap, and Sihanoukville), seven domestic airports (Rattanakiri, Stung Treng, Mondulkiri, Battambang, Koh Kong, Preah Vihear and Kratie) and a number of other airfields under their direct responsibility (SSCA, 2011). Most of the smaller airfields are not operational. The current operation status of all international and domestic airports is shown in **Table 3-23**. A map of all currently operational airports is shown in **Figure 3-44**.

Phnom Penh Airport has a 3,000-meter runway and is linked with many parts of Asia by direct services (SSCA, 2011).

Sihanoukville's airport has a surfaced 2,200 m runway with a 50 tonne load rating (SSCA, 2011). There are currently no scheduled flights.

Table 3-23: Current Operation Status of Airports in Cambodia

Airports (Alternative Name)	Airport Reference Code	Current Operation Status (as of 2011)	Airfield Condition*
International			
Phnom Penh	4D	Operational	Good
Siem Reap	4C	Operational	Good
Sihanouk Ville (Kampong Som)	3C	Charter Only	Good
Domestic			
Kampong Chhnang	4C	Re-construction Pending	-
Rattanakiri	3C	Operational	Average
Koh Kong	3C	Operational**	Average
Battambang	3C	Operational	Average
Stung Treng	3C	Operational	Poor
Mondulkiri	2B	Not Operational	Poor
Preah Vihear (Phnom Tbeng Meanchey)	3C	Not Operational	Poor
Kratie	3C	Not Operational	Poor

Source: http://www.civilaviation.gov.kh/, http://www.aeroflight.co.uk/waf/aa-eastasia/cambodia/cam-af-bases.htm, Accessed July 2011

* Based on SSCA's own ranking system of (Excellent – Good – Average – Poor)

** SSCA lists status as "Operational", but BOT (Construction Funding) as "To be confirmed". www.aeroflight.co.uk maintains a list of airports and claims that, as of 2007, the airport "is still used by civilian aircraft".

Figure 3-44: Map of Cambodia Airports

Source: http://www.mapsofworld.com/international-airports/asia/cambodia.html, modified by IEM, 2011

3.5.4.3 Shipping and Port Facilities

Cambodia has three international ports: Sihanoukville, Phnom Penh and Koh Kong. Sihanoukville is the main deep-sea port. Sihanoukville handled 2,057,967 tons of cargo and 954 vessels in 2008 (PAS, 2011) (**Table 3-24**). Included in this total are refined oil products imported to Cambodia by the Petroleum Authority of Thailand (PTT) and Sokimex via their specialized terminals and storage facilities at the port. All berthing facilities at Sihanoukville port are shown in **Table 3-25**. Sihanoukville port has five warehouses covering an area of 36,000m^2 with a total storage capacity up to 84,000 tons.

Maximum vessel dimensions at Sihanoukville Port are 10,000 dwt, -8.50 m draft (PAS, 2011). The port has four components: the old portaging with concrete finger jetties and a cargo berth with transit sheds of 265m long; a general cargo wharf serving as a container terminal with approximately

(350m); a further container berth and a tanker berth servicing import vessels to 13,000dwt and local distribution tankers of 500 to 1,500dwt (REPSF, 2005).

Principal imports at Sihanoukville port are container cargo, cement, oil products, steel, rice & general cargo. Principle exports are container cargo, processed wood and agricultural products. The quantity of export cargo, predominantly garments, heavily outweighs imports such as raw materials. There is also a noticeable seasonality, the peak being in June to October. A weekly peak is recorded with most feeder vessel scheduled to call at the end of the week to suit the garment manufacturers' shipping program (REPSF, 2005).

The Phnom Penh port is the country's traditional river port, accessible to vessels from the South China Sea through Vietnam. Phnom Penh port is located in the city on the Sap river, some 3-4 km from its junction with the Mekong River. Vessels of up to 2,000 dwt-can use the route without difficulty, and 5,000 dwt boats can pass the entrance to the Mekong on favourable tides. The port serves up to 150 ships per year. Koh Kong is situated near the Thai border and is used by small boats, below 500 dwt.

Table 3-24: Traffic at Sihanoukville Port

Item	2003	2004	2005	2006	2007	2008
Gross Throughput (Tons)	1,772,361	1,503,050	1,380,847	1,586,791	1,818,877	2,057,967
Gross throughput Not Including Fuel	1,454,856	1,242,011	1,131,699	1,320,102	1,428,992	1,605,672
Not Including Fuel &Cont.	650,329	308,153	107,929	197,573	193,573	291,114
Cargo Containerized	804,527	933,858	1,023,770	1,122,529	1,235,419	1,314,559
Container Throughput (TEUs)	181,286	213,916	211,141	231,036	253,271	258,775
Vessel Calling (Units)	878	730	686	912	876	954

Source: http://www.pas.gov.kh, Accessed July 2011

Table 3-25: Berthing Facilities at Sihanoukville Port

Terminal	Length (m)	Depth (m)	Berths	Other
Container Terminal	750	10.50	05	Medium size vessel
General Cargo	290	9.00	02	Inner berth of old jetty
Passenger Terminal	290	8.40	02	Outer berth of old jetty
Sokimex	200	9.20	01	Oil jetty
Pontoon		6.50	01	Oil jetty
Stone Wharf	53	4.20	01	Oil jetty

Source: http://www.pas.gov.kh, Accessed July 2011

3.5.4.4 Communications

Cellular telephone communications are developing rapidly in Cambodia and are available throughout the coastal provinces. Satellite communications link provincial centers within Cambodia and link Cambodia with international networks (JICA, 2002).

Internet usage has grown significantly in the past decade in Cambodia. Internet usage statistics from 2000 to 2010 are shown in **Table 3-26**.

Table 3-26: Internet Usage and Population Statistics in Cambodia

YEAR	Users	Population	% Pen.	GDP p.c.*	Usage Source
2000	6,000	12,573,580	0.05 %	US$ N/A	ITU
2007	44,000	15,507,538	0.3 %	US$ 648	ITU
2009	74,000	14,494,293	0.5 %	US$ 775	ITU
2010	78,000	14,753,320	0.5 %	US$ 805	ITU

Source: http://www.internetworldstats.com/asia/kh.htm
* Note: Per Capita GDP in US dollars, source: International Monetary Fund.

3.5.4.5 Waste Handling

Wastewater

Urban areas in the coastal provinces dispose of wastewater via combined sewage systems to local waterways or the sea. Sewage in these areas is not usually treated, and most sewer systems have not been maintained since the early 1970s. In rural areas, wastewater is disposed of via septic systems or directly to waterways.

Sihanoukville generates approximately 5,500 m^3/day of wastewater (MOE, 2002). Consultations are currently underway with the Asian Development Bank to provide new wastewater transport and treatment capability in the urban area.

Solid Waste

According to a study commissioned by the Ministry of Environment, the management of solid waste in urban centers along the coastline as well as in the whole country is a major environmental problem (Ministry of Environment and Danida, 2004). Waste are reported to be frequently disposed of in open areas, or illegally dumped into roads, rivers, stream, lakes, vacant lots, private properties, in public places and into the sea, which contributes to unsanitary conditions, blockage of drainage systems, and pollution. Collected waste is taken to landfill sites, but these are not engineered.Although Cambodia does not have a high levelof waste generation, almost all urban areas have significant waste disposal problems (Ministry of Environment and Danida, 2004).

Solid waste generated and collected in the main coastal centers in 2002 is shown in **Table 3-27**.

Table 3-27: Waste Generation and Collection (MoE, 2002)

Location	Waste Generated (tonnes/day)	Waste Collected (tonnes/day)
Sihanoukville	68.6	18.8
Kampot	15.1	9.1
Koh Kong	12.1	7.3
Kep	14.9	Unknown

Waste collection is now under the control of a private company responsible for collection and transportation of solid waste for households, markets, hospitals, hotels, restaurants, public-private offices, parks, and roads/streets in Sihanoukville (Preah Sihanouk Environmental Department, 2011). The disposal site for waste is located in Bettrain Commune, about 18 km from Sihanoukville (Preah Sihanouk Environmental Department, 2011).

3.6 Socio-Economic and Quality-of-Life Values

3.6.1 Administration

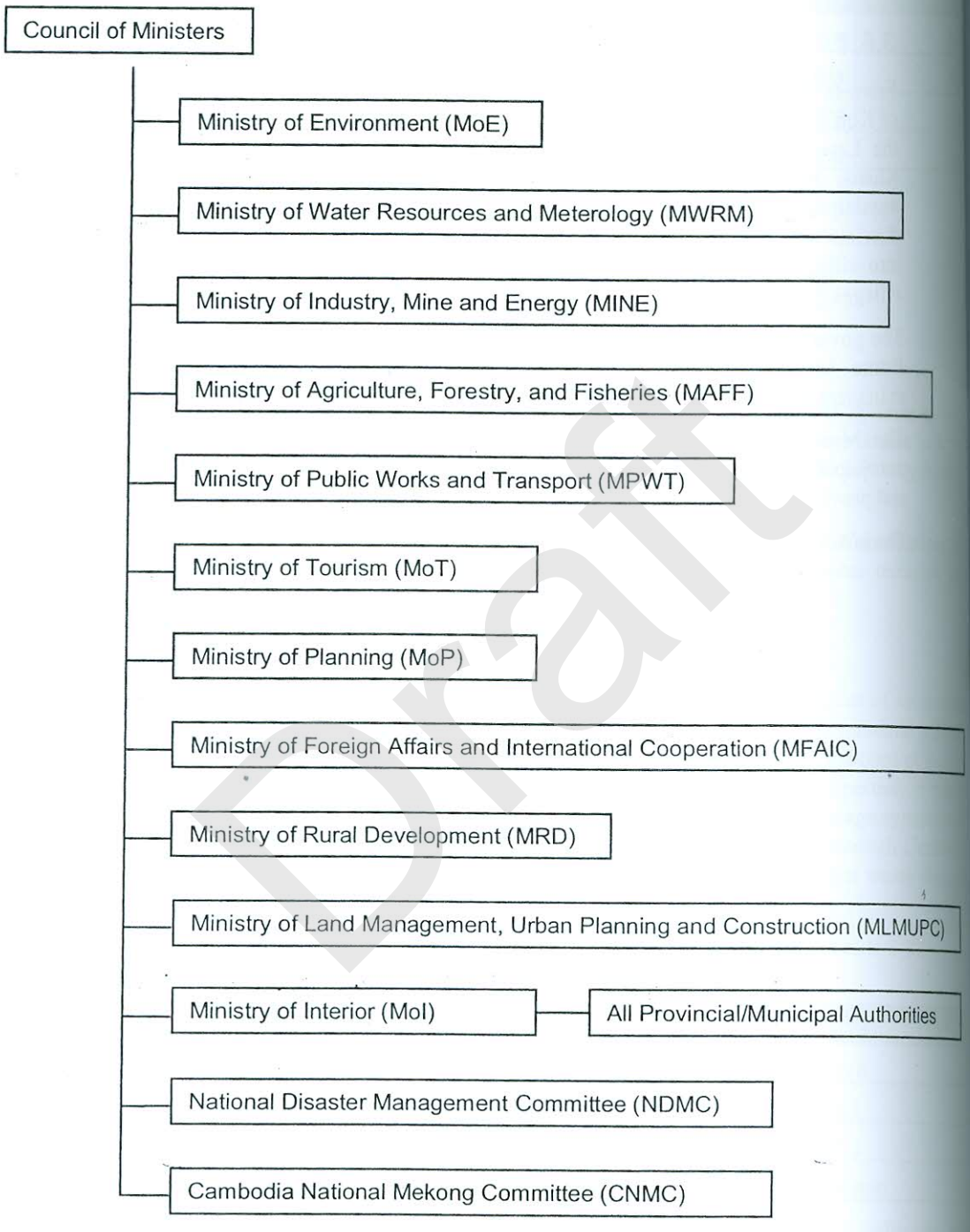
From an administrative perspective, the coastal zone falls into four administrative units; the provinces of Koh Kong, Kampot, Sihanoukville, and Kep. Cambodia is divided into 23 provinces. According to the Law on Administrative Management of the Capital, Provinces, Municipalities, Districts and Khans, Royal Kram No. NS/RKM/0508/017, provinces are further divided into districts and municipalities, which are shown in **Figure 3-47** to **Figure 3-50** for each coastal province. The districts are further subdivided into communes (khum) and quarters (sangkat), then further divided into villages (phum). The municipalities are divided into quarters (sangkat), which are divided into villages (phum), and further divided into groups (krom).

The government's top executive organ is the Council of Ministers, or cabinet, which is headed by the Prime Minister. **Figure 3-45** shows the organization of ministries related to environmental management under the administration of the Council of Ministers.

The Ministry of Interior is responsible for administration throughout Cambodia's provinces and municipalities, as well as for supervision of the national police, protecting social order and security, and providing safety to the people of the Kingdom of Cambodia (DOLA, 2011).

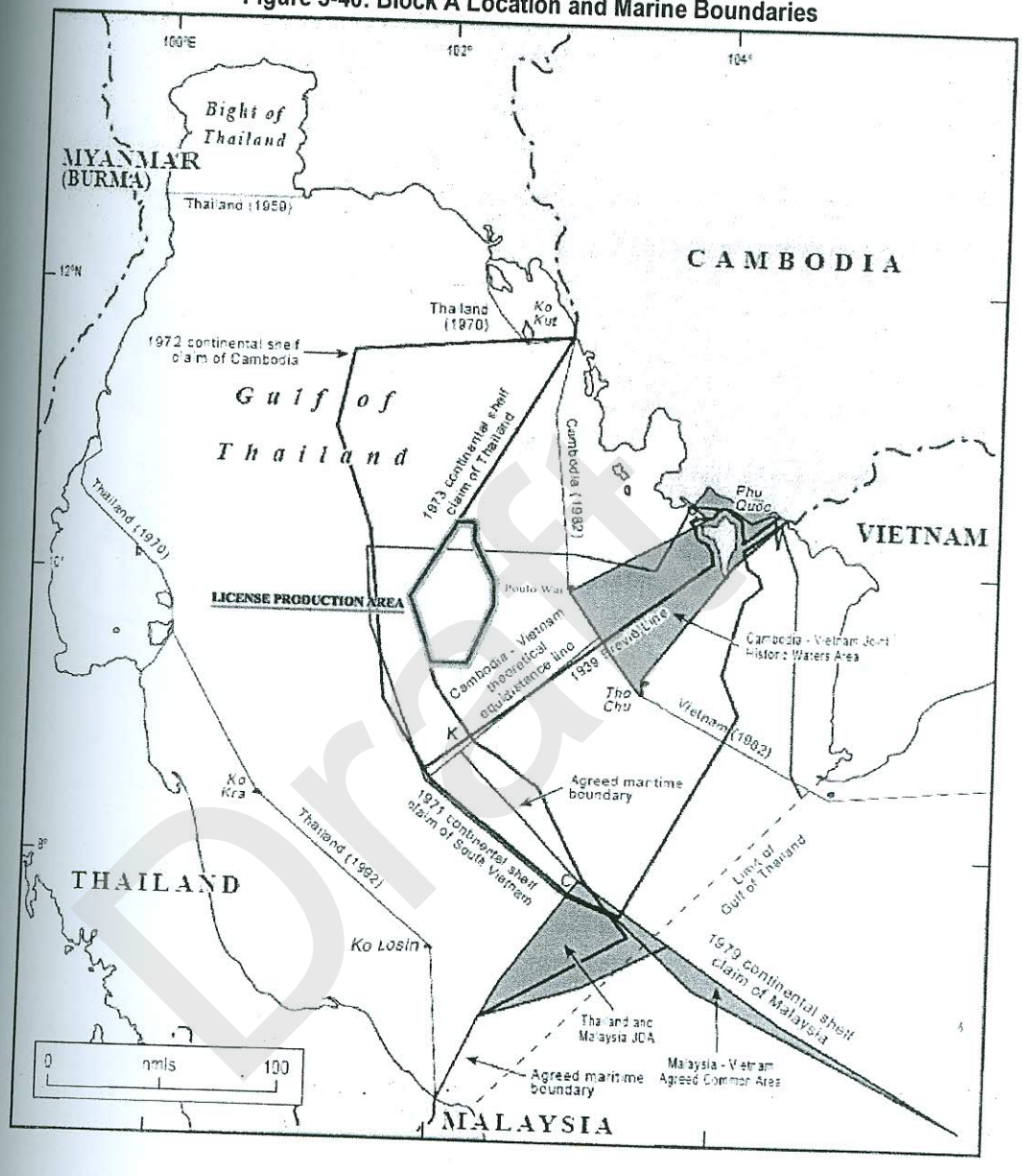
The historical marine boundary is illustrated in **Figure 3-46**.

Figure 3-45: Administrative Organization for Ministries Related to Management of the Environment



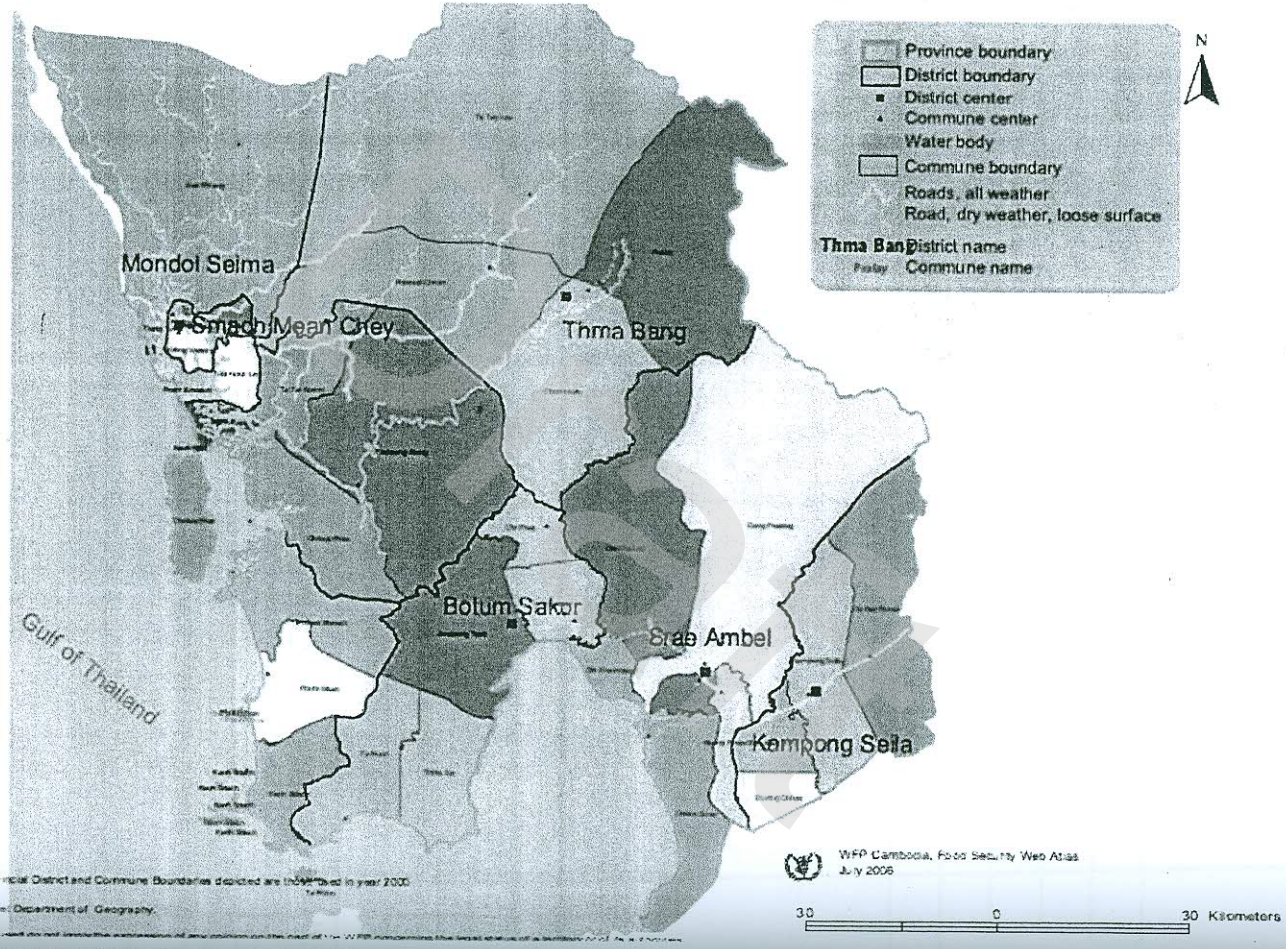
Source: http://www.wepa-db.net/policies/structure/chart/cambodia/index.htm, modified by IEM, 2011

Figure 3-46: Block A Location and Marine Boundaries



Source: Hong Thao, 1999

Figure 3-47: Koh Kong Administrative Map

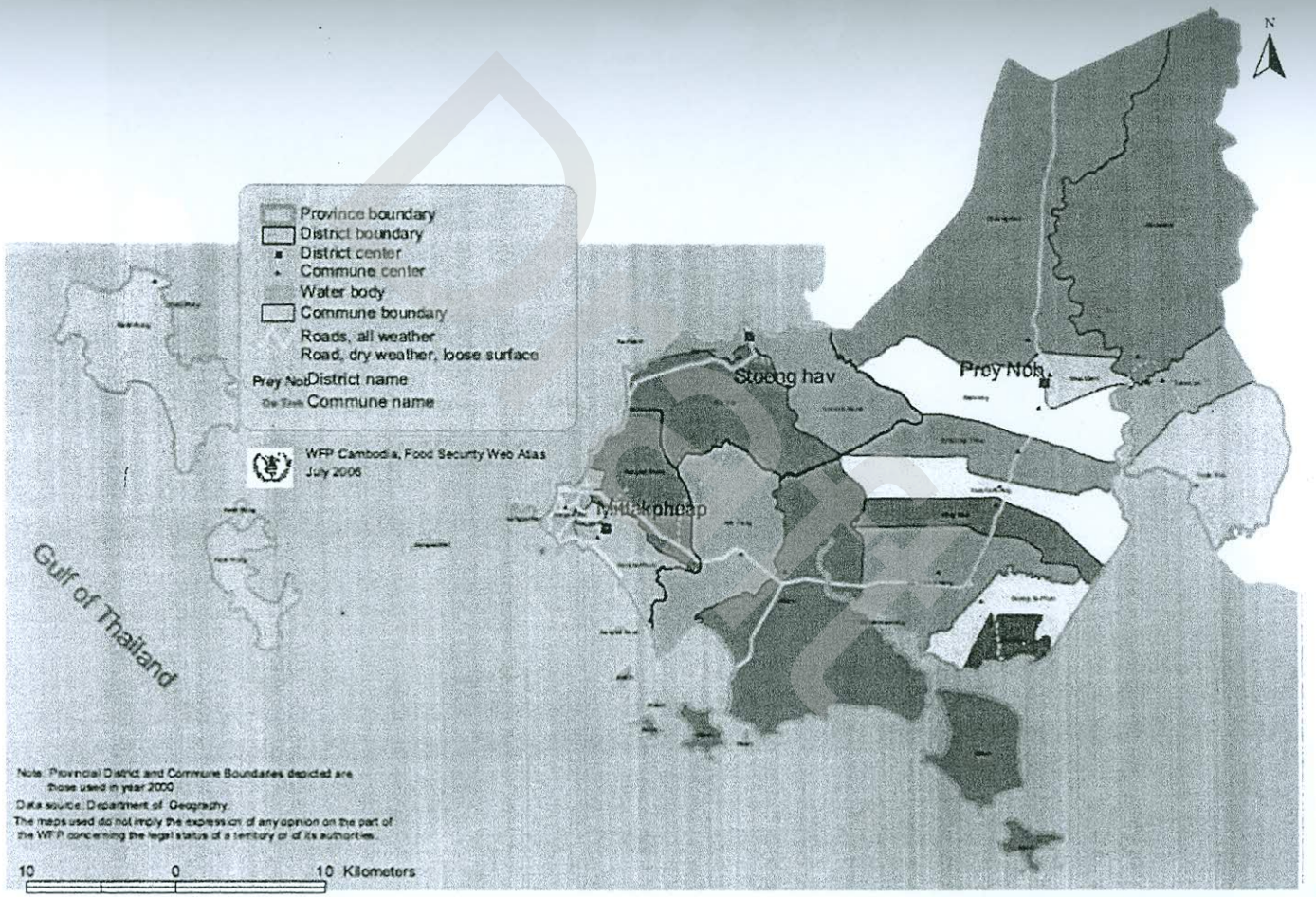


Source: http://foodsecurityatlas.org/khm/country/provincial-Profile

Figure 3-48: Sihanoukville Administrative Map

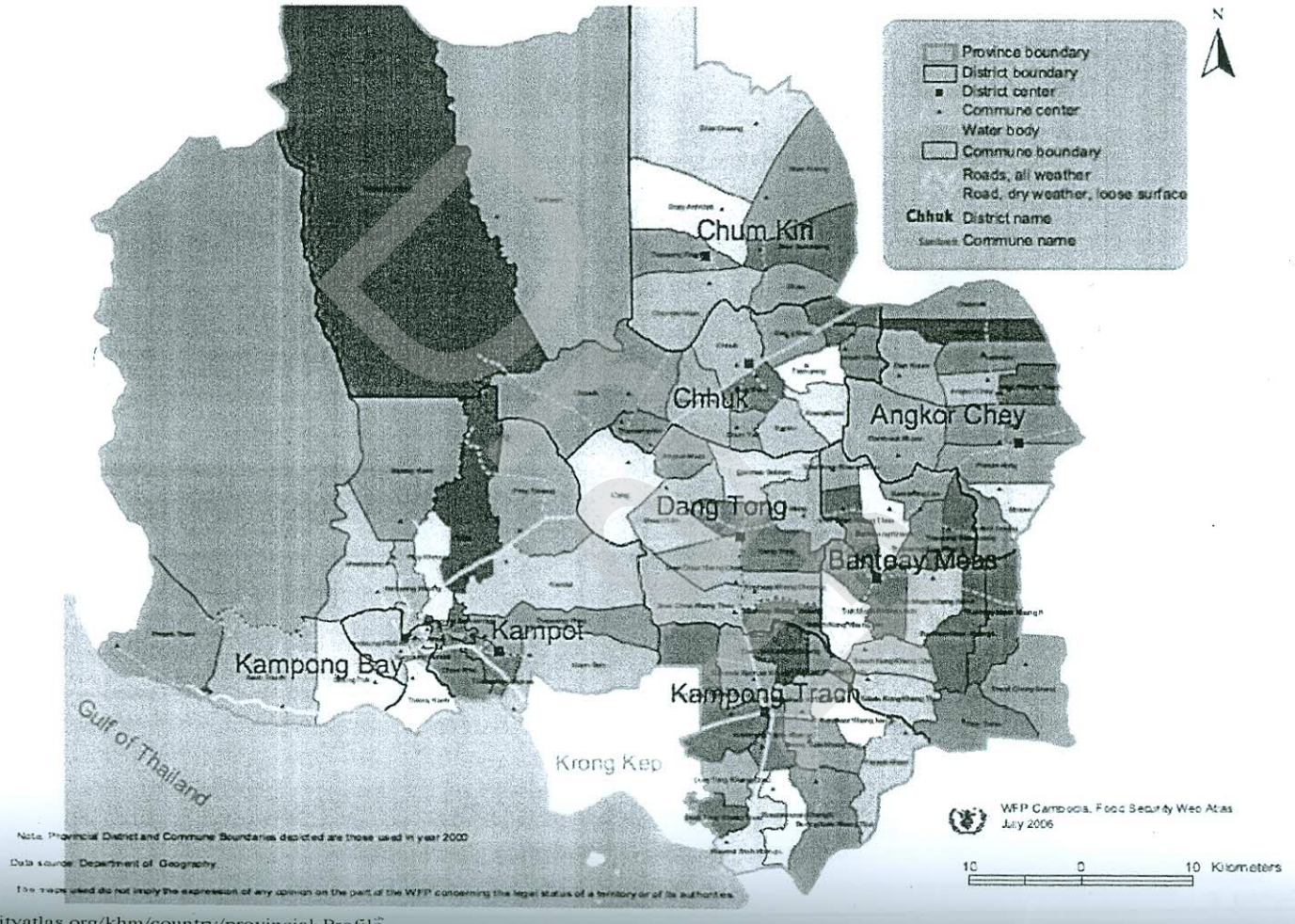
Source: http://foodsecurityatlas.org/khm/country/provincial-Profile

Figure 3-48: Sihanoukville Administrative Map



Source: http://foodsecurityatlas.org/khm/country/provincial-Profile

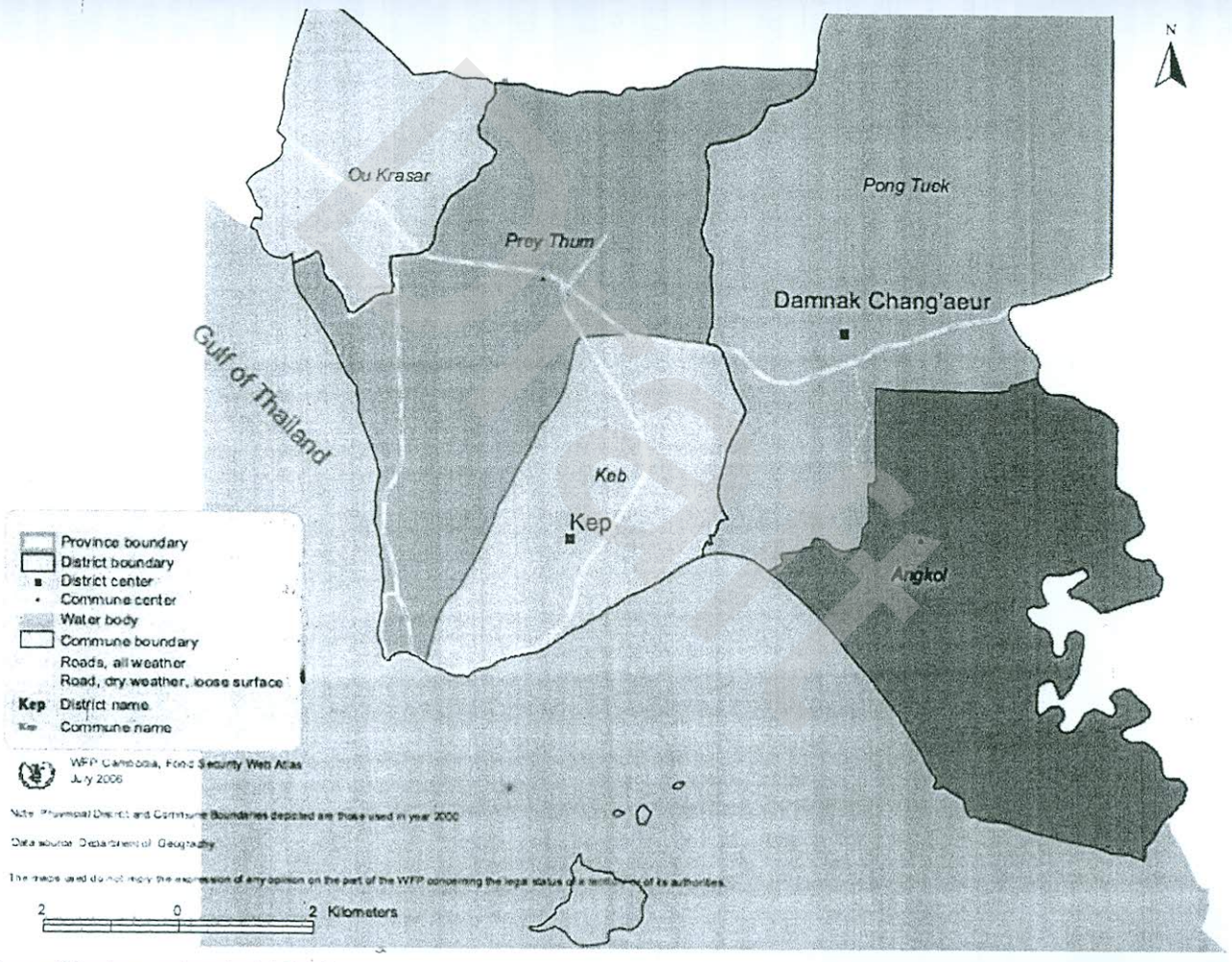
Figure 3-49: Kampot Administrative Map



Source: http://foodsecurityatlas.org/khm/country/provincial-Profile

Source: http://foodsecurityatlas.org/khm/country/provincial-Profile

Figure 3-50: Kep Administative Map



Source: http://foodsecurityatlas.org/khm/country/provincial-Profile

3.6.2 Population and Demographics

According to the final results from the General Population Census 2008, published in September 2009, the Cambodian population was estimated to 13.395 million (NIS, 2010). In 2007 there were about 2.8 million households in Cambodia (NIS, 2010).

The total area of Cambodia is 181,035 km^2, which includes the area of the Tonle Sap Lake. The 435 km Cambodia coastline is sparsely populated. **Table 3-28** shows details of Cambodia's coastal area.

Table 3-28: Cambodian Coastal Characteristics

Administrative region	Area (km^2)	Length of Coast (km)	Number of Districts	Number of Communities
Koh Kong	11,160	237	8	33
Sihanoukville	868	128	3	22
Kampot	4,873	67	8	92
Kep	374	26	2	5
Total	**17,275**	**458**	**21**	**152**

Source: 1) Data Book Report from National Committee for Sub-National Democratic Development (NCDD), Ministry of Interior, 2009. 2) http://foodsecurityatlas.org/khm/country/provincial-Profile/

The most recent population data for Cambodia's coastal provinces are presented in **Table 3-29**.

Table 3-29: Coastal Provinces - Population Statistics

		Koh Kong	Sihanoukville	Kampot	Kep
Estimated Population		117,481	221,396	585,850	35,753
Population Density (individuals/km^2)		10.53	255.06	120.22	95.60
Average Household Size		4.83	4.89	4.50	4.94
Age Distribution	<15 years	36.3%	32.4%	35.5%	26.6%
	15-64 years	60.9%	64.6%	59.8%	69.4%
	>64 years	2.8%	3.0%	4.7%	4.0%

Source: NIS, 2009

Throughout the coastal provinces, children make up approximately 30% of the population, economically productive adults 60%, and elderly <5%.

3.6.3 Employment, Education and Income

In 2008, the employment rate in Cambodia was approximately 75%, with approximately 70%participation for women and 81%participation for men (NIS, 2010). In general, Cambodia's employment is largely in the primary sector (agriculture and fisheries), with 54% of the total population involved in these activities as their primary occupation (**Table 3-30**). In the coastal provinces, male and female unemployment is generally below 5%, and the literacy rate is similar to that of the national level (above 70%) (**Table 3-31**). In terms of employment sector, the vast majority of jobs in the coastal provinces are in the private sector (**Table 3-31**).

In Sihanoukville province, the most common occupations are "Subsistence farmers, fishers, hunters and gatherers" (37.03%), followed by "Sales workers" (13.43%), and "Food processing, wood working and garment workers" (7.13%) (**Table 3-32**).

Approximately 59 percent of the labour force had "no or only some education/primary school not completed" (NIS, 2010). As of 2005, 34.7 percent of the total population liveed below the poverty line, although this value is higher in rural areas (NIS, 2006). More than 70 percent of the population age 7 years and over was literate (NIS, 2010).

Table 3-30: Cambodian Employed Population (10 years and over), by Main Occupation, 2007 (%)

Primary occupation	Cambodia	Phnom Penh	Other urban	Other rural
Legislators, senior officials and managers	1	2	3	1
Professionals	3	13	5	1
Technicians and associate professionals	2	8	5	1
Clerks	2	10	4	1
Service workers and shop and market sales workers	13	34	24	8
Skilled agricultural and fishery workers	54	1	28	63
Craft and related trades workers	9	10	12	8
Plant and machine operators and assemblers	8	12	7	7
Elementary occupations	10	8	12	10
Armed forces	0	2	1	0
Occupation not adequately described	0	0	0	0
Total	**100**	**100**	**100**	**100**

Source: NIS, 2010

Table 3-31: Employment Sector and Labor Force Indicators in Coastal Provinces

Employment and Labor Force Indicator	Koh Kong	Sihanoukville	Kampot	Kep
Literacy Rate (%)	70.57% (76.33% male; 64.71% female)	75.62% (80.71% male; 70.56% female)	74.15% (79.93% male; 68.77% female)	70.83% (76.74% male; 65.13% female)
Male Unemployment Rate, Age 7+ (%)	2.12	1.70	1.33	0.37
Female Unemployment Rate, Age 7+ (%)	4.45	2.65	1.41	0.42
% of Labor Force in Government Sector	6.17	5.78	3.76	5.56
% of Labor Force in State Owned Enterprise Sector	0.23	1.34	0.12	0.14
% of Labor Force in Cambodian Enterprise (Private) Sector	91.95	84.12	95.23	93.02
% of Labor Force in Foreign Enterprise Sector	0.88	6.70	0.60	0.71
% of Labor Force in Non Profit Institution Sector	0.03	0.30	0.05	0.02
% of Labor Force in Household Sector	0.52	1.35	0.18	0.35
% of Labor Force in Embassies, NGO's and	0.21	0.30	0.06	0.12

Employment and Labor Force Indicator	Koh Kong	Sihanoukville	Kampot	Kep
Development Agencies				
% of Labor Force in "Other" Sector	0.01	0.10	0.01	0.09

Source: NIS, 2009

Table 3-32: Main Occupations in Sihanoukville

Occupation	Percentage		
	Male	Female	Total
Chief executives, senior officials and legislators	0.658	0.097	0.407
Administrative and commercial managers	0.174	0.144	0.161
Production and specialized services managers	0.194	0.040	0.125
Hospitality, retail and other services managers	0.251	0.173	0.216
Science and engineering professionals	0.034	0.013	0.025
Health professionals	0.099	0.049	0.076
Teaching professionals	2.310	1.579	1.983
Business and administration professionals	0.113	0.060	0.089
Legal, social and cultural professionals	0.030	0.009	0.021
Science and engineering associate professionals	0.452	0.144	0.314
Health associate professionals	0.455	0.381	0.422
Business and administration associate professionals	1.124	0.399	0.800
Legal, social, cultural and related associate professionals	1.854	1.010	1.476
Information and communications technicians	0.082	0.053	0.069
General and keyboard clerks	1.510	0.616	1.110
Customer services clerks	1.687	1.623	1.659
Numerical and material-recording clerks	0.628	0.066	0.377
Other clerical support workers	0.326	0.128	0.238
Personal service workers	1.462	3.837	2.525
Personal care workers	0.072	0.250	0.152
Protective services workers	3.160	0.350	1.902
Sales workers	6.840	21.567	13.430
Market-oriented skilled agricultural workers	1.922	2.033	1.972
Market-oriented skilled forestry, fishery and hunting workers	8.321	1.758	5.384
Subsistence farmers, fishers, hunters and gatherers	32.491	42.623	37.025
Building and related trades workers	5.780	1.023	3.651
Metal, machinery and related trades workers	1.951	0.128	1.135
Handicraft and printing workers	0.793	0.529	0.675
Electrical and electronic trades workers	0.827	0.077	0.491
Food processing, wood working and garment workers	2.948	12.290	7.129
Stationary plant and machine operators	0.217	0.038	0.137

Occupation	Percentage		
	Male	Female	Total
Drivers and mobile plant operators	8.784	0.447	5.053
Cleaners and helpers	0.585	1.397	0.948
Agricultural, forestry and fishery labourers	3.556	2.201	2.950
Labourers in mining, construction, manufacturing and transport	6.716	1.492	4.378
Food preparation assistants	0.016	0.139	0.071
Street and related sales and service workers	0.499	0.414	0.461
Refuse workers and other elementary workers	1.080	0.824	0.965

Source: NIS, 2009

3.6.4 Health

This section describes the existing health condition and support systems in the project's zone of influence. Health conditions in Cambodia have improved recently. The infant mortality rate has decreased from 95 per 1,000 live births in 2000 to 66 in 2005 and the under-five mortality rate from 124 to 83 in the same period (NIS, 2006). Life expectancy at birth is 58 years for male and 64 years for female (Ministry of Planning, 2006). The government expenditure on health per capita is $4.09 (Ministry of Health, 2006).

3.6.4.1 Health Centers

Facilities and capabilities in provincial hospitals are limited; doctors and nurses have limited training and experience, and diagnostic, surgery and treatment capability are limited to basic procedures (JICA, 2002).

All coastal provincial centers have hospitals (**Table 3-33**). According to MoE, 2005, the Cambodian Government provides health services through Health Posts, Health Centres and Referral Hospitals. There were eight Referral Hospitals and 71 Health Centres in the Coastal Zone in 2003 providing an average bed availability of a little less than 1 bed per 1000 people.

Skilled health workers provided at the government's health facilities include doctors, assistant doctors, medium and primary nurses and medium and primary midwifes. The average number of doctors at government health facilities per thousand population in the coastal zone in 2003 was 0.16 or 0.269 if assistant doctors are included. The average number of trained nurses (medium and primary) at government health facilities per thousand population in 2003 was 0.681. The average number of trained midwifes (medium and primary) at government health facilities per thousand people in 2003 was 0.292. There are generally low levels of access to health professionals at district level with the exception of districts hosting referral hospitals.

In addition to professional staff at health centres there are private providers of health services in the coastal zone (private clinics primarily in urban areas and traditional healers in rural areas). The Commune database reports that most communes in the coastal zone have both government-trained and traditional midwifes. Statistics for all available health facilities in the coastal provinces are shown in **Table 3-33**.

3.6.4.2 Common Diseases

The main health problems of Cambodia are HIV/AIDS, Tuberculosis, and diarrhoeal diseases (WHO, 2006). There have however been significant improvements in recent years, including increase in cure/detection of tuberculosis; decrease in incidence and fatality rate of malaria, dengue fever, measles and cholera; and the eradication of poliomyelitis in 2000 (Ministry of Planning, 2006).

HIV/AIDS also poses a serious existing public health problem in Cambodia due to the epidemic rapid pace of growth. Results from the 2005 Cambodia Demographic and Health Survey in 2005 indicate that 0.6 percent of Cambodian adults age 15-49 are infected with HIV, with prevalence levels highest in Phnom Penh (1.7 percent) and Krong Preah Sihanouk/Kaoh Kong (1.3 percent) (NIS, 2006).

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Table 3-33: Health Facilities in Coastal Provinces and Municipalities

Province/ Municipality	District	Referral Hospitals	Health Centers	Beds	Doctors	Assistant Doctors	Medium Nurses	Primary Nurses	Medium Midwife	Primary Midwife	Government Trained Midwife	Traditional Midwife
Kampot	Angkor Chey	1	7	79	3	7	21	25	10	9	63	65
	Banteay Meas	0	7	30	1	0	13	16	8	4	66	99
	Chuk	1	7	115	12	3	20	16	5	5	36	151
	Chum Kiri	0	4	76	0	1	5	6	1	4	37	76
	Dang Tong	0	5	93	0	0	9	5	2	6	30	93
	Kampong Trach	1	7	20	7	5	24	10	6	3	88	55
	Kampot	0	7	30	0	5	14	7	10	9	42	115
	Kampong Bay	1	3	157	15	15	71	29	23	6	42	19
	TOTAL	**4**	**47**	**478**	**38**	**36**	**177**	**114**	**65**	**46**	**404**	**673**
Kep	Damnak Chang'aeur	1	3	20	6	3	6	15	4	2	14	15
	Kep	0	1	0	3	2	9	10	1	0	7	9
	TOTAL	1	4	20	9	5	15	25	5	2	21	24
Koh Kong	Botum Sakor	0	2	12	0	0	2	1	0	1	13	55
	Kiri Sakor	0	1	5	0	1	5	1	1	0	8	21
	Kaoh Kong	0	1	3	0	1	3	2	0	0	9	13
	Smach Mean Chey	1	2	44	13	4	17	8	8	5	8	9
	Mondol Seima	0	1	12	0	1	2	1	3	0	10	21
	Sre Ambel	1	2	37	9	16	16	15	5	9	43	104
	Thma Bang	0	1	0	0	0	2	1	0	1	5	28
	Kampong Seila	0	1	2	0	1	1	1	0	0	21	24
	TOTAL	**2**	**11**	**115**	**22**	**24**	**48**	**30**	**17**	**16**	**117**	**275**
Sihanoukville	Mittakpheap	1	2	160	70	29	95	50	72	22	0	8
	Prey Nob	0	6	0	2	1	19	23	3	11	43	110
	Stueng Hav	0	1	0	1	2	8	2	1	0	2	4
	TOTAL	1	9	160	73	32	122	75	76	33	49	129
Coastal Zone Total		**8**	**71**	**773**	**142**	**97**	**362**	**244**	**163**	**97**	**591**	**1101**

Source: MOE, 2005

3.7 Summary

This chapter has described the physical and ecological resources, and human-use and quality-of-life values as well as the public health settings for the area of influence of COPCL's Block A project. The project is located in Block A off the coast of Cambodia in the Gulf of Thailand, approximately 157km from the Cambodian mainland. Block A covers an area of 4,905 km^2. Onshore support will be provided from a shorebase located at the port in Sihanoukville. Sihanoukville is the main deep-sea port in Cambodia. Sihanoukville port has warehouses Principal imports at Sihanoukville port are container cargo, cement, oil products, steel, rice & general cargo. Principle exports are container cargo, processed wood and agricultural products.

An environmental baseline survey was conducted by IEM in Block A between October 23rd and October 29th, 2010, covering physical and chemical parameters in both seawater and sediment. In general, no unusual concentrations or values were found at any of the stations sampled in Block A. The only exception was the high barium concentration at station A. Barium was found to range from 24 to 247 mg/kg. It is possible that the elevated barium concentration is the result of previous drilling operations in the area. Barite is virtually insoluble and thus non-toxic under most environmental conditions.

Data on biological resources was gathered by primary survey (for benthos, phytoplankton, zooplankton, and fish larvae), as well as secondary research. Sensitivities relevant to the Block A project are as follows:

- Five species of marine turtles have been reportedly seen in Cambodia's waters in the past. These include the Hawksbill (*Eretmochelys imbricata*), Green (*Chelonia mydas*), Olive Ridley (*Lepodochelys olivacea*), Loggerhead (*Caretta caretta*) and Leatherback (*Dermochelys coriacia*) turtles. All of these species are considered endangered according to IUCN.
- The Irrawaddy Dolphins (*Orcaella brevirostris*), considered as endangered freshwater mammals by IUCN, have been reported in many places within the Cambodian coastal zone.
- The endangered dugong (*Dugong dugon*) has been cited in parts of the coast especially near Pre Ksach in Koh Kong District, and in Kampot Bay.
- There are at least 11 marine species in Cambodia that are considered Endangered or Critically Endangered (Humphead wrasse, Green turtle, Hawksbill turtle, Leatherback turtle, Loggerhead turtle, Hairy-nosed otter, Black-faced spoonbill, Largetooth sawfish, Narrowsnout sawfish, Great hammerhead, Spotted greenshank)
- Sensitive ecosystems, such as seagrass beds, mangroves, wetlands, and coral occur throughout the coastal zone of Cambodia. Seagrass are most extensive in Kampot province, Prek Kompong Bay Delta and Kep municipality. Mangrove are found in Koh Kong Province, around Veal Renh and Kompong Som Bays and north of Kas Kong up to the border with Thailand. However, there are no seagrass, mangroves, wetlands, or coral reefs within Block A.
- The Royal Government of Cambodia has designated national protected areas for the conservation and protection of biodiversity. Several of these are located in the coastal zone, but none are located in Block A. However, some protected areas are located near the shore base in Sihanoukville.

Secondary data was also collected on Human Use, Socio-Economic, and Quality of Life Values. The aspects relevant to the Block A project are as follows:

- Fisheries are an important sector in Cambodia, playing an important role in the daily food production and contributing to the national economy. Marine fishery and the aquaculture sector is small compared to the inland fishery. Fishing boats are not expected to be operating as far out as Block A due to the limited horsepower found for most boats in Cambodia's fishing fleets. There are some fisheries communities in Sihanoukville.
- The Gulf of Thailand is traversed by small to medium sized cargo ships but is not regarded as an international shipping lane due to its shallow depth and geographic location away from Singapore and the Malacca Straits. Only very low numbers of large vessels were observed during several offshore surveys for this and previous projects in Block A.
- Sihanoukville and surrounding provinces have a large and growing tourism-based service sector.

4. PUBLIC INVOLVEMENT

4.1 Introduction

The Cambodia legislation relating to public participation is provided in the Sub-decree on Environmental Impact Assessment Process (1999), and Prakas on General Guidelines for Preparing IEIA and EIA Report (2009)which "encourage(s) public participation in the implementation of EIA process and to take into account of their conceptual input and suggestion for re-consideration prior to the implementation of project".

IEM has developed a public participation plan for Chevron's Cambodia Block A Development Project that complies with the national legislative requirements. The plan meets the needs of the project team by assisting to identify public concerns and by formulating environmental and socialmanagement/monitoring plans.

4.2 Objective

The purpose of the public consultation process is to:

- Increasepublic understanding of the project through information distribution and exchange between the project proponent and the communities that may potentially beaffected directly or indirectly by the proposed project activities.
- Obtain information on local sensitivities, capacity, and attitudes.
- Assist in evaluating potentially significant environmental, social and public health impacts.
- Develop a comprehensive environmental and social management plan that takes into consideration all of the above.

4.3 Identification of Areas of Public ConsultationActivities

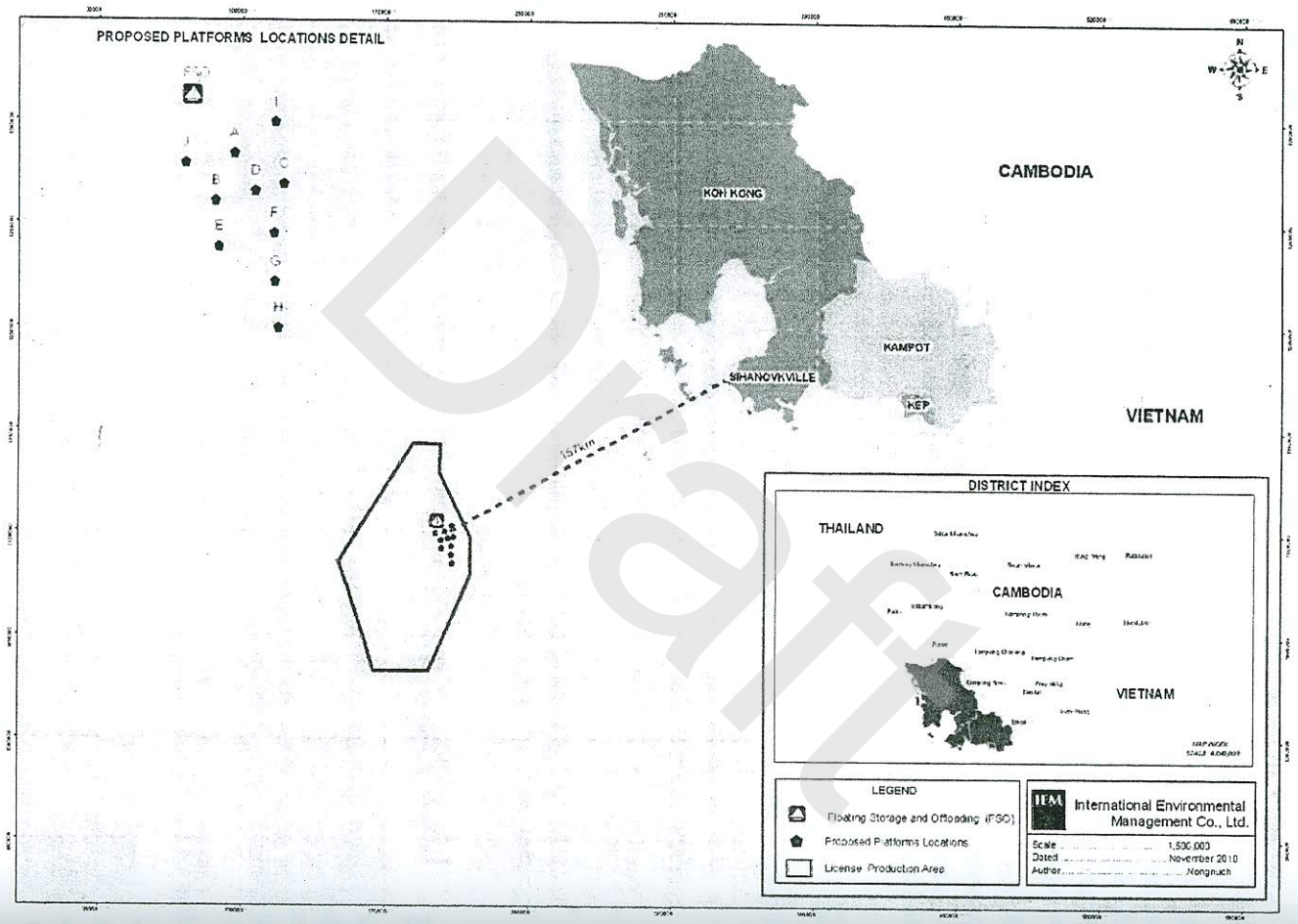
Most onshore activities will be based out of Sihanoukville. Since the Cambodia Block A project is offshore, coastal communities along the entire Cambodia coastlines.may have some concerns or interest in the project. In coordination with CNPA and MoE, it was therefore decided that the geographical scope of the public participation plan would cover all four coastal provinces (**Figure 4-1**).

The four coastal provinces are:

- Preah Sihanouk
- Kampot
- Kep
- Koh Kong

In addition to the Public Participation activities, COPCL has been meeting regularly with the Ministry of Environment and CNPA.

Figure 4-1: Study Area for Public Involvement during EIA Preparation



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4.4 Public Consultation Stakeholder Identification

The stakeholders for this project are listed in **Table 4-1**.

Table 4-1: Major Stakeholder Groups

Province	Stakeholders
Preah Sihanouk	
Local Regulators	Governor of Preah Sihanouk Province
	District Governors of StoeungHav District, Preah Sihanouk City, Prey Nob District
	Fishery Department
	Environmental Department
	Tourism Department
	Historical or Archaeological Department
	Chief Officer/Deputy Director of Sihanoukville Autonomous Port
	Water Resources &Meteorology Department
	National Committee for Maritime Security
	Police sea navigation
	Royal Cambodian Navy in Sihanoukville
	Sihanoukville Autonomous Port
Community Stakeholders	Chief of Commune Ream, Ortres, Mouy
	President of Fishery Community
	Fishermen who fish near Block A. Aquaculture farmer
	President of Tourism Association
	Business groups, i.e. tour operators, hotel owners, etc
Koh Kong	
Local Regulators	Provincial Governor of Koh Kong
	Fishery Department
	Environmental Department
	Water Resources &Meteorology Department
	National Committee for Maritime Security
Community Stakeholders	President of Fishery Community
	Chief of commune which has fishermen who fish near Block A
	Fishermen who fish near Block A or have an interest in the project. Aquaculture farmer
	President of Tourism Association
Kampot	
Local Regulators	Provincial Governor of Kampot
	Fishery Department

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Province	Stakeholders
	Environmental Department
	Water Resources &Meteorology Department
	National Committee for Maritime Security
Community Stakeholders	President of Fishery Community
	Chief of commune which has fishermen who fish near Block A
	Fishermen who fish in or near Block A or who may be impacted by potential oil spill. Aquaculture farmer
	Coastal Salt Production Operations
	President of Tourism Association
Kep	
Local Regulators	Provincial Governor of Kep
	Fishery Department
	Environmental Department
	Water Resources &Meteorology Department
	National Committee for Maritime Security
Community Stakeholders	President of Fishery Community
	Chief of commune which has fishermen who fish near Block A
	Fishermen who fish in or near Block A Aquaculture farmer
	President of Tourism Association
NGOs (various provinces)	
	WorldFish
	Save Cambodia Wildlife (SCW)
	Fisheries Action Coalition Team (FACT)
	Flora and Fauna International (FFI)
	Association Buddhist For Environment (ABE)
	PACT
	Khmer Women's Cooperation for Development (KWCD)
	Community Health & Education Target for Reforming Inter-Group (CHETRIG)

4.5 Public Participation Plan

The Public Involvement Program was developed to provide a structured management of information dissemination to parties external to the company. More specifically, the objective of COPCL's Public Involvement Program was to foster an understanding and dialogue between the company business operations and the local communities near the project location. These discussions involved a presentation of the project overview, followed by a question and answer session. Opinions on perceived environmental issues weregathered by encouraging participants to provide comments and recommendations on project activities and related public consultation efforts.

The Public Involvement Program consisted of a series of 13 Public Consultation Meetings with stakeholders (governors, local regulators, communities, and NGOs) as described in this section.

4.5.1 Dissemination of Information

Brochures were distributed to participants at each of the focus group meetings. The brochures provided information on the company's background and previous activities, project description, potential environmental impacts and mitigation, monitoring measures, potentialbenefits associated withthe project and contact information for the company.

Information in the presentation included, but was not limited to:

- Project overview/description;
- Purpose of EIA;
- Impact assessment; and
- Mitigation and monitoring measures.

A copy of the brochure used during the meeting is available in **Appendix 7.**

4.5.2 Targeted Stakeholders

The following meetings were organized to achieve the objectives of public consultation:

- One-on-one Meetings with Governors;
- Public Participation Meetings with Local Regulators;
- Public Participation Meetings with Communities;
- Public Participation Meetings with NGOs.

Table 4-2and **Table 4-3** summarize schedules and locations of the meetings.

4.5.2.1 *One-on-One Meetings with Governors*

Objectives:

The objectives of the meetings with the governors were as follows:

- Dissemination of project information to governors;
- Respond toquestions and concerns from governors;
- Obtain recommendations from governors.

Target Audience:

- Governor of Preah Sihanouk Province

- Governor of Kampot Province
- Governor of Kep Province
- Governor of Koh Kong Province

Presenters:

- IEM (Management, and Project assistant)
- COPCL(Management, Health, Environment, and Safety (HES), Policy, Government, and Public Affairs (PGPA))
- Ministry of Environment,Department of EIA
- CNPA

4.5.2.2 Public Participation Meetings with Local Regulators

Objectives:

The objectives of the meetings with the local regulators were as follows:

- Dissemination of project information to regulators;
- Respond to questions and concerns from regulators;
- Obtain information on local knowledge, perceptions and relevant capacities;
- Obtain recommendations.

Target Audience:

- Local regulators who are considered well informed members and experts in their communities

Presenters:

- IEM (Management and Project Assistant)
- COPCL (Management, Facility engineering, Drilling and Completion, PGPA, and HES)
- Ministry of Environment,Department of EIA
- CNPA

4.5.2.3 Public Participation Meetings with Community Stakeholders, Business Owners, and Commune Leaders

Objectives:

The objectives of the meetings with community stakeholders were as follows:

- To disseminate project information to community members;
- To respond to community's questions and concerns;
- To obtain the perceptions of the local community towards the project and its potential impacts;
- To better understand the local context and their sensitivities;
- To obtain valuable local knowledge that is not available from desktop research.

Target Audience:

- Specific resource users, such as fishermen, aquaculture owners, business owners (hotel owners)

Presenters:

- IEM (Management and Project Assistant)

- COPCL (Management, Facility engineering, Drilling and Completion, PGPA and HES)
- Ministry of Environment,Department of EIA
- CNPA

4.5.2.4 *Public Participation Meeting with NGO*

Objectives:

The objectives of the meeting with NGOs were as follows:

- To disseminate project information to NGOs;
- Collect feedback from NGOs;
- To obtain the perceptions of NGOs towards the project and its potential impacts;
- To obtain valuable local knowledge that is not available from desktop research.

Target Audience:

- Non Governmental Organizations whose activities are the most relevant in relation to the project

Presenters:

- IEM (Management and Project Assistant);
- COPCL (Management, Facility engineering, Drilling and Completion, Public Affairs and HES)
- Ministry of Environment,Department of EIA
- CNPA

4.5.3 Meeting Schedule

The meetings with stakeholder representatives were carried out during two different periods. The meetings with governors were held from October 3 – October 5, 2011 (**Table 4-2**). The meetings with regulators and communities were held from October 10 – October 14, 2011 (**Table 4-3**).

Table 4-2: Schedule of Governor Meetings

Date	Time	Activity	Location	Meeting Duration	Number of Participants (including IEM, CNPA, MoE, Chevron)
Mon. Oct 03	AM	Meeting with the Governor of Kep Province	Governor Hall	2 hours	13
Mon. Oct 03	PM	Meeting with the Governor of Kampot Province	Governor Hall	2 hours	12
Tue. Oct 04	AM	Meeting with the Governor of Preah Sihanouk Province	Governor Hall	3 hours	16
Wed. Oct 05	AM	Meeting with the Governor of Koh Kong Province	Governor Hall	2 hours	12

Table 4-3: Schedule of Regulators and Community Meetings

Date	Time	Activities	Location	Organizations that Attended	Meeting Duration	Number of Participants (including IEM, CNPA, MoE, Chevron)
Mon. Oct 10	AM	Meeting with Koh Kong governmental officers	Koh Kong City Hotel	1. Fishery Department 2. Environmental Department 3. Water Resources & Meteorology Department 4. National Committee for Maritime Security	2.5 hours	15
Mon. Oct 10	PM	Meetings with Koh Kong communities	SraeAmbel District Office	1. ChrouySvay commune 2. Chi KhaKraom commune	2 hours	37
Tue. Oct 11	AM	Meeting with Preah Sihanouk governmental officers	New Beach Hotel	1. District Governor of StoeungHav District 2. District Governor of Preah Sihanouk City 3. District Governor of Prey Nob District 4. Fishery Department 5. Tourism Department 6. Environment Department 7. History and Archaeological Department 8. Police sea navigation 9. Royal Cambodian	3 hours	24

Date	Time	Activities	Location	Organizations that Attended	Meeting Duration	Number of Participants (including IEM, CNPA, MoE, Chevron)
				Navy in Sihanoukville 10. Sihanoukville Autonomous Port 11. Water Resources & Meteorology Department 12. National Committee for Maritime Security		
Tue. Oct 11	PM	Meeting with NGOs	New Beach Hotel	1. KWCD 2. CHETRIG 3. PACT	2 hours	18
Wed. Oct 12	AM	Meetings with Preah Sihanouk communities	New Beach Hotel	1. StuengHav district a. OuTreh commune b. Kam Penh commune c. TomnopRolok commune 2. Preah Sihanouk Town a. SangkatMouy b. TomnupRolork commune 3. Prey Nup district a. Ream commune	3 hours	35
Thu. Oct 13	AM	Meeting with Kampotcommunities	PreaekThnot Commune Office	1. TeukChhou district a. PreaekTnot commune	2 hours	38
Thu. Oct 13	PM	Meeting with Kampot governmental officers	Kampot Diamond Hotel	1. Fishery Department 2. Environmental Department 3. Water Resources & Meteorology Department 4. National Committee for Maritime Security	2.5 hours	24
Fri. Oct 14	AM	Meeting with Kep governmental officers	N4 Hotel	1. Fishery Department 2. Environmental Department 3. Water Resources & Meteorology Department 4. National Committee for Maritime Security	3 hours	16
Fri Oct 14	PM	Meetings with Kep communities	N4 Hotel	1. Damnak Chang Aeur district a. Pong Tuek commune	2.5 hours	38

4.6 Outcomes of the Public Participation Meetings

Public involvement at the four coastal provinces (Preah Sihanouk, Kampot, Kep and Koh Kong) indicated that:

- The public has general concerns about potential impacts on fishing, transportation activities, subsurface geology, risk of earthquakes and accidental releases.
- The public showed interest in:
  - General mitigation plans;
  - Specific management measures for risks of accidental oil releases and typhoons;
  - Management of gas, cuttings and waste;
  - Benefits for local communities i.e. job opportunities, revenue.
- Regulators and participating communities fully supported the project.

More details on the outcomes of the discussions from all 13 meetings are shown in **Table 4-4.** Photographs of the meetings are shown in **Figure 4-2** to **Figure 4-11**.

Table 4-4: Main Concerns and Clarifications from Public Involvement Meetings

Table 4-4: Main Concerns and Clarifications from Public Involvement Meetings

Topics	Concerns	Clarification (*unless otherwise indicated, Clarification was provided by COPCL*)
General Project Information		
Refinery Location and Destination of Refined Crude	Why will oil from Block A be sent to a refinery in a different country instead of Cambodia?	There are no existing facilities in Cambodia to transform the crude into a refined product. Oil needs to be processed (in a refinery) before it can be used. Therefore it must be sent to countries where refineries exist. Crude will be sold and refined in a different location in Southeast Asia. In the future, if Cambodia develops a refinery, it may be possible to refine there without having to export. However, from Chevron's experience in the Gulf of Thailand, crude produced in this location will require complex and expensivefacilities due to high heavy metal content in the oil. From exploration projects, COPCL has found that Block A oil is very waxy oil. It is very difficult to refine and requires special equipment.
	Will oil be sold here or exported?	Hydrocarbons will be sold to open market because currently there is no facility to refine crude in Cambodia.
	After oil is produced, sold, and refined - will that refined product come back to Cambodia?	COPCL sells the oil to the open market, and cannot control what happens to the refined product. Although it is possible that the refined oil will come back to Cambodia, it is determined by the markets, and is not possible to confirm.
Water Re-injection	Please explain more about the drilling process and water reinjection. Will water re-injection impact soil or rock layers (i.e. cause earthquake)?	Well fluids contain gas, water and oil. The reservoir has pressure; when we drill, that pressure helps lift the oil to our system. We use a powerful pump to re-inject water into the reservoir. Water reinjection is an environmental protection measure, by which all produced water is re-injected back into the reservoir, rather than discharging it to the sea. By injecting water to take the place of the produced hydrocarbons, we maintain the reservoir pressure which prevents subsidence. Earthquakes are caused by large tectonic plate movements, not small localized wells. Waterflood uses one well to inject water that push the reservoirs' hydrocarbons toward another well that transports the hydrocarbons to the surface. Both wellbores are drilled the same way, but one is used to produce hydrocarbons from while the other is used to inject water into the reservoir.
	What is the purpose and benefit of water injection?	Water injection benefits are to help disposal of produced water and also increase production. Water reinjection is a key environmental protection measure as it means that it is not discharged to the sea. Re-injecting water helps maintain pressure which prevents changes to the geology. In

Topics	Concerns	Clarification (*unless otherwise indicated, Clarification was provided by COPCL*)
		addition it can help push hydrocarbons from the injection well to the production well.
	Are the 2-4 wells used for water injection new or old wells?	They are new wells. They are dedicated water injection wells.
	Will oil be separated at FSO, platform, or refinery?	Oil+water+gas from the ground flow into a vessel on the platform (separator), gas moves to the top of the production separator, while water and oil come out at the bottom. Oil is sent to the FSO, water will be treated and reinjected to the ground. Oil sent to FSO contains some water. Over time, water will settle out on the FSO. COPCL will send water back to the platform to reinject in the reservoir.
Pipeline	Will the pipeline transport oil to a refinery onshore?	There will be a 3.5 km pipeline between the platform and FSO, but the pipeline will not transport crude to a refinery. To transport the crude, another vessel will offload it from the FSO and transport it to a refinery in a different location.
	Is there any methodology to check for pipeline leaks?	COPCL continuously monitors the pressure of the pipeline.If there is a leak, the pressure in the pipeline will drop substantially, and COPCL will be able to take action accordingly.
Crude Oil Properties	How are crude properties of oil in Cambodia different from other locations where Chevron operates?	Crude properties for the oil in Block A may potentially have high heavy metal content when compared to other locations where Chevron operates. This type of crude requires special treatment and refinery facilities.
Support from Thailand	Can you explain further about the support that will come from Thailand?	There are two Chevron entities; CTEP and COPCL. To begin the oil and gas operation in Cambodia, COPCL needs initial support from Thailand since there are no existing services in Cambodia. For phase 1A, rig and equipment will be mobilized from Thailand. Installation phase will also get support from the Thailand side. As COPCL begins to develop 1A, 1B, and 1C, industry in Cambodia is likely togrow and more services will be available from Cambodia to support theBlock A operations. While there are two companies, they can request support from one another. For example, if an accidental releaseoccurs, Chevronin Cambodia can request support from Chevron Thailand. Support from the Thailand side will be temporary, for the initial phases only.
Schedule	Is the schedule/plan still in line to begin production December 12, 2012?	COPCL will need 2.5 years after the PPA is approved, and PPA approval is still pending. Therefore the date of Decemberr 12, 2012 is no longer attainable for this project.
	How long will production last?	Phase 1A will last for 5-6 years. If good results are obtained, more platforms will be installed and wells will be drilled to increase/maintain production. Apsara is just one of the six fields in Block A, so there is potential to continue developing other fields as well. Phase 1 development is about 18-19 years. It's difficult to predict how long one well will

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produce. For comparison, in Thai

		COPCL will need 2.5 years after the PPA is approved, Therefore the date of Decemberr 12, 2012 is no longer attainable for this project.
Schedule	Is the schedule/plan still in line to begin production December 12, 2012?	
	How long will production last?	Phase 1A will last for 5-6 years. If good results are obtained, more platforms will be installed and wells will be drilled to increase/maintain production. Apsara is just one of the six fields in Block A, so there is potential to continue developing other fields as well. Phase 1 development is about 18-19 years. It's difficult to predict how long one well will

Topics	Concerns	Clarification (*unless otherwise indicated, Clarification was provided by COPCL*)
		produce. For comparison, in Thailand one well lasts 3-5 years in average. Assuming Phase 1A successful, then COPCL will move on to 1B and 1C. After production phase, COPCL will decommission platforms and pipeline, in an environmentally friendly and safe manner. Apsara is one of six fields in Block A. COPCL will continue explore and develop other areas if Phase 1 is successful. Drilling period will take 10 years. After drilling and decommissioning, COPCL will perform monitoring to see if anything has changed.
	Will the fields be developed one at a time?	The fields may be developed simultaneously. If COPCL observes favourable trends in the oil content and production, it will begin to develop other fields. It will be simultaneous development so as to keep the production rate stable.
Personnel	Can you explain about the offshore personnel plan?	Once the platform is installed, there will be about 60 persons working offshore. Offshore personnel will work 28 days and then have 28 days off. This is international practice. Each person's shift is 12 hours long. Out of 60 people, 30 will work during day time, and 30 will work during night time because it is 24 hour operation.
Waste Generation	What kind of waste will be generated? What kind of waste will be stored and sent to KCC?	There will be two main categories of waste; waste from office and living quarter and waste from processing. Examples of waste are: combustible waste (paper, chemical sack, and packaging), used oil, oily rag, and sludge from tank cleaning. Most combustible waste can be sent to KCC. Sludge from tank cleaning will be analysed before determining treatment or final disposal method. Final details and arrangements are still being discussed at this time with KCC.
	During past drilling campaigns, did Chevron export any hazardous waste?	For operations in the Gulf of Thailand, Chevron exports hazardous waste to Netherlands. The reason is that there are no suitable facilities in South East Asia that can handle this type of waste. For the 18 exploration wells drilled in Cambodia, COPCL did not export any hazardous waste.
Decommissioning	After finishing production, will the project be decommissioned?	COPCL will cement and plug the wells to make sure that they do not leak. As far as platforms are concerned, they will be decommissioned and the steel structures will be removed.
	Is all casing still present in wells after Chevron has finished drilling?	For exploration drilling, COPCL didnot run tubing for the production section. Casing for other sections is cemented, and cannot be removed. When COPCL has finished drilling, COPCL cements the well, and cuts and plugs the well below themudline.
Shorebase	What is the function of the shorebase?	COPCL plans to have a shorebase in PAS, Preah Sihanouk province. Examples of Shorebase activities are pipe yard, crew change, logistics support, etc..
	Is PouloWai island an option for crew change location?	Crew changes should ideally occur near COPCL'sshorebase.

Topics	Concerns	Clarification (*unless otherwise indicated, Clarification was provided by COPCL*)
Other	How big is the reservoir and what is the expected quantity of production?	Maximum capacity is 26,000 bbl per day (4 MM liter per day).
	Why are there 3 different sections of casing in the wells?	The main reason is that the hole may lose stability when drilled deeper, so progressively smaller casing must be run to prevent large open hole sections from collapsing.
	Will there be a medical officer offshore or will someone be brought in?	On theFSO,COPCL will haveHES officers or personnel to look after crews health and safety. This position will be for a medic. Sometimesthere maybe a nurse or medical doctor present.
	Will the18 exploration wells be used for production? How far apart are the exploration wells?	COPCL will not produce crude from those wells. Those wells were used to understand if there are any oil and gas reservoirs. Block A covers more than 2000 sq km (4,905). The 18 wells are scattered throughout this area.
Impacts		
Impact to Fisheries and Transportation	How large is the exclusion zone?	The exclusion zone is 500 m. It is there to restrict fishing operations to prevent any safety incidents with COPCL's marine vessels that operate within the area.
	Fishing boats sometime have no lights. If they accidentally float to the platform, will there be any penalty?	There will not be any penalty or legal action.
	Will there be any potential impacts to fisheries and transportation?	The potential impact to fishermen in Block A is not significant as Cambodian fishermen use low horsepower vessels which are unlikely to fish far offshore near Block A. In Cambodia,COPCL has drilled 18 wells already, with no incident or impacts to fishermen. If an accidental releaseoccurs, it will be difficult to say how bad the impact may be. It would depend on volume released at that time, type of oil, current and winds. With a distance 157 km offshore, if there is any accidental release, COPCL will have enough time to initiate the response aiming at reduding the potential impact to fishermen. There will be an exclusion zone of 500 m around the platform to protect vessels from coming into contact with the platform. For marine transportation, a potential impact will be the 500 meter exclusion zone. Once COPCL has installed their facility and started production, the exclusion zone will be set to prevent any incidents that may occur to fishing boats and the facility.

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Topics | Concerns | Clarification

Topics	Concerns	Clarification (*unless otherwise indicated, Clarification was provided by COPCL*)
	In case of an oil spill, will there be any impact to fish?	The effect on fish depends on the amount of oil released. In the case of a large release, there is likely to be an impact to fish in the area. However, Chevron has experience drilling many wells in GoT, and Chevron has never had a majoraccidental release of oil in the Gulf of Thailand. With a distance of 157 km offshore, COPCL will have time to initiate the response if there is a spill.
	Is there any potential impact to the fishing or fishermen living near by the port? What about ecological resources?	Short term effects from drilling including cutting discharges, could have potential impact to fish from increased turbidity. Fish will likely migrate away from that area. The sea bed is very dynamic, and cuttings dispersion will be very thin over the seabed within 100 meters of the wells. The safety zone is 500 m. Block A is far from shore, and only large vessels will normally frequent that area, so there will be only a minimal impact to fisheries. The 500 m zone is very insignificant compared to the surrounding area. Over the longer term, the platform can create a habitat for fishes. Many fish can be found around platforms in the Gulf of Thailand.
Impact to Sub-Surface Geology	Will the underground geology be altered when you re-inject water?	There will be no impact to the ground structure. In Thailand,Chevron drilled more than 4,000 wells and there have beenno reported effects. The amount of fluid Chevron takes out from the ground is very small compared to ground area. For this project, COPCL plans on injecting water back to the formation, so this will help keep the same structure for the formation. Cuttings will be returned, treated, and discharged overboard.
Impact to Likelihood of Earthquakes	Will there be any effect from drilling, i.e. to geology, tsunami, earth quake?	There is no evidence that drilling creates earthquakes. For some drilling operations, there may be a case where land subsidence occurs, but COPCL will re-inject water to the formation, which is likely toprevent this event from taking place.
Previous Chevron Incidents	Have there ever been anyincidents with Chevron that led to potential impacts to the environment?	In the past, there have been some releases and impacts from Chevron's global operations. However, no major accidental releases have been experienced in the Gulf of Thailand during Chevron's 30 years operating there.
	Has Chevron ever had a spill?	Chevron has experienced spills in its global operations. However, Chevron has never had any major incidents in the Gulf of Thailand. Chevron drilled more than 4,000 wells, and installed more than 200 platforms without any major incidents. In Cambodia. COPCL also drilled 18 exploration wells in Block A without any incidents.
Mitigation		
General Mitigation Plans	Can Chevron elaborate about the execution of their plans to mitigate any risks or impacts	Mitigation plans have been developed by IEM and COPCL, and it is COPCL's responsibility to execute the plans. Chevron will work together with CNPA to executethe plans. Monitoring

Topics	Concerns	Clarification (*unless otherwise indicated, Clarification was provided by COPCL*)
	associated with the project? Is Chevron committed to complying with these plans?	measures are implemented to measure success of mitigation of potential impacts. COPCL also has in place an oil spill response drill, exercise and training program.
Oil Spill Response	Is there any plan in place to protect or respond to oil spills?	COPCL has an Oil Spill Response Plan in place, and exercises and training are periodically conducted. Oil Spill equipment will be stored both offshore and at the shorebase. Additional equipment and response personnel can be brought from Singapore if needed. Training and exercise plans are in place. Staff will be trained in equipment deployment and response activities. Tankers and port destinations also have their own response plan and equipment.
	How do you actually protect the spill and eliminate it?	There are several response techniques which can be used depending on oil type, weather conditions, locations of the spill. For instance, booms can be used when there is oil on the water surface, and if the conditions allow. A boom limits the area where oil drifts. A skimmer can be installed to collect the oil (sweep the oil up).
	How can you eliminate the risk of spill?	Secondary containment is installed under most equipment offshore. Secondary containment captures spilled oil and prevents the oil being discharged to sea COPCL has many safety and standard operating procedures in place to prevent a spill.
Typhoon Evacuation	Regarding the Typhoon Evacuation Plan, how will Chevron be able to tell if a storm or tsunami is approaching?	COPCL has a weather monitoring system. The weather will be monitored daily. COPCL can prepare to respond to the situation ahead of time.
Gas Management	What is the plan to manage gas?	COPCL will use gas as much as possible for fuel gas for engines, compressors, etc. There will be some gas left over, which will be flared. COPCL has designed their platform to accommodate scenarios of large or small quantities of gas. In case there is too much gas in future phase, COPCL willreinject to the reservoir. Gas reinjection is an environmentally friendly option. The amount of gas produced is very small and cannot be sent to shore to be used for commercial purposes.
Cuttings Management	What is Chevron's cuttings management plan?	For the first section, there will be no casing. COPCL will pump the fluid into the well to lift the cuttings out, and small pieces of cuttingswill come up to the sea floor. For section 2 and 3, cuttings will be returnedto the rig, treated (i.e drilling fluids will be removed), and then discharged overboard.
Waste Management	What is the waste management process, and who is responsible?	COPCL, as waste generator, is responsible for managing the waste. COPCL will follow solid waste regulations according to Cambodian law. COPCL is preparing a waste management plan. Once solid waste is generated COPCL will send it to shore. Most waste will be sent to a cement plant. Cambodia law says any facility must have permit to manage the waste. The

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Topics	Concerns	Clarification (*unless otherwise indicated, Clarification was provided by COPCL*)

		For section 2 and 3, cuttings will be returnedto the rig, treated (i.e drilling fluids removed), and then discharged overboard.
Waste Management	What is the waste management process, and who is responsible?	COPCL, as waste generator, is responsible for managing the waste. COPCL will follow solid waste regulations according to Cambodian law. COPCL is preparing a waste management plan. Once solid waste is generated COPCL will send it to shore. Most waste will be sent to a cement plant. Cambodia law says any facility must have permit to manage the waste. The

Topics	Concerns	Clarification (*unless otherwise indicated, Clarification was provided by COPCL*)
		cement plant is responsible to obtain a permit – once the permit is in place, COPCL can use the facility for disposal of waste. COPCL visited landfills in Cambodia, and it is unlikely that these facilities will meet Chevron requirements, so COPCLdoes not plan to send any waste to these facilities. The final waste management plan is still a work in progress.
Social Benefits	Will there be any social engagement projects in this area?	Chevron commits to develop communities where it operates. With project growth, Chevronwill try to help communities to develop their capability.
	Will Chevron wait until oil is produced before contributing to community?	No, COPCL will not wait.COPCL has already started our community engagement - COPCL has been helping communities since 2002 after the license to explore Block A was granted.
	When oil is exported to refine outside the country, what benefit will Cambodia get?	CNPA Response: COPCL has an agreement with the Government to produce oil only, and send somewhere else to refine it. The revenue from the sale will be divided according to the petroleum agreement. The portion that the government receives will be used for the benefit of the country, i.e. to build infrastructure such as roads, bridges, schools, hospitals, etc
	What is the plan to manage revenue from oil production? Is there any mechanism to ensure that revenue will be spent properly?	CNPA Response: In regards to spending oil revenue, CNPA actually has no authority to manage revenue from Block A oil production. CNPA is a regulator for oil and gas development. Revenue will be shared according to PA between government and operators and partner. Revenue from oil will go to the state. CNPA would like to pass the message to the communities, and the community can contact CNPA directly for further information.
	What percentage of profit from Block-A will be earmarked for social investment in the country?	The social investment that COPCL makes is not calculated as a percentage of profit derived from any of its projects. The level of social investment is fit-for-purpose, need-based and tailored to meet specific social and business objectives. Chevron operates in areas of the country where they have not profited, but Chevron still invested in community development initiatives.
	Does Chevron plan to recruit local people?	Offshore, COPCL will initially need cooks, janitors and general hands. Onshore, COPCL will initially need truck drivers, forklift drivers and computer operators etc. Over time COPCL will train local people to do more of the jobs. In addition, sub contractors will be hired from local people for supporting functions. If COPCL is successful with the first platform, they will likely develop the industry wider.
	What are the requirements for those that want to work for Chevron?	The age range must be between 18 and 65, and the skills must meet the project's requirements.
	Is there any way to develop skills that will be appropriate for the project?	People's skill will be developed over time, and COPCL will help develop community skills. The initial operation is small, but may grow over time. As production increases, COPCL is likely to need more people. Over 30 years of operation in Gulf of Thailand, now more than 90 percent

Topics	Concerns	Clarification (*unless otherwise indicated, Clarification was provided by COPCL*)
		of employees are Thai. COPCL will likely be able to hire more personnel in Cambodia as COPCL move forward with development.
Miscellaneous		
Oil Price	After the oil production refining, what will happen to oil price - will there be any difference?	CNPA Response: Oil price is dependent on the world market. So ifoil was refined in Cambodia, the price wouldn't be lower. If Cambodia produces a lot of crude oil and gets more revenue in the future, the government may consider subsidizing the oil price using the revenue, although this is up to the government.
	Thailand and Vietnam produce oil, and their oil price is lower than Cambodia. Why will the oil price in Cambodia still be high?	CNPA Response: Thailand and Vietnam governments may subsidize the import tax. This may be an option for Cambodia in the future, but it is dependent on the government.
	If Chevron was able to refine the oil in Cambodia, would the price of fuel be lower?	CNPA Response: Oil price is dependent on the world market. So ifoil was refined in Cambodia, the price wouldn't be lower.
Terrorism	How will Chevron protect the Block A operation from terrorist attacks?	Border issues between Cambodia and Thailandare beyond Chevron responsibility. However, for platform security, Chevron has security mitigation and monitoring measures to protect their platform and facility, and Chevron has a process in place to contact appropriate authorities in case of a threat or danger.
Other	Does Chevron always experience economic success in their production operations?	In some countries, after exploration, Chevron does not find economically viable reserves. However, in the case of Block A in Cambodia, after several years of exploration, COPCL has found reserves that are appropriateto start the production phase.
	Are there any expectations from Chevron for governors of Kep, Koh Kong, Sihanoukville, or Kampot provinces?	In the future when COPCL startsoperating, there will be an exclusion zone . COPCL requires fishermen and vessels not to enter that zone for safety reasons. COPCL may need governor support to communicate this requirement.
	Is there a risk of blowout like in the Gulf of Mexico BP incident?	Gulf of Mexico is deep water, and the well is a subsea well, which is very different from Gulf of Thailand operations. Gulf Of Thailand water depth is much shallower, only 70m depth. The risk of a blowout for this operation is considered small.
	What is the linkage between the project and EIA work?	IEM has been commissioned by COPCL to conduct the EIA study. IEM is a licensed consultant in Cambodia and an independent organization. After EIA is submitted and approved, COPCL is responsible to implement mitigation measure and monitoring program. It is Cambodian regulation that a third party (licensed independent consultant) will conduct EIA for project owner. This is to provide transparency of results. COPCL has worked closely with IEM to provide project description, and plan for

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Clarification (unless otherwise indicated,

	What is the linkage between the project and EIA work?	IEM has been commissioned by COPCL to conduct the EIA study. IEM is a licensed consultant in Cambodia and an independent organization. After EIA is submitted and approved, COPCL is responsible to implement mitigation measure and monitoring program. It is Cambodian regulation that a third party (licensed independent consultant) will conduct EIA for project owner. This is to provide transparency of results. COPCL has worked closely with IEM to provide project description, and plan for

Topics	Concerns	Clarification (unless otherwise indicated, Clarification was provided by COPCL)
		environmental baseline survey.
	Other oil companies have green energy projects - what about Chevron?	Chevronconducts research on renewable energy. Chevron is producing energy from sources such as biofuel, solar energy, wind farms, and geothermal. Chevron also has a department focused on alternative energy technology.
	If Chevron produces all oil from one reservoir, will Chevron get more oil from the same reservoir in the future?	No, it takes millions years for plants and animal remains to become crude.
	Can Chevron find oil and gas onshore?	Oil and gas is developed from plants and animal remains over millions of years. Anywhere that acts as a trap for plants and animal remains, either onshore or offshore, can become an oil and gas reservoir.
	Will waste landfills become oil reservoirs?	It takes millions of years to generate oil reservoirs. However, landfills generate methane from the decomposing process. There are many places where methaneis collected from landfills and used as an energy source.

Figure 4-2: Meeting with Governors (Kep, Kampot, Preah Sihanouk, Koh Kong during October 3-5, 2011)

October 3-5, 2011)

Figure 4-3: Koh Kong Province Regulator Meeting on October 10, 2011

Figure 4-4: Community Meeting in SraeAmbel district, Koh Kong province, on October 10, 2011

Figure 4-5: Preah SihanoukProvince Regulator Meeting on October 11, 2011

Figure 4-6: NGO Meeting on October 11, 2011

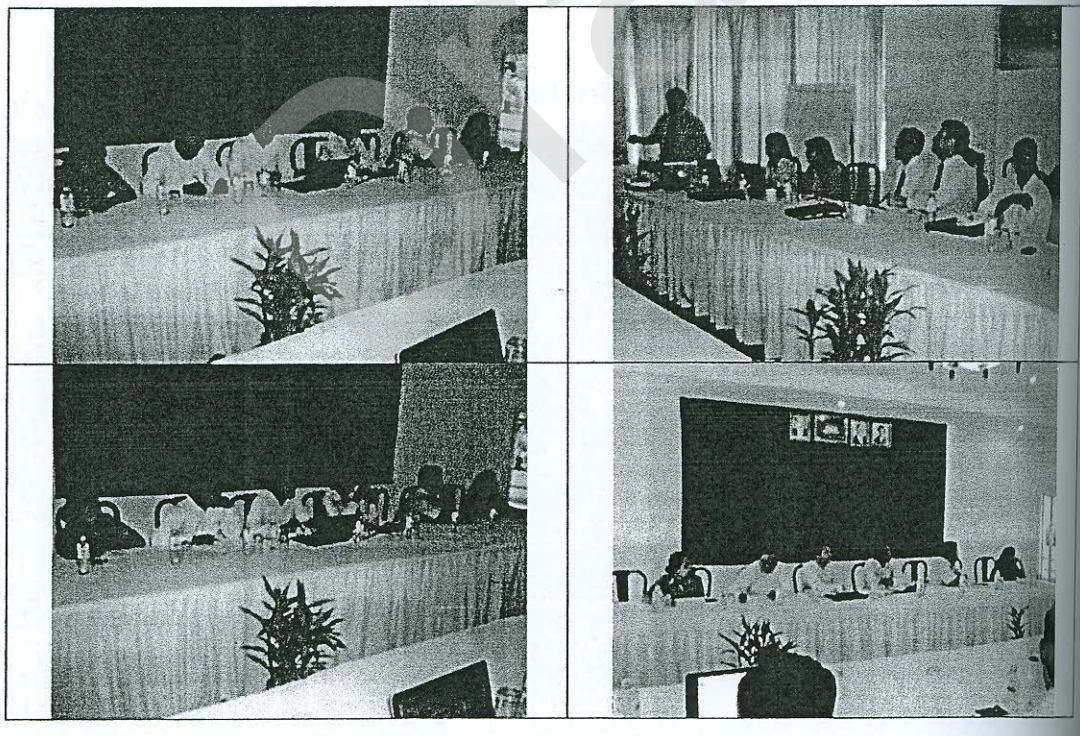


Figure 4-7: Community Meeting in Preah Sihanouk Province, on October 12, 2011

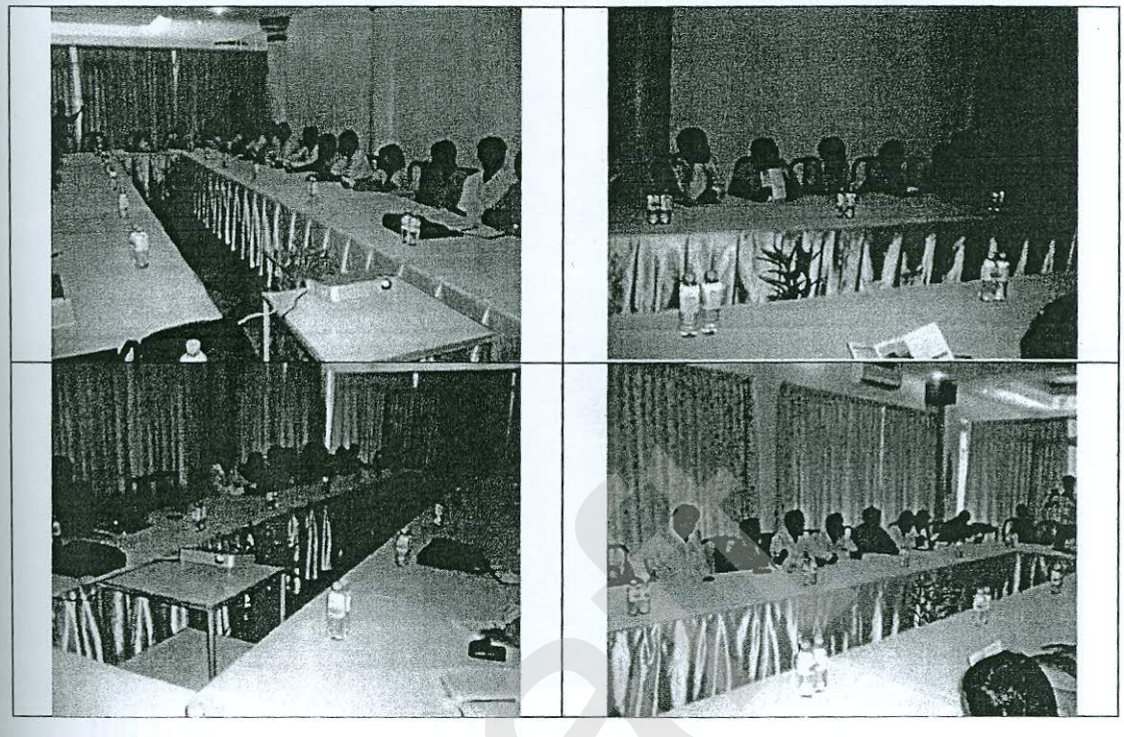


Figure 4-8: Community Meeting in Kampot Province, on October 13, 2011

Figure 4-9: Regulator Meeting in Kampot Province, on October 13, 2011

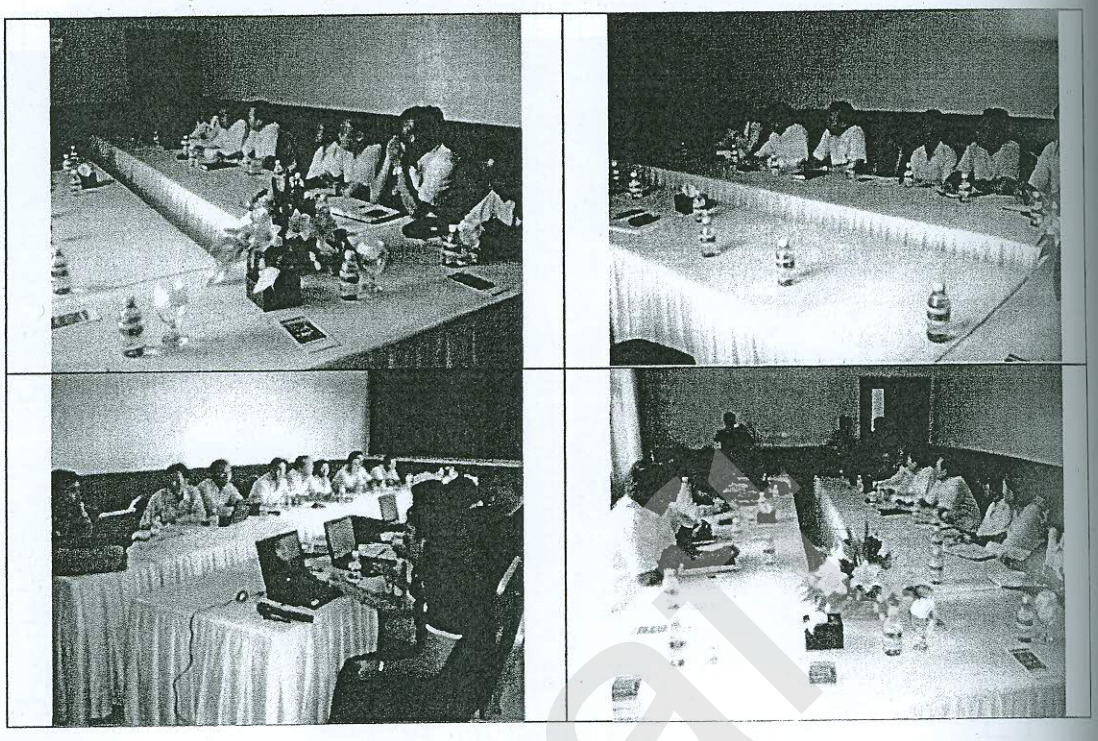


Figure 4-10: Regulator Meeting in Kep Province, on October 14, 2011

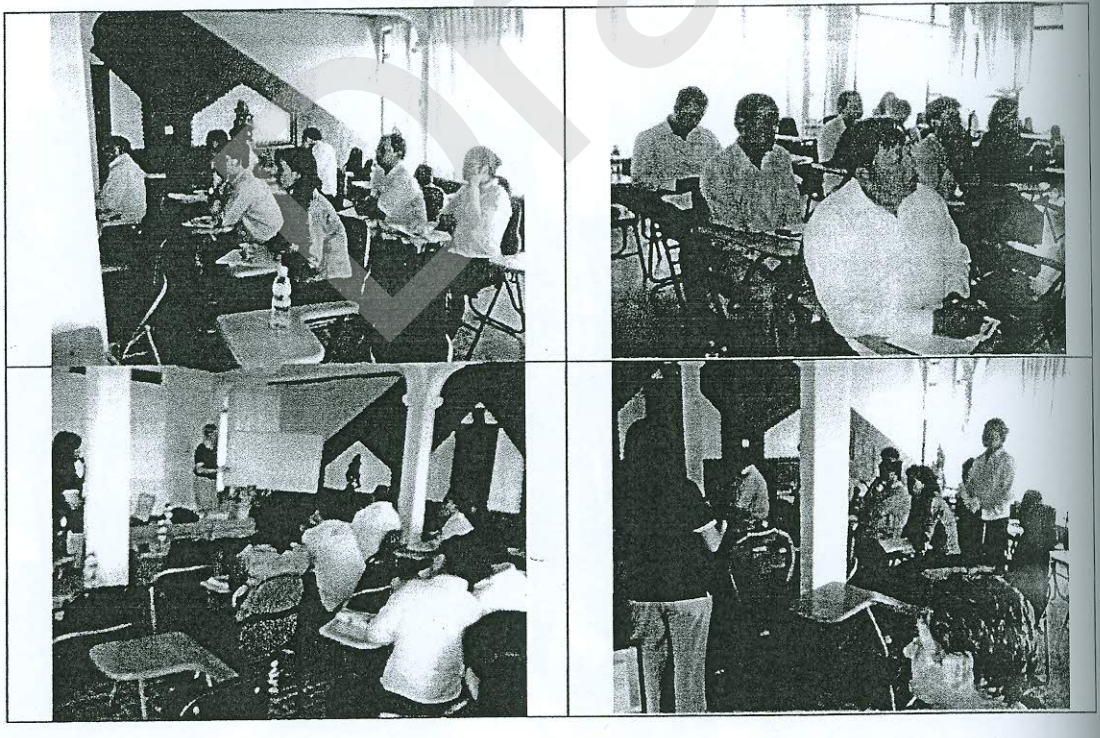
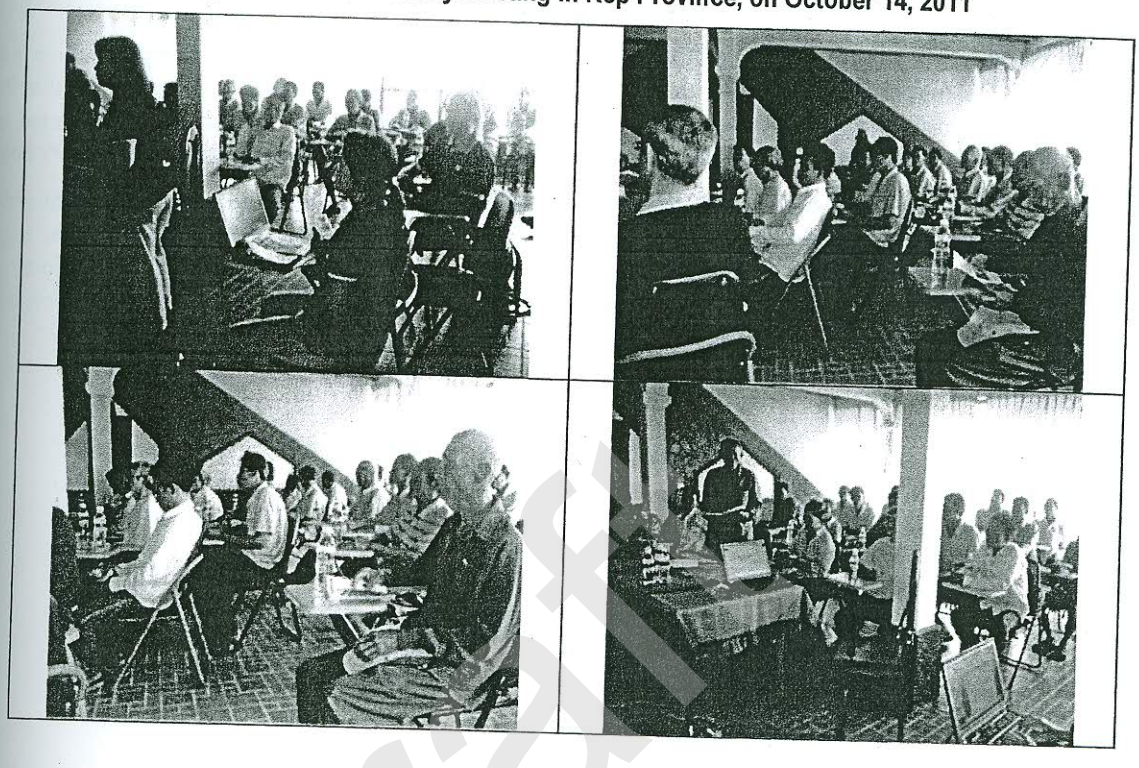


Figure 4-11: Community Meeting in Kep Province, on October 14, 2011



4.7 COPCL's Public Relations Program

Public involvement is an important component of the EIA process. Its primary objective is to increase public understanding of the projects.This is accomplished through information distribution and exchange between the project proponent and the communities that might be affected directly or indirectly by the proposed project activities.This process helps identify the community's concerns.

COPCL has developed a Community Awareness Plan to initiate public involvement activities and maintain open communication of relevant information. This will allow COPCL to be responsive to public concerns and questions during the development and operations of projects within its concession. The goal is to develop and maintain an ongoing process to gather, assess and address community questions and concerns, if appropriate.

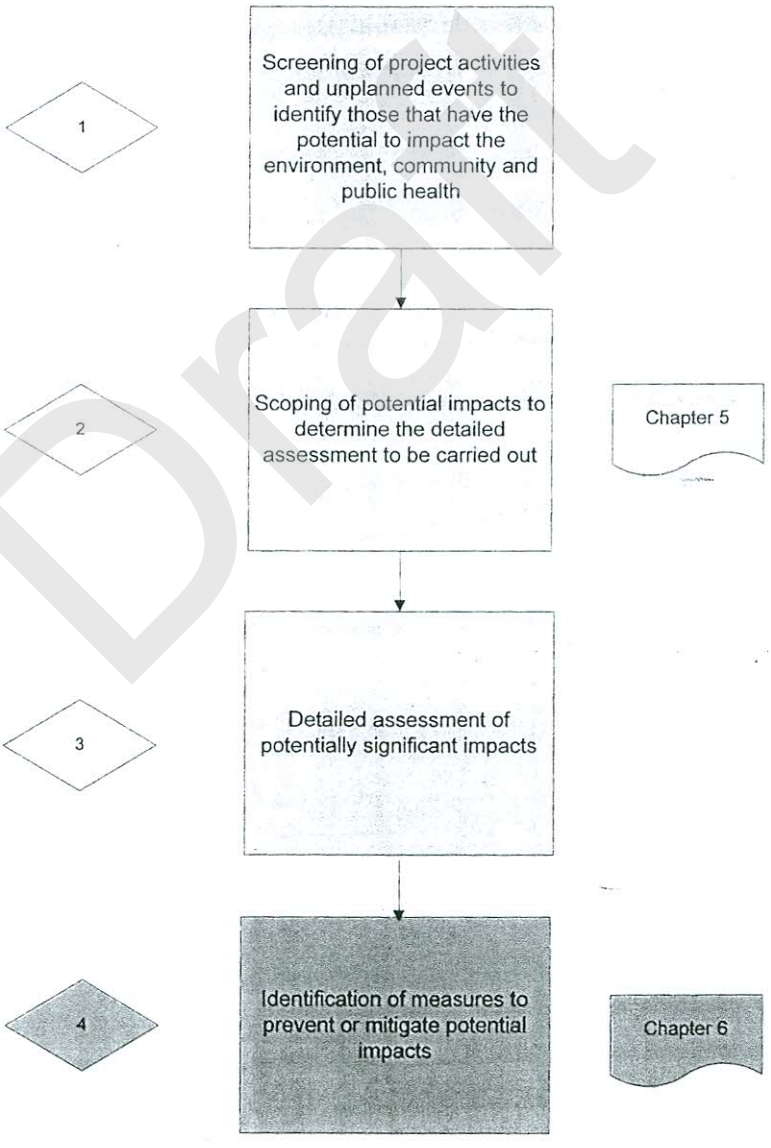
5. ENVIRONMENTAL IMPACT ASSESSMENT

5.1 Assessment Methodology

5.1.1 Introduction

An Environmental Impact Assessment (EIA) seeks to identify and, to the extent possible, quantify the potential impacts of a proposed project (negative impacts and positive benefits) with respect to the environment (physical resources, ecological or biological resources, human use of resources, quality of life values and public health). This EIA follows a logical process summarized in **Figure 5-1**.

Figure 5-1: Four-Step Process for Conducting the EIA



5.1.2 Screening

Screening is a process used to systematically review all project activities and potential unplanned events in order to identify those that may have the potential to impact the environment. Screening enables the impact assessment (IA) to focus on those project activities and potential unplanned events most likely to have a potentially significant impact. One way to link project activities with the environmental components and elements that project activities may impact is by use of a matrix.

The list of project activities, potential unplanned events and environmental elements was obtained through:

- Consultations with Chevron;
- Applying IEM experience with similar projects.

The interactions between activities and environmental components and elements are determined qualitatively based on the above guidelines and experience.

The screening matrix has the following structure:

Columns represent **environmental elements**, categorized as:

- Physical Resources
- Ecological Resources
- Human-Use Values
- Quality-of-Life Values
- Public Health

Rows show **project activities/events**, grouped into:

- General project activities
- Drilling
- Installation
- Production
- Abandonment
- Unplanned Events

The completed screening matrix for this project is presented in **Table 5-11**.

5.1.3 Scoping

Scoping includes identification of the studies and data required to conduct the assessment and conclude on the significance of the potentially significant impacts identified during screening.

The assessment area for the proposed COPCL Block A EIA includes the Gulf of Thailand and coastal areas surrounding it, particularly the project area around project facilities (platforms, pipelines, floating storage and offloading tanker) and the coastal areas and communities that could potentially be impacted by project activities.

The nature of potential impacts from project activities and unplanned events on environmental elements for this project are scoped in **Table 5-12**.

5.1.4 Detailed Impact Assessment

The potentially significant impacts identified during Screening are thoroughly assessed for each phase of the project:

- Installation
- Drilling
- Production
- Abandonment

5.1.4.1 *Assessment of Potential Environmental Impacts*

The assessment of potential environmental impacts is based on quantitative and qualitative data and professional judgment. Factors used to analyze potential environmental impacts include comparison with standard values, nature of environmental change, duration, reversibility, magnitude and importance (linked to the sensitivity of the receptor) of the potential impact as outlined in **Table 5-1**.

The significance of potential environmental impacts is ranked as insignificant, positive, low negative, medium negative or high negative using the criteria outlined in **Table 5-1**.

Table 5-1: Factors Considered in Environmental Impact Assessment

Factor	Detail
Standard Values	• Potential impact meets standard values/guidelines • Potential impact does not meet standard values/guidelines
Environmental Change	• Changes the original structure of environmental system or ecosystem • Changes some factors in environmental system or ecosystem but does not change the structure • Minor changes in some factors of the environmental system or ecosystem but does not change the structure or functioning of the ecosystem • Change of the environmental system or ecosystem from project activity is within naturally occurring variability
Magnitude	• Global -area of potential impact is beyond the concession boundary • Regional - area of potential impact is within the Gulf of Thailand • Local - area of potential impact is beyond a radius of 500 m from structures but within the concession block • Localised - area of potential impact is in the project area within a radius of 500 m from drilling rig, pipeline or FSO
Duration	• Potential impact occurs over long-term duration (>15 years) • Potential impact occurs over medium-term duration (5-15 years) • Potential impact occurs only during part of project operations
Reversibility	• Potential permanent impact • Potential impact can be reversible over time • Potential impact is reversible quickly
Importance	• Potential impact disturbs pristine area that has a value for conservation • Potential impact damages rare/endangered species

Factor	Detail
	• Potential impact disturbs the area that has a value for conservation • Potential impact causes change in species diversity • Potential impact disturbs degraded area or slightly disturbs area with value for conservation • Potential impact causes small changes in species and diversity

Table 5-2: Potential Environmental Impact Categories and Criteria

Potential Impact Category	Definition
Insignificant	Potential impact has no effect.
Positive	Potential impact has positive changes on resources and ecosystem
Low Negative	Potential impact may result in a change in resources and environment but this change does not decrease the value of these resources and environment. Potential impact can be managed and resolved by implementation of general mitigation measures.
Medium Negative	Potential impact may result in changes that affect the value of resources and environment. Mitigation measures are required to manage or reduce the potential impacts and monitoring measures to determine effectiveness of mitigation measures.
High Negative	Potential impact is classified as severe and may result in other effects. Potential impact cannot be managed or resolved by any mitigation measures.

5.1.4.2 Assessment of Potential Social Impacts

The assessment of potential socio-economic impacts is based on quantitative and qualitative data and professional judgment. Factors used to analyze potential social impacts are similar to those used above, such as likelihood, duration, reversibility, and magnitude of the potential impact.

Additional factors include consideration of changes in the value of assets that households depend upon for their livelihoods, manageability of the change and potential for it to lead to further changes beyond the control of the project, and whether the effects are acute or chronic. The significance of the potential social impact is ranked as beneficial, low negative, medium negative or high negative using the criteria outlined in **Table 5-3**.

Table 5-3: Potential Social Impact Categories and Criteria

Potential Impact Category	Criteria
Beneficial	Improvement in the ability of households or settlement to maintain or improve its livelihood or store of assets Enhancement in quality or availability of resources resulting in improvement in quality of life. For example: • Enhancement in physical capital including availability of infrastructure • Enhancement in social capital, including skills for future employment • Enhancement of relationship between Project Proponent, Contractor and communities
Low Negative	Possible short term decrease in availability of resources or access to infrastructure not affecting livelihood Possible short term decrease in quality of life of household or settlement not affecting long term outcomes

Potential Impact Category	Criteria
	No discernable long term effect on the local economy Potential impacts which are long lasting but to which the community is able to adapt, such as increased access to information, slow cultural change, changes in economic structure
Medium Negative	Potential effect on ability of households to maintain livelihoods or store of assets in short term Potential reduction in quality of life in short-term Potential disruption to lifestyle in short term Perception of missed opportunity to improve Possible decrease in access to infrastructure to which community is unable to adapt in the short term Reduction in quality of life Potential impacts which may result in high levels of complaint in the short term
High Negative	Effect on ability of household to maintain livelihood/store of assets to an extent not acceptable to affected people Permanent reduction in quality of life Permanent cultural change to which the communities are unable to adapt Frustration and disappointment resulting in significant tensions with communities

5.1.4.3 *Assessment of Potential Health Impacts*

The potential impact on health is assessed for nearby communities and people close to project operations. Factors used to analyze the scale of potential health impacts are similar to the criteria used for environmental and social impact analysis such as extent, duration, reversibility, and magnitude of the potential impact.

Additional factors unique to health aspects are provided in **Table 5-4**. The method of assessing the *significance* of health involves an evaluation of the probability or likelihood of the potential health impact occurring, and also the severity of the potential impact. The significance of potential health impact can be ranked as insignificant, low negative, medium negative or high negative using the criteria outlined in **Table 5-5**.

Table 5-4: Factors Considered in Health Impact Assessment

Factor	Detail
Hazardous Chemicals or Health Threats	• Chemicals: heavy metals, toxic organic compounds. • Physical: noise and vibration • Biological: viruses, bacteria • Psychological: stress, annoyance, and nuisance
Environment Resulting in a Potential Health Impact	• Change of environmental quality: water quality, air quality resulting in a potential health impact • Change of utilization or acquiring resources: water use resulting in a potential health impact • Physical: noise, dust, radiation and vibration resulting in a potential health impact
Factors of Exposure	• Exposure pathway: eating or skin exposure • Risk group: people around the project area

Factor	Detail
Potential Health Impact	• Death rate • Injury rate from infectious diseases or non-infectious diseases, acute or chronic effects • Rate of emotional impact, stress • Injuries and accidents • Impacts on the next generation • Impacts to high-risk groups • Stimulate or enhance the severity of the disease • Cumulative impacts
Potential Impacts on Medical Services	• Overall increase in the demand for health care • Demand for special health care • Changes to existing medical services

Table 5-5: Health Impact Categories and Criteria

Potential Impact Category	Criteria
Insignificant	No injuries or illness: No effect on work or lifestyle and does not cause illness in community No evidence that the situation occurs Health risk is at very low level.
Positive	May have a positive impact on Public Health
Low Negative	Few injuries or illnesses: Mild effects, require 2-3 days for recovery: e.g., skin irritation, food poisoning from bacteria Can occur in theory, but no report of incident in the region or abroad Health risk is at very low level but must be controlled to prevent increased risk to unacceptable levels.
Medium Negative	Medium injuries or illness: Moderate effects, long-term/continuous group risk: e.g., loud noise at shorebase Can occur in theory or may have occurred once in the region or abroad The risk must be managed/ reduced.
High Negative	Permanent illness: severe potential impact resulting in loss or death in community risk group: e.g., cancer from chemical exposure Intensifying effect: severe potential impact affects a large population or cannot be handled by local authorities Occurred more than 1 time in Cambodia or abroad from the development of a similar project The risk must be managed/ reduced.

5.1.4.4 Assessment of Potential Impacts Associated with Unplanned Events Impact

The potential impacts associated with unplanned events are evaluated by determining the likelihood (or probability) of an event occurring and its potential consequences. Unplanned events are evaluated using a risk assessment methodology.

The probability of a specific event occurring can be determined either in terms of historica precedence or by calculation. Probability has been categorized as rare, remote, unlikely, seldom occasional and likely, as shown in **Table 5-10**.

The potential consequence of an event occurring is determined according to the following themes:

- Environment (physical and ecological);
- Society (including socio-economic); and
- Public Health.

Each of these has a set of associated pre-defined criteria as shown in **Table 5-6** to **Table 5-8**.

Potential environmental impacts are inherently variable because the degree of vulnerability is heavily dependent on local environmental conditions. The significance designation for potential environmental impacts takes into consideration environmental information and environmental science expertise.

Table 5-6: Potential Environmental Impact Consequence

Impact	Definition
Incidental	Potential impacts such as localized or short-term effects on habitat, species, or environmental media.
Minor	Potential impacts such as localized, long-term degradation of sensitive habitat or widespread, short-term impacts to habitat, species, or environmental media.
Moderate	Potential impacts such as localized but irreversible habitat loss or widespread, long-term effects on habitat, species, or environmental media.
Major	Potential impacts such as significant, widespread, and persistent changes in habitat, species, or environmental media.
Severe	Potential impacts such as persistent reduction in ecosystem function on a landscape scale or significant disruption of a sensitive species.
Catastrophic	Potential impacts such as loss of a significant portion of a valued species or loss of effective ecosystem function on a landscape scale.

Potential social impacts are inherently variable because community response to a potential impact, perceptions of existing and changing conditions, and the degree of vulnerability is heavily dependent on local conditions. The significance designation for potential social impacts takes into consideration social science expertise and previous experience regarding the relationships between individuals, communities, government agencies, NGOs and special interest groups, and the oil and gas industry.

Table 5-7: Potential Social Impact Consequence

Significance	Definition
Incidental	Potential impacts that are practically indistinguishable from the social baseline, with little to no potential impacts to or concerns from affected external stakeholders.
Minor	Potential impacts that are short-term nuisance or inconvenience; potentially affected external stakeholders concerned but likely able to adapt with relative ease.
Moderate	Potential impacts such as localized or short term effects; potentially affected stakeholders concerned but likely able to adapt with relative ease.
Major	Potential impacts such as local-to-regional (sub-national) or medium term effects; potentially affected stakeholders concerned and raise the issue as a high priority, but may be able to adapt with some targeted support or assistance.
Severe	Potential impacts such as local-to-national or long term effects; potentially affected stakeholders concerned and raised as a high priority; may not be able to adapt without targeted support or assistance in order to maintain pre-impact livelihood.
Catastrophic	Potential impacts such as local-to-global or irreversible long term effects; potentially affected stakeholders concerned raise the issue as a high priority and are likely not able to adapt without targeted support or assistance.

To determine potential public health impacts, the public which could be exposed to various aspects of the project is taken into consideration, whether it is a permanent resident continuously exposed to the project area or a periodically exposed fisherman visiting or transiting through the project area. The significance determination of a potential public health impact takes into consideration local and regional public health expertise and previous experience regarding the relationships between individuals, communities, health care providers, government agencies, NGOs, and the oil and gas industry.

Table 5-8: Potential Public Health Impact Consequence

Significance	Definition
Incidental	No potential impact to the public
Minor	Potential illness or adverse effect with limited or no impacts on ability to function and medical treatment is limited or not necessary.
Moderate	Potential illness or adverse effects with mild to moderate functional impairment requiring medical treatment or management.
Major	Potential serious illness or severe adverse health effect requiring a high level of medical treatment or management.
Severe	Potential serious illness or chronic exposure of a few resulting in life shortening effects.
Catastrophic	Potential serious illness or chronic exposure of many resulting in life shortening effects.

The level of risk is identified using a matrix evaluating probability against consequence (**Table 5-10**). The risk level can be separated into four levels: low, medium, high or very high (**Table 5-9**).

If the risk is determined to be "medium" or "high", it needs to be managed to reduce the frequency of occurrence or to mitigate any potential consequences to achieve a risk which is low, or if it cannot be mitigated to a low level, to a level that is "As Low As Reasonably Possible" (ALARP). If the risk is determined to be "very high" (i.e. unacceptable), specific actions must be developed to reduce the risk, which may involve a full Quantified Risk Assessment (QRA).

For COCPL's Apsara Petroleum Development Project, the unplanned events considered are:

- Collision;
- Fire or Explosion; and
- Spill, including detailed assessments of a well blowout and FSO rupture.

Table 5-9: Significance of Unplanned Events Risk

Risk Level	Definition
Low	Low level risk does not require additional management
Medium	The risk must be controlled to prevent increased risk
High	The risk must be managed/ reduced
Very High	The risk must be managed/ reduced immediately

Note: The definition might be adjusted depending on discretion of expertise and project characteristic

Table 5-10: Risk Assessment Matrix

			Probability					
			The consequence is rare or unheard of	The consequence has occurred once or twice in the industry	The consequence has occurred in the industry in the past but is not likely to occur on this project during the lifecycle of the facility	The consequence could occur on this project during the lifecycle of the facility but only under exceptional conditions	The consequence may occur on this project during the lifecycle of the facility	The consequence can reasonably be expected to occur on this project during the lifecycle of the facility
			1	2	3	4	5	6
			Rare	***Remote***	***Unlikely***	***Seldom***	***Occasional***	***Likely***
Consequence	Catastrophic	**1**	Medium	High	High	Very high	Very high	Very high
	Severe	**2**	**Low**	**Medium**	**High**	**High**	Very high	Very high
	Major	**3**	**Low**	**Low**	**Medium**	**High**	**High**	Very high
	Moderate	**4**	**Low**	**Low**	**Low**	**Medium**	**High**	**High**
	Minor	**5**	**Low**	**Low**	**Low**	**Low**	**Medium**	**Medium**
	Incidental	**6**	**Low**	**Low**	**Low**	**Low**	**Low**	**Low**

5.1.5 Impact Prevention and Mitigation

Measures to prevent or mitigate (reduce) the severity of potentially significant impacts are developed and linked back to the related activities and an Environmental Management Plan (EMP) is prepared. The EMP brings together the environmental management requirements needed to prevent or reduce potential impacts from activities and accidental events, and forms part of the EIA Report and company commitment to the project. This forms the substance of Chapter 6.

5.2 Outcomes of Screening and Scoping

Table 5-11, the Screening Matrix, shows potential impacts that may occur as a result of planned project activities and unplanned events.

Each of the potential impacts, shown by a square in the matrix, was assessed qualitatively based on the approach outlined in Section 5.1.2. The colour scale, amber and white, shows the results of this screening. The amber squares indicate a potential for impacts and the white squares indicate the lack of impact.

COPCL implements strict operational procedures to reduce the potential for accidental releases. An accidental release is therefore considered an unplanned event and any potential impact of accidental release on the environment is discussed in the section for unplanned events.

The amber squares show the combination of activities/unplanned events and environmental elements that may result in potential impacts, and these are discussed further in the following sections.

The principal elements potentially impacted by COPCL's project are related to air quality, seawater quality, ocean sediments, marine biota, endangered species, fishing, shipping, and public health. In addition, the potential impacts on sensitive areas, tourism, socio-economy and visual aesthetics are discussed, where appropriate.

The information from **Table 5-11** and **Table 5-12** regarding the potential impacts from the identified project activities and unplanned events are discussed in the remainder of this chapter.

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Table 5-11: Screening Matrix of Potential Impacts from Project Activites or Unplanned Events

Environmental Parameters	Physical Resources	Ecological Resources	Human Use Values	Quality of Life Values	Healt

Table 5-11: Screening Matrix of Potential Impacts from Project Activites or Unplanned Events

Environmental Parameters		Physical Resources		Ecological Resources				Human Use Values			Quality of Life Values			Health
Project Activities/Events		Air Quality / GHG emissions	Seawater Quality	Ocean Sediment	Marine Biota	Endangered Species	Sensitive / Protected Areas	Fishing	Shipping	Tourism	Socio-economy	Cultural-Archaeological	Visual Aesthetics	Public Health
	General Project Activities													
1	Crew/Materials Transport				■	■		■	■		■		■	■
2	Shore Base Support									■	■		■	■
3	Offshore Fuel Storage & Handling	■												
4	Hazardous Materials Handling and Storage													■
5	Wastewater Production and Disposal		■		■	■		■						
6	Non-Hazardous and Hazardous Waste Handling and Storage										■			■
7	Energy Use (generators etc)	■												
	Installation													
8	Rig Placement, Production Platform and FSO Installation			■	■	■		■	■					
9	Infield Pipeline Installation			■	■			■	■					
10	Pipeline Testing and Commissioning		■		■	■		■						
	Drilling													
11	Drilling & Completion of Wells				■	■		■	■					
12	Mud & Cuttings Disposal		■	■	■	■		■						■
	Production													
13	Oil Extraction and Processing		■		■	■					■		■	
14	Produced Water Generation and Disposal													
15	Flaring	■												
	Abandonment													
16	Well Suspension		■	■	■			■	■					
17	Production Facilities Decommissioning		■	■	■			■	■					
	Unplanned Events													
18	Accidental Release	■	■	■	■	■	■	■	■	■	■	■	■	■
19	Collision							■	■	■				■
20	Fire or Explosion	■						■	■				■	■

[blank box] No Impact identified   [shaded box] Potential impact identified

Table 5-12: Potential Project Impacts Identified through Screening

Environmental Element	Potential Impact
Physical Resources	
Air Quality/Greenhouse Gas Emissions	▪ Deterioration of air quality from combustion and fugitive emissions ▪ Emissions of air pollutants and Greenhouse gases
Seawater Quality	▪ Seawater quality reductions from operational discharges ▪ Deterioration of seawater quality from increased suspended solids and turbidity or low concentrations of contaminants
Ocean Sediments	▪ Sediment quality reductions from operational discharges ▪ Sediment disturbance from sediment re-suspension ▪ Change in sediment sizes or substrates
Ecological Resources	
Marine Biota and Seabirds	▪ Disturbance from elevated noise and/or light levels ▪ Adverse effects to marine organisms associated with elevated turbidity levels (e.g. smothering of eggs or benthic organisms) or low levels of contaminants ▪ Adverse effects from operational discharges
Endangered Species	▪ Disturbance from elevated noise and/or light levels ▪ Adverse toxic effects from operational discharges
Human-Use Values	
Fishing	▪ Restriction or closure of fishing areas ▪ Adverse effects from operational discharges
Shipping	▪ Restriction of movement, rerouting of traffic ▪ Enhanced Shipping
Tourism/ Recreation	▪ Reduced attractiveness of area for tourism due to increased noise, increased traffic ▪ Reduced attractiveness of area for tourism due to reduced visual aesthetics from operational discharges
Quality-of-Life Values	
Socio-Economy	▪ Enhanced Socio-Economy ▪ Increased work opportunities ▪ Increased income
Cultural/ Archaeological Features	▪ Damage to archaeological features
Visual Aesthetics	▪ Reduced attractiveness of area for tourism due to increased noise, traffic, and industrial facilities ▪ Reduced attractiveness of area for tourism due to flare and reduced visual aesthetics from operational discharges
Public Health	
Public Health and Safety	▪ Health and safety potentially affected by accidents and injuries ▪ Reduced health and safety due to exposure to hazards
Unplanned Events	
Accidental releases (chemicals, fuel, waste, crude oil) including Well Blowout and FSO Rupture	▪ Seawater and sediment quality reductions ▪ Adverse toxic effect on marine biota and endangered species

Environmental Element	Potential Impact
	▪ Adverse toxic effects on sensitive/protected areas from accidental releases during transport potentially near these areas ▪ Reduced quality/quantity of catch because of tainted fish (from exposure to hydrocarbon or other tainting compounds) ▪ Reduced attractiveness of area for tourism due to reduced visual aesthetics from releases, accidental releases or improper disposal
Collision	▪ Accidents with fishing and shipping vessels affecting public health
Fire or Explosion	▪ Deterioration of air quality from combustion and fugitive emissions ▪ Restrict traffic of fishing and shipping vessels ▪ May affect public health

These potential impacts are assessed in the following sections.

5.3 Assessment of Impacts on Physical Environment

COPCL implements strict operational procedures to reduce the potential for accidental releases. An accidental release is therefore considered an unplanned event and any potential impact of accidental releases on the physical environment is discussed under unplanned events.

5.3.1 Air Quality and Greenhouse Gas Emissions

Air emissions from the project will be generated primarily from energy use (engines, turbines, transport etc) and flaring of natural gas.

Air pollutants resulting from combustion as a result of energy use include CO_2, CO, NO_X, N_2O, SO_X, and CH_4. These emissions could affect air quality locally. In addition, CO_2, CH_4 and N_2O are direct greenhouse gases and contribute to increased concentrations of greenhouse gases in the atmosphere. Potential impacts of these emissions are summarized in **Table 5-13**.

Table 5-13: Potential Environmental Impacts of Energy Use

Emission	Environmental/Health Impacts
CO	Contributes indirectly to greenhouse gas concentrations in the atmosphere by enhancing low-level ozone formation
NO_X	Contributes to the formation of acidic species that can be deposited by wet and dry processes, potentially impacting aquatic and terrestrial ecosystems
N_2O	Direct greenhouse gas
SO_2	Contributes to the formation of acidic species that can be deposited by wet and dry processes, potentially impacting aquatic and terrestrial ecosystems
CO_2	Direct greenhouse gas
Methane	Direct greenhouse gas

Air quality could also be potentially impacted by fugitive emissions from hazardous materials and wastes, such as paints, waste oil, solvents and chemicals but the volumes of these emissions are negligible and considered to be insignificant.

Emissions of greenhouse gases (GHG) and other gases emissions from engines/ turbines/ flaring combustion activities and from venting are assessed below.

5.3.1.1 Greenhouse Gas Emissions

Potential impacts may arise from emissions of GHG from fuel combustion over the project lifecycle and flaring during the operations phase. Emissions have been estimated using emission factors and

global warming potentials for the three main GHG emitted by the project: carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) and are summarized by phase below. Detailed calculations are provided in **Appendix 8**.

5.3.1.2 Other Gas Emissions

Fuel combustion also releases NOx and SOx that have potential environmental impacts as outlined in **Table 5-13**.

Emission factors are based on the Revised 1996 IPPC Guidelines and are summarized by phase below. Detailed calculations are provided in **Appendix 8**.

5.3.1.3 Installation

GHG Emissions

Description -Quantification

Fuel combustion during the installation phase consists of fuel use from mobile water-borne navigation and from helicopter aviation. The fuel use during the installation phase and the estimated greenhouse gas emissions are provided in **Table 5-14**.

The total amount of GHG emissions is estimated to be 3,144.5 t CO_2 eq for the Apsara platform A. Installation of the nine following platforms (Phases 1b and 1c) is estimated to generate 15,096.8 t CO_2 eq.

The total GHG emissions for the entire installation program are estimated to be 18,241.4 t CO_2 eq. The installation of platforms is expected to be limited to 3 per year in Phases 1b and 1c (**Table 2-1**), with a total estimated GHG emissions of 5,032.3 t CO_2 eq (15,096.8/9*3).

Table 5-14: Estimated GHG Emissions during the Installation Phase

Phase	Use	Activities/Sources	Fuel Use (MT)	CH_4 (ton)	N_2O (ton)	CO_2 (ton)	Estimated GHG (ton CO_2-eq)
Phase 1a (1 platform)	Water-Borne	Vessels (MDO)*	957	0.3	0.1	3,049	3,081
	Aviation	Helicopter (jet)	20.3	0	0	63.0	63.5
Phase 1b (3 platforms)	Water-Borne	Vessels (MDO)	1,395	0.4	0.1	4,444.9	4,491.1
	Aviation	Helicopter (jet)	60.9	0.0	0.0	188.9	190.5
Phase 1 c (6 platforms)	Water-Borne	Vessels (MDO)	3,116	0.9	0.3	9,928.5	10,034.2
	Aviation	Helicopter (jet)	121.8	0.0	0.0	377.7	381.0
		Total Installation	**Phase 1a**	**0.3**	**0.1**	**3,112.2**	**3,144.5**
			Phase 1b	**0.4**	**0.1**	**4,633.7**	**4,681.6**
			Phase 1c	**0.9**	**0.3**	**10,306.2**	**10,415.2**
			Total	**1.7**	**0.5**	**18,052.2**	**18,241.4**

*MDO Marine Diesel Oil

Assessment of Potential Impacts

The Cambodian historical national GHG emissions in 1994 were 13 million tonnes of CO_2-eq (United Nations Statistics Division, 2011). No recent data were available for Cambodia. According to the Asian Development, emissions from the South East Asia region were 5,187million tonnes of CO_2-eq in 2000 (ADB, 2009). The annual GHG emissions during installation of three platforms would result in Cambodia's 1994 GHG emissions increasing by less than 0.04%. Emissions during installation are therefore considered to be insignificant compared to Cambodia's total GHG emissions.

The potential impact from GHG emissions during installation is unlikely to result in a significant change in air quality and greenhouse gas emissions, and is unlikely to change the value of the environment. *The overall **significance** of potential environmental impacts from installation activities on air quality and greenhouse gas emissions is rated as **insignificant**.*

Non-GHG Emissions

Description - Quantification

Fuel combustion during the installation phase consists of fuel use from mobile water-borne navigation and from helicopter aviation. The fuel use during the installation phase and the associated NOx, CO, NMVOC, and SOx and emissions are provided in **Table 5-15**.

The total emissions for installation of the Apsara platform A are estimated to be 64.9 t NOx, 20.5 t CO, 4.7 t NMVOC, and 2.9 t SOx.

Installation of the nine other platforms (Phases 1b and 1c) is expected to generate 306.8 t NOx, 97.0 t CO, 22.2 t NMVOC, and 13.7 t SOx. The installation for platforms is expected to be limited to 3 per year in Phases 1b and 1c (**Table 2-1**), with a total of 102.3 t NOx, 32.3 t CO, 7.4 t NMVOC, and 4.6 t SOx per year.

Table 5-15: Non-GHG Emissions during the Installation Phase

Phase	Use	Activities/Sources	Fuel Use (MT)	NOx (ton)	CO (ton)	NMVOC (ton)	SOx (ton)
Phase 1a (1 platform)	Water-Borne	Vessels (MDO)	957	64.6	20.4	4.7	2.9
	Aviation	Helicopter (jet)	20.3	0.3	0.1	0.0	0.0
Phase 1b (3 platforms)	Water-Borne	Vessels (MDO)	1395	94.2	29.7	6.8	4.2
	Aviation	Helicopter (jet)	60.9	0.8	0.3	0.0	0.1
Phase 1c (6 platforms)	Water-Borne	Vessels (MDO)	3116	210.3	66.4	15.3	9.3
	Aviation	Helicopter (jet)	121.8	1.5	0.6	0.1	0.1
		Total Installation	**Phase 1a**	**64.9**	**20.5**	**4.7**	**2.9**
			Phase 1b	**94.9**	**30.0**	**6.9**	**4.2**
			Phase 1c	**211.9**	**67.0**	**15.4**	**9.5**
			Total	**371.6**	**117.5**	**27.0**	**16.6**

*MDO Marine Diesel Oil

Assessment of Potential Impacts

The installation of platforms is expected to be limited to 3 per year during Phases 1b and 2 per year during 1c (**Table 2-1**), resulting in an estimated total of 102.3 t NOx and 4.6 t SO_2. NOx and SOx could result in acidification, impacting freshwater and terrestrial resources on land (**Table 5-13**). However, emissions will occur offshore, at 157 km from shore and populated areas. Emissions are expected to be widely dispersed in the windy offshore environment. Due to the dispersion and the substantial distance of platforms from land, the non-GHG emissions are not expected to result in a significant impact.

The potential impact from non-GHG emissions during installation is unlikely to result in a significant change in air quality, and is not likely change the value of the environment.

*The overall **significance** of potential environmental impacts from installation activities on air quality is rated as **insignificant**.*

5.3.1.4 Drilling

GHG Emissions

Description – Quantification

Fuel combustion during the drilling phase consists of fuel use from stationary generators, fuel use from mobile water-borne navigation and fuel use from helicopter aviation. The fuel use during the drilling phase is provided in **Table 5-16**. The total amount of GHG emissions for the initial drilling phase (Phase 1a) is estimated to be 16,926 t CO_2 eq per platform.

Drilling at each platform is expected to result in a similar amount of GHG emissions as for Phase 1a. . The total GHG emissions for the entire drilling program are estimated to be 169,242 t CO_2 eq. The entire drilling program is expected to last 7.5 years (see Chapter 2; **Table 2-1**). Therefore, the annual GHG emissions for the drilling program are estimated to be 22,566 t CO_2 eq/year.

Assessment of Potential Impacts

The Cambodian historical national GHG emissions in 1994 were 13 million tonnes of CO_2-eq (United Nations Statistics Division, 2011). No recent data were available for Cambodia. According to the Asian Development, emissions from the South East Asia region were 5,187million tonnes of CO_2-eq in 2000 (ADB, 2009). The GHG emissions during drilling per year would result in Cambodia's 1994 GHG emission increasing by less than 0.2%. Emissions during drilling are therefore considered to be low compared to Cambodia's total GHG emissions.

The potential impact from GHG emissions during drilling is unlikely to result in a significant change in air quality and greenhouse gas emissions, and is unlikely to change the value of the environment. *The overall **significance** of potential environmental impacts from drilling activities on air quality and greenhouse gas emissions is rated as **low**.*

Table 5-16: GHG Emissions during the Drilling Phase

Phase	Use	Activities/Sources	Fuel Use (MT)	CH_4 (ton)	N_2O (ton)	CO_2 (ton)	GHG (ton CO_2-eq)
Phase 1a	Stationary	Drilling Rig (MDO)	2,232	0.3	0.1	7,111.8	7,136.2
(1 platform)	Water-Borne	Vessels (MDO)	2,965	0.9	0.3	9,447.4	9,545.7
	Aviation	Helicopter (jet)	78	0.0	0.0	241.9	244.0
Phase 1b	Stationary	Drilling Rig (MDO)	6,696	0.9	0.2	21,335.5	21,408.5
(3 platforms)	Water-Borne	Vessels (MDO)	8,895	2.7	0.8	28,342.1	28,637.0
	Aviation	Helicopter (jet)	234	0.0	0.0	725.6	731.9
Phase 1c	Stationary	Drilling Rig (MDO)	13,392	1.7	0.3	42,670.9	42,817.1
(6 platforms)	Water-Borne	Vessels (MDO)	17,785	5.4	1.5	56,668.3	57,258.0
	Aviation	Helicopter (jet)	468	0.0	0.0	1,451.3	1,463.9
		Total Drilling	**Phase 1a**	**1.2**	**0.3**	**16,801.1**	**16,925.8**
			Phase 1b	**3.5**	**1.0**	**50,403.2**	**50,777.5**
			Phase 1c	**7.1**	**1.9**	**100,790.5**	**101,538.9**
			Total	**11.8**	**3.2**	**167,994.9**	**169,242.3**

Non-GHG Emissions

Description – Quantification

Fuel combustion during the drilling phase consists of fuel use from stationary generators, mobile water-borne navigation and from helicopter aviation. The fuel use during the drilling phase and the associated NOx, CO, NMVOC, and SOx emissions are provided in **Table 5-17**.

Table 5-17: Non-GHG Emissions during the Drilling Phase

Phase	Use	Activities/Sources	Fuel Use (MT)	NOx (ton)	CO (ton)	NMVOC (ton)	SOx (ton)
Phase 1a (1 platform)	Stationary	Drilling Rig (MDO)	2,232	446.4	33.5	0.0	209.4
	Water-Borne	Vessels (MDO)	2,965	200.1	63.2	14.5	8.9
	Aviation	Helicopter (jet)	78	1.0	0.4	0.1	0.1
Phase 1b (3 platforms)	Stationary	Drilling Rig (MDO)	6,696	1,339.2	100.4		628.1
	Water-Borne	Vessels (MDO)	8,895	600.4	189.5	43.6	26.7
	Aviation	Helicopter (jet)	234	2.9	1.2	0.2	0.2
Phase 1c (6 platforms)	Stationary	Drilling Rig (MDO)	13,392	2,678.4	200.9	0.0	1,256.2
	Water-Borne	Vessels (MDO)	17,785	1,200.5	378.8	87.1	53.4
	Aviation	Helicopter (jet)	468	5.9	2.4	0.4	0.5
		Total Drilling	**Phase 1a**	**648**	**97**	**15**	**218**
			Phase 1b	**1943**	**291**	**44**	**655**
			Phase 1c	**3,884.7**	**582.1**	**87.5**	**1,310.0**
			Total	**6,475**	**970**	**146**	**2,183**

Assessment of Potential Impact

The entire drilling program is expected to last 7.5 years (see Chapter 2 - **Table 2-1**). Thus, drilling is expected to result in annual emissions of 863 t NOx 129 t and CO and 291.0 t SO_2.

Emissions will occur offshore, at 157 km from shore and populated areas. Emissions are expected to be widely dispersed in the windy offshore environment. NOx and SOx could result in acidification, impacting freshwater and terrestrial resources on land (**Table 5-13**). However, due to the dispersion and the substantial distance of platforms from land, the non-GHG emissions are not expected to result in a significant impact.

The potential impact from non-GHG emissions during drilling is unlikely to result in a significant change in air quality and is unlikely to change the value of the environment. *The overall **significance** of environmental impacts from drilling activities on air quality is rated as **low**.*

5.3.1.5 Production

The development schedules for Phases 1b and 1c are dependent on the result of Phase 1a. The number of platforms producing at any one time is therefore uncertain. For the purpose of the impact assessment, the worst case will be considered for each phase[1]

- 1 platform during phase 1a;
- 4 platforms during phase 1b;
- 10 platforms during phase 1c.

GHG Emissions

Description and Quantification

Fuel combustion during the production phase consists of fuel use (diesel and associated gas) from stationary generators, fuel use from mobile water-borne navigation, fuel use from helicopter aviation and flaring of excess associated gas during Phase 1a.

For Phase 1b, Chevron will investigate the feasibility to reinject associated gas (see Chapter 2). The fuel use and associated gas used and flared during the production phase is provided in **Table 5-18**.

The GHG emissions from the field during production operations are estimated to range from approximately 79,484 to 259,038 tonnes CO_2 equivalent per year (**Table 5-18**).

Table 5-18: Estimated Annual GHG Emissions during the Production Phase

Phase	Use	Activities/Sources	Fuel Use	CH_4 (ton)	N_2O (ton)	CO_2 (ton)	GHG (ton CO_2-eq)
Phase 1a (1 platform)	Stationary	Processing Platform (associated gas)	328.5 mmscfyr	0.34	0.03	18,857.98	18,876.4
		Platform A FSO	200 MT/yr MDO	0.03	0.01	637.26	639.4
			1,105 MT/yr DO	0.14	0.03	3,520.86	3,532.9
			1,000 MT/yr IFO	0.13	0.03	3,186.30	3,197.2
	Water-Borne	Vessels (MDO)	3,461 MT/yr	1.0	0.3	11,027.8	11,142.5
	Aviation	Helicopter (jet fuel)	52.5 MT/yr	0.0	0.0	162.8	164.2
	Flaring	Associated gas	Yr 1: 730 mmscf	0.01	0.07	41,908.86	41,931.5
			Yr 2: 912.5 mmscf	0.02	0.09	52,386.08	52,414.4
			Yr 3: 1,277.5 mmscf	0.03	0.13	73,340.51	73,380.1
Phase 1b (max of 4 platforms: 1 CPP and 3 WHP)	Stationary	Processing Platform (associated fuel gas)	328.5 mmscf/yr	0.34	0.03	18,857.98	18,876.4
		Platform A	200 MT/yr MDO	0.03	0.01	637.26	639.4
		Wellhead Platform (associated fuel gas)	346.75 mmscf/yr/platform	1.06	0.11	59,716.94	59,775.3
		Wellhead Platform (MDO)	23 MT/yr	0.01	0.00	219.85	220.6

[1] Calculations are based on EV values (see definition in Chapter 2).

Phase	Use	Activities/Sources	Fuel Use	CH_4 (ton)	N_2O (ton)	CO_2 (ton)	GHG (ton CO_2-eq)
		FSO	1,105 MT/yr DO	0.14	0.03	3,520.86	3,532.9
			1,000 MT/yr IFO	1,000	0.13	0.03	3,186.30
	Water-Borne	Vessels (MDO)	3,461 MT/yr	1.0	0.3	11,027.8	11,142.5
	Aviation	Helicopter (jet fuel)	58.5 MT/yr	0.0	0.0	181.4	58.5
	Flaring	Associated gas	2mmscfd	0.01	0.07	41,908.86	41,931.5
Phase 1c (max of 10 platforms: 2 CPPs and 8 WHP)	Stationary	CPP (associated fuel gas)	657mmscf/yr	0.67	0.07	37,715.96	37,752.8
		CPP	400 MT/yr MDO	0.05	0.01	1,274.52	1,278.9
		Wellhead Platform (associated fuel gas)	346.75 mmscf/yr/platform	2.84	0.28	159,245.16	159,400.7
		Wellhead Platform (MDO)	23 MT/yr	0.02	0.00	586.28	588.3
		FSO	1,105 MT/yr DO	0.14	0.03	3,520.86	3,532.9
			1,000 MT/yr IFO	0.13	0.03	3,186.30	3,197.2
	Water-Borne	Vessels (MDO)	3,461 MT/yr	1.0	0.3	11027.8	11142.5
	Aviation	Helicopter (jet fuel)	68.2 MT/yr	0.0	0.0	211.5	213.3
	Flaring	Associated gas	2mmscfd	0.01	0.07	41,908.86	41,931.5
Total	**Production**	**Phase 1a**	**Year 1**	**1.69**	**0.47**	**79,301.85**	**79,484.22**
			Year 2	**1.70**	**0.49**	**89,779.07**	**89,967.09**
			Year 3	**1.70**	**0.53**	**110,733.50**	**110,932.84**
		Max Phase 1b		**2.76**	**0.58**	**139,257.25**	**139,498.86**
		Max Phase 1c		**4.92**	**0.80**	**258,677.22**	**259,038.18**

* 4 platforms are assumed to produce at the same time for phase 1b and 10 platforms during phase 1c. These assumptions represent a worst case. Calculations based on EV volumes. Gas reinjection assumed for Phase 1b and 1c.

Assessment of Potential Impacts

The Cambodian historical national GHG emissions in 1994 were 13 million tonnes of CO_2-eq (United Nations Statistics Division, 2011). No recent data were available for Cambodia. According to the Asian Development, emissions from the South East Asia region were 5,187million tonnes of CO_2-eq in 2000 (ADB, 2009). The maximum GHG emissions during production (considering 10 platforms, including two CPPs) would result in a maximum of approximately 260,000 tonnes of CO_2 equivalent a year. This would represent 2% of Cambodia's historical 1994 GHG Emissions during production are therefore not considered to be significant compared to Cambodia and South East Asia's total GHG emissions.

Greenhouse gases emissions during production is likely to only result in a small impact on greenhouse gas emissions, but this is not expected to change the value of the environment. *The overall **significance** of potential environmental impacts from production activities on air quality and greenhouse gas emissions is rated as **low**.*

Non-GHG Emissions

Description and Quantification

Fuel combustion during the production phase consists of fuel use (diesel, intermediate fuel oil (FSO only) and associated gas) from stationary generators, diesel from mobile water-borne navigation, fuel use from helicopter aviation and flaring of excess associated gas during Phase 1a.

The estimated fuel use during the production phase and the associated NOx, SOx and CO emissions are provided in **Table 5-19**.

Assessment of Potential Impact

The annual emissions are expected to range from 858-1,411 t NOx and 227-263 t SO_2.

Emissions will occur offshore, at 157km from shores and populated areas. Emissions are expected to be widely dispersed in the windy offshore environment, and are not expected to result in a significant impact.

The potential impact from non-GHG emissions during production is likely to only result in a small increase in non-GHG pollutants, and is unlikely to change the value of the environment. *The overall **significance** of potential environmental impacts from production activities on air quality is rated as **low**.*

Other Flaring Emissions

Mercury is naturally present in subsurface fluid in the Gulf of Thailand., Mercury goes preferentially to the water phase, and the amount of mercury in the gas would be insignificant (European Commission, 2001). Based on Chevron's experience in the Gulf of Thailand, there are only trace amounts of mercury in the gas.

The potential impact from mercury emissions on air quality is unlikely to be significant, and is not likely change the value of the environment. *The overall **significance** of potential environmental impacts from mercury emissions during flaring is rated as **insignificant**.*

Table 5-19: Non-GHG Emissions during the Production Phase

Phase	Use	Activities/Sources	Fuel Use	NOx (ton)	CO (ton)	NMVOC (ton)	SO (to
Phase 1a (1 platform)	Stationary	Processing Platform (associated gas)	328.5 mmscfyr	50.42	6.72	0.0	0.0
		Platform A	200 MT/yr MDO	40.0	3.0	0.0	18.0
		FSO	1105 MT/yr MDO	221.0	16.6	0.0	100
			1000 MT/yr IFO	200.0	15.0	0.0	93.0
	Water-Borne	Vessels (MDO)	3,461 MT/yr	233.6	73.7	0.0	10.4
	Aviation	Helicopter (jet fuel)	52.5 MT/yr	0.7	0.3	0.0	0.0
	Flaring	Associated gas	Yr 1: 730 mmscf	112.05	14.94	0.0	0.0
			Yr 2: 912.5 mmscf	140.06	18.67	0.0	0.0
			Yr 3: 1277.5 mmscf	196.09	26.14	0.0	0.0
Phase 1b (max of 4 platforms: 1 CPP and 3 WHP)	Stationary	Processing Platform (associated fuel gas)	328.5 mmscf/yr	50.42	6.72	0.0	0.0
		Platform A	200 MT/yr MDO	40.0	3.0	0.0	18.0
		Wellhead Platform (associated fuel gas)	346.75 mmscf/yr/platform	159.67	21.29	0.0	0.0
		Wellhead Platform (MDO)	23 MT/yr	13.8	1.0	0.0	6.5
		FSO	1105 MT/yr MDO	221.0	16.6	0.0	100
			1000 MT/yr IFO	200.0	15.0	0.0	93.0
	Water-Borne	Vessels (MDO)	3,461 MT/yr	233.6	73.7	17.0	10.4
	Aviation	Helicopter (jet fuel)	58.5 MT/yr	0.7	0.3	0.0	0.0
	Flaring	Associated gas	730 mmscf	112.05	14.94	0.0	0.0
Phase 1c (max of 4 platforms: 1 CPP and 3 WHP)	Stationary	Processing Platform (associated fuel gas)	328.5 mmscf/yr	100.84	13.45	0.0	0.0
		Platform A	200 MT/yr MDO	80.0	6.0	0.0	37.0
		Wellhead Platform (associated fuel gas)	346.75 mmscf/yr/platform	425.79	56.77	0.0	0.0
		Wellhead Platform (MDO)	23 MT/yr	36.8	2.8	0.0	17.0
		FSO	1105 MT/yr MDO	221.0	16.6	0.0	100
			1000 MT/yr IFO	200.0	15.0	0.0	93.0
	Water-Borne	Vessels (MDO)	3,461 MT/yr	233.6	73.7	17.0	10.4
	Aviation	Helicopter (jet fuel)	68.5 MT/yr	0.9	0.4	0.1	0.1
	Flaring	Associated gas	730 mmscf	112.05	14.94	0.0	0.0
Total	**Production**	**Phase 1a**	**Year 1**	**857.7**	**130.2**	**17.0**	**226.0**
			Year 2	**885.8**	**134.0**	**17.0**	**226.0**
			Year 3	**941.8**	**141.4**	**17.0**	**226.0**
		Max Phase 1b		**1,031.3**	**152.6**	**17.0**	**233.1**
		Max Phase 1c		**1410.95**	**199.57**	**17.01**	**262.0**

* 4 platforms are assumed to produce at the same time for phase 1b and 10 platforms during phase 1c. These assumptions represent a worst case. Calculations based on EV volumes. Gas reinjection assumed for Phase 1b and 1c.

5.3.1.6 Abandonment

At the time of writing, details on decommissioning activities are not available; therefore no estimated emissions resulting from that phase can be presented. Emissions are expected to be in the same order of magnitude as those during installation.

*The overall **significance** of potential environmental impacts from installation activities on air quality and greenhouse gas emissions is rated as **insignificant-low**.*

5.3.2 Seawater Quality

5.3.2.1 Installation, Hookup and Commissioning

Operational Discharges (Wastewater and Hydrostatic Testing)

Wastewater - Section 2.17.1 outlines the wastewater streams that will be produced by the project. The streams include: sewage, domestic wastewater (grey water), deck drainage and hydrotest water.

Sewage: the amount of sewage generated per day during installation is a maximum of 60 m^3, assuming that the installation of the platform (20 m^3/d), pipeline and CALM Buoy (20 m^3/d) and flowlines (20 m^3) occur at the same time. Platform hookup (1.6 m^3/d) will occur after platform installation and thus result in less sewage.

Sewage from any installation and support vessels (such as the DLB) with a capacity more than 400 gross tons will be treated by the onboard sewage treatment plants before being discharged overboard in line with MARPOL 73/78 Annex IV regulations. The sewage treatment system is certified by the International Maritime Organization (IMO). It treats and disinfects sewage before discharge. The resulting quality prior to discharge will meet: pH between 6 and 8.5; Biochemical Oxygen Demand (BOD) geometric mean < 25 ppm; Chemical Oxygen Demand (COD) geometric mean < 125 ppm; Suspended Solids (SS) geometric mean < 35 ppm; and Thermotolerant Coliform geometric mean < 100/100 ml (MEPC 55/23, Annex 26, 2006).

Sewage generated from vessels with a capacity less than 400 gross tons (such as a crew boat) will be discharged directly into the sea without treatment as per MARPOL 73/78 Annex IV requirements.

Domestic wastewater: the amount of domestic wastewater generated per day during installation is a maximum of 90 m^3, assuming that the installation of the platform (30 m^3/d), pipeline and CALM Buoy (30 m^3/d) and flowlines (30 m^3) occur at the same time. Platform hookup and commissioning (2.4 m^3/d) will occur after platform installation and thus result in smaller quantities of sewage.

Domestic wastewater (gray water) is discharged directly to the sea in accordance with applicable regulatory requirements.

Deck drainage from designated machinery spaces on the supply, transportation and installation vessels is routed to a waste oil storage tank. Collected wastewater is then passed through an oil water separator to meet MARPOL discharge standard. Treated water with oil content < 15 ppm is discharged to the sea. Separated oil is collected in the slop tank and disposed through a waste contractor according to applicable laws and regulations.

***Hydrostatic Testing** - Section 2.17.1.3* outlines the procedures that will be used for pipeline testing. The pipelines will undergo hydrostatic testing to verify their structural integrity. Seawater with added biodegradable and environmentally non toxic oxygen scavenger and biocides to prevent fouling is used for the test. The potential environmental effects of the hydrotest chemicals are provided in **Table 5-20**.

At the moment there is no hydrotest water release procedure but a plan is in place to develop a hydrotest procedure. A worst case scenario would be to release all the hydrotest water into

ase

CO (ton)	NMVOC (ton)	SO2 (ton)
6.72	0.0	0.0
3.0	0.0	18.8
16.6	0.0	103.6
15.0	0.0	93.8
73.7	0.0	10.4
0.3	0.0	0.1
14.94	0.0	0.0
18.67	0.0	0.0
26.14	0.0	0.0
6.72	0.0	0.0
3.0	0.0	18.8
21.29	0.0	0.0
1.0	0.0	6.5
16.6	0.0	103.6
15.0	0.0	93.8
73.7	17.0	10.4
0.3	0.0	0.1
14.94	0.0	0.0
13.45	0.0	0.0
6.0	0.0	37.5
56.77	0.0	0.0
2.8	0.0	17.3
16.6	0.0	103.6
15.0	0.0	93.8
73.7	17.0	10.4
0.4	0.1	0.1
14.94	0.0	0.0
130.2	**17.0**	**226.6**
134.0	**17.0**	**226.6**
141.4	**17.0**	**226.6**
152.6	**17.0**	**233.1**
199.57	**17.01**	**262.68**

ng phase 1c. These assumptions
e 1b and 1c.

seawater. Release of hydrotest water may result in impacts to seawater quality from the hydrotest chemicals and depletion of oxygen.

The oxygen scavenger (Hydrosure O-3670R) may potentially have an effect on water quality depending on its concentration. In addition, the lack of oxygen in the hydrotest water could affect seawater quality when released. However, Hydrosure O-3670R is readily degradable and would not persist long in seawater. Hydrosure O-3670R is a 'gold' chemical in the Offshore Chemical Notification Scheme (OCNS) in the UK, which means it poses low hazard in terms of toxicity, biodegradability, and bioaccumulation. The compound however is identified with a substitution warning.

Table 5-20: Environmental Toxicity of Hydrostatic Test Chemicals

Chemical	Concentration in Hydrostatic Test Water	Environmental Effects
Hydrosure O-3670R (EC6226A, 60-100% Ammonium Bisulphite; CAS 10192-30-0)	750 ppm	OCNS Gold rating (lowest hazard) with substitution warning[2] Readily biodegradable[3]
Fluorescein LT Dye (Uranine; CAS 518-47-8)	40 ppm	*Psetta maxima* 4-d LC50 997 mg/L, 4-d LC0 700 mg/L[1] Fish and aquatic organisms: high toxicity 1-2 acid groups, low toxicity ≥3 acid groups[3] Algae: moderate toxicity, partly due to light inhibition[3] Visible in water as low as 1 mg/L[3] Persistent in the environment[3]

Source: [1]http://cfpub.epa.gov/ecotox/quick_query.htm; [2] no info on saltwater available; OCNS (Offshore Chemical Notification Scheme) Hazard quotient; [3] MSDS

Table 5-21: Hydrotest Water Generated during Installation

Phase	Pipeline	Volume of Hydrotest Water (m^3)	Phase Total (m^3)
1a	Between FSO and Platform A	109.9	109.9
1b	Between Platforms B and D	113.0	656.5
	Between Platforms C and D	78.8	
	Between Platforms D and A	464.7	
1c	Between Platforms F and D	198.2	917.3
	Between Platforms J and B	150.7	
	Between Platforms E and B	122.5	
	Between Platforms H and G	127.2	
	Between Platforms G and F	149.1	
	Between Platforms I and C	169.6	

The total amount of hydrotest water is listed in **Table 5-21**. The released hydrotest water would be diluted quickly and dispersed by sea currents, resulting in lower Hydrosure concentrations and higher dissolved oxygen concentrations. The highest amount of water released in one location would be from the pipeline between Platforms D and A. A localized and temporary impact on water quality from

hydrotest water can be expected. It is expected to be reversible due to the rapid dilution of the chemicals.

The dye concentrations are not expected to have an impact on water quality and biota because the effect concentrations are well below the concentration in the hydrotest water (**Table 5-20**).

The potential environmental impacts of release of wastewater and hydrostatic test water on seawater quality:

- Meet MARPOL standards;
- May result in small, temporary and reversible changes in water quality;
- Are localized;
- May result in very small, temporary changes in species and diversity due to the potential decrease in dissolved oxygen in the hydrotest water.

COPCL will periodically assess whether the use of new chemicals with lower potential environmental impact is feasible.

The potential impact from wastewater and hydrostatic test water discharges is likely to only result in a very small change in seawater quality, and is unlikely to change the value of the environment. *The overall **significance** of the potential environmental impacts from wastewater and hydrostatic test water discharge on seawater quality is therefore rated as **low**.*

Increased Turbidity (from Sediment Disturbance)

Rig placement and installation of the platforms, FSO and infield pipelines will disturb and temporarily suspend seabed sediments. These installation activities are likely to result in an increase in suspended solids and turbidity in seawater around the installation areas.

Marine sediments in the Gulf are finely textured. Sediment dispersion and re-deposition during project activities will be limited by the small areas of sediment disturbed and the weak currents in the Gulf. The larger particles will settle very quickly and the finer particles will spread and settle more slowly. The potential environmental impacts from installation activities on seawater turbidity:

- May result in small, temporary and reversible changes in water quality;
- Affect a small area (localised);
- May result in small, temporary changes in species and diversity.

The potential impact from installation activities is likely to only result in a small change in seawater quality, and is unlikely to change the value of the environment. *The overall **significance** of potential environmental impacts from installation activities on water quality is rated as **low**.*

5.3.2.2 *Drilling*

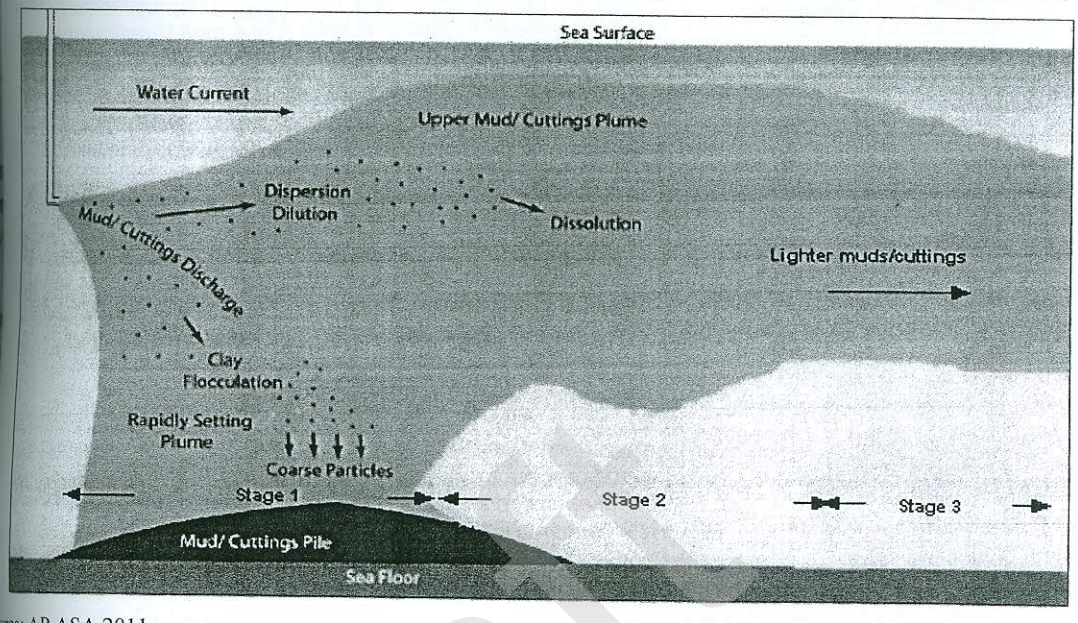
Operational Discharges (Wastewater)

Wastewater during drilling consists of:

- Sewage water (black water) 8.8 m^3/d
- Domestic wastewater (grey water) 13.2 m^3/d (**Table 2-34**) and
- Deck drainage from the drilling rig.

Sewage from the drilling rig and any installation and support vessels with a capacity more than 400 gross tons will be treated by the onboard sewage treatment plants before being discharged overboard in line with MARPOL 73/78 Annex IV regulations. The sewage treatment system is certified by the IMO. It treats and disinfects sewage before discharge. The resulting quality prior to discharge will

Figure 5-2: Conceptual Diagram Showing the Fate of Drilling Waste following Discharge into Sea



Source: AP ASA 2011

The increase in suspended solids as a result of drilling waste discharges is contained within a small area based on field studies and a dispersion modeling study (Neff 2005). Several field studies indicated that discharges to the ocean are diluted rapidly to very low concentrations, usually within 1000 to 2000 m down-current from the discharge and in less than an hour after the discharge. WBM dispersion modeling confirms a rapid dilution of WBM and WBM cuttings in the receiving water environment. The increase of suspended solids is therefore contained within a small area.

Dispersion and re-deposition of drilling waste is limited as discussed above and because of the weak currents in the Gulf. The larger particles are expected to settle quickly and the finer particles are expected to spread and settle more slowly.

Additional potential environmental impacts from drilling could result from the toxicity of drilling mud constituents. Common mud constituents and their environmental hazard information are summarized in **Table 5-22**.

It is important to note that no NAF will be discharged without treatment. The only NAF discharged is residual NAF mud attached to the cuttings after treatment on the rig (less than 8.5%).

Table 5-22: Environmental Toxicity of Drilling Chemicals

Chemical	Potential Environmental Effects
Barite	Fish: Rainbow trout 4-d LC50 76,000 mg/L [1,3] Not regarded as dangerous for the environment [3]
Xanthan Gum	Fish: rainbow trout 96-hr TLM 320-560 mg/L [1,3] Not regarded as dangerous for the environment [3]
PAC	Fish: golden orfe 96-hr TLM >500 mg/L Readily biodegradable [2,3]
ESCO	Fish: flounder 96-hr LC50 >1800 mg/L Crustacean: *Acartia tonsa* 48-hr EC50 73.2 mg/L Biodegradation 38% in 28 days [2]
Primary Emulsifier	Acute Fish Toxicity: EC50: 1785 mg/l (Corophium volutator) Acute Crustaceans Toxicity:TLM48: 33.9 mg/l (Acartia tonsa) Acute Algae Toxicity: EC50: 8.4 mg/l (Skeletonema costatum)

Chemical	Potential Environmental Effects
Secondary Emulsifier	Acute Fish Toxicity: EC50: 1701 mg/l (Corophium volutator) Acute Crustaceans Toxicity:TLM48: 199.4 mg/l (Acartia tonsa)
Gilsonite	Acute Crustaceans Toxicity:TLM96: 717,000 ppm (Mysidopsis bahia) SPP @ 20 ppb
Pliolite	Biodegradation Not soluble in water, so only minimally biodegradable. WGK class (Germany) Non-hazardous to waters
Organophylic Clays	NA
Lime	Fish: guppy 4-d LC50 356 mg/L; blueback herring 2-d LC50 250 µg/L; naked goby 4-d LC50 80 µg/L; inland silverside 2-d LC50 210 µg/L; Atlantic silverside 4-d LC50 37 µg/L; white perch 3.2-d LC50 270 µg/L; striped bass 4-d LC50 250 µg/L; golden shiner 4-d LC50 190 µg/L; northern pipefish 4-d LC50 270 µg/L; Crustacean: *Acartia tonsa* 1-d LC50 <50 µg/L; *Palaemonetes pugio* 4-d LC50 220 µg/L; Common mud crab 2-d LC50 410 µg/L; Mollusc: green mussel 26.8-d LT50 1 mg/L[1]
Calcium Chloride	Fish: sheepshead minnow IC25 growth 0.0981 M; inland silverside 7-d IC25 growth 0.0397 M Crustacean: opossum shrimp 2-d LC50 530 mg/L; harpacticoid copepod 4-d LC50 580 mg/L; opossum shrimp 2-d NOEC mortality 260 mg/L[1] Little danger to environment [3]
Saraline 185v	Poorly soluble, readily biodegradable under aerobic conditions, not harmful (almost non-toxic to non-toxic) to aquatic organisms [2]

Notes: [1] Source - http://cfpub.epa.gov/ecotox/quick_query.htm; [2] Source - MSDS; [3]Freshwater biota info, no info on saltwater available; [4]No ecological information available; NA – no information available

Barium (as barite) is a major component of drilling mud (acting as a weighting additive) and the release of barium from drilling mud could affect water quality, sediments and possibly aquatic life.

Barite has a very low solubility in seawater. Most metals in drilling mud are associated with barite and are present as insoluble sulfide minerals in barite particles. Several laboratory and field studies have shown that the metals associated with drilling mud barite or cuttings piles have a low bioavailability to marine animals; they do not accumulate in the tissues of bottom-living animals (Neff, 2005).

Two processes dominate the distribution of barium in the marine environment. The first is its solubility coefficient, which limits the maximum concentration to approximately 24 µg/L. In surface waters dissolved barium is metabolized following the uptake pattern of phosphate (although it plays no part in biological processes), reducing surface concentrations to about 4 to 5 µg/L in the open ocean. Biological uptake means that it is not possible for barium to approach toxic concentrations in the dissolved form.

According to a study by Neff (1987), water column organisms will never be exposed to drilling mud for long enough or at sufficiently high concentrations to result in acute or sub-lethal responses.

Previous drilling activities within the Gulf of Thailand and at other locations have not resulted in significant changes in water quality as shown by environmental monitoring programmes conducted by Chevron (TetraTech, 2009).

The potential environmental impacts from drilling waste on seawater quality:

- May result in small, temporary and reversible changes in water quality;
- Affect a medium size area (i.e. impact outside the project area but within the concession block);
- May result in small, temporary changes in species and diversity.

The potential impact from drilling waste is likely to only result in a small change in seawater quality and is not likely to change the value of the environment. *The overall* ***significance*** *of potential environmental impacts from release of drilling waste on water quality is rated as* ***low****.*

5.3.2.3 *Production*

Operational Discharges (Wastewater and cooling water)

Wastewater during production consists of:

- Sewage water 5.6 m3/d
- Domestic wastewater 8.4 m3/d (**Table 2-34**) and
- Deck drainage from the FSO and platforms.

In addition, cooling water will also be discharged. Seawater will be taken for the purpose of cooling water. No chemicals will be added to the open loop cooling water before it is discharged to sea.

The wastewater streams, treatment and their potential impacts are discussed in *Section 5.3.2.1 Installation*. The daily amount of sewage and domestic wastewater generated during production is less than during installation; however, the generation of wastewater will occur for a much longer time.

Deck drainage from designated machinery spaces on the supply vessels and FSO is routed to a waste oil storage tank. Collected wastewater is then passed through an oil water separator to meet MARPOL discharge standard. Treated water with oil content less than15 ppm is discharged to the sea. Separated oil is collected in the slop tank and disposed through a waste contractor in accordance with applicable laws and regulations.

On the platforms, deck drainage is routed to the open drain system. Oil is separated from water in the open drain tank. The overflow oil is collected and pumped back to the system; the treated water is discharged overboard.

Deck drainage from areas that do not have the potential to contact oil or chemicals will be discharged directly overboard without prior treatment.

Cooling water will be discharged from the FSO. As the exact amount of cooling water will depend on the FSO that will be selected, the volume of cooling water is unknown at the time of writing. Cooling water will be discharged at a temperature of approximate 30°C (+/- 2°C). Measurements have shown that seawater temperature is comprised between 27.6°C and 31°C (see Chapter 3). The discharge of cooling water may potentially form a thermal plume very close to the point of release. The plume will disperse and its temperature falls rapidly to reach ambient seawater temperature.

In addition to domestic wastewater, deck drainage and cooling water, produced water will be generated during production. Produced water will be reinjected: therefore any discharge of produced water is considered an accidental release and is discussed in Section 5.8.3.

The potential impact from operational discharges is likely to only result in a small change in seawater quality and is unlikely to change the value of the environment. *The overall* ***significance*** *of the potential environmental impacts from operational discharge on seawater quality is therefore rated as* ***low****.*

5.3.2.4 *Abandonment*

Increased Turbidity (Sediment Disturbance)

Chevron will submit a separate EIA dealing with decommissioning of the Apsara production field. This decommissioning EIA will address potential impacts from well suspension and production

facilities decommissioning. At that time the details on specific abandonment methods will be developed.

Removal of production facilities and structures can re-suspend sediments, potentially leading to deterioration in seawater quality. The potential impacts are similar to those discussed for *Section 5.3.2.1. Installation*, which was rated as having a *low* level of *significance.*

The potential environmental impacts from well suspension and production facilities decommissioning activities on seawater quality:

- May result in small, temporary and reversible changes in water quality;
- Affect a small area (i.e. impact limited to within 500 m radius of the decommissioning areas);
- May result in small, temporary changes in species and diversity.

The potential impact from well suspension and production facilities decommissioning activities is likely to only result in a small change in seawater quality and is unlikely to change the value of the environment. *The overall potential environmental impacts from well suspension and production facilities decommissioning activities on water quality is rated as* ***low****.*

5.3.3 Ocean Sediment

5.3.3.1 Installation

Sediment Disturbance

Installation activities (i.e., rig placement, production and wellhead platforms installation, FSO installation, pipeline installation) will result in disturbance and temporary re-suspension of seabed sediments, however this disturbance will be limited to the localized area of installation.

The drilling rig, production platform and FSO placement is likely to only affect sediments near the areas where the legs are placed for the drilling rig, the production platform and wellhead platforms, and the mooring system for the FSO.

The areas affected are estimated at approximately:

- 15 m^2 for the drilling rig assuming a worst case scenario of using a Jack up rig rather than a tender rig.
- 11 m^2 for the FSO mooring system (6 piles 60" diameter),
- 1.2 m^2 for piling activities for the PLEM assuming a worst case scenario of piling (piles of 12" diameter) rather than gravity base,
- 5 m^2 for piling activities for the production platform (4 piles 48" diameter) and
- 4 m^2 for piling activities for each wellhead platform (4 piles 42" diameter).

The pipelines will be laid directly on the seabed without trenching or burial. The project is planning on using a Dynamic Positioning (DP) Barge to install the pipelines. DP barges maintain their position using thrusters and do not require anchors. Using DP barges limits the seabed disturbance. Should anchored lay barges be used for future Phase 1b and Phase 1c pipelines, anchors would disturb sediments as they are placed and moved. The direct disturbance of sediments from anchor placement will be limited to the small areas where anchors were placed. Disturbance of sediments will be limited to a strip 200m wide along the length of the pipelines, which should result in only minor sediment disturbance.

Although marine sediments in the Gulf of Thailand are finely textured, sediment dispersion and re-deposition during installation activities will be limited by the small volumes of sediment disturbed and the weak currents in the Gulf.

Surveys that have been conducted within Block A have not shown presence of sensitive marine seabed fauna or flora and therefore do not indicate that the sediments potentially affected by installation activities have value for conservation.

The potential environmental impacts from installation activities on sediment quality:

- May result in small, temporary and reversible changes in sediment quality;
- Affect a small area (i.e. impact limited to within 500 m radius of the installation areas);
- May result in small, temporary changes in sediment with no demonstrated value for conservation (low sensitivity).

The potential impact from installation activities is likely to only result in a small change in sediment quality and is unlikely to change the value of the environment. *The overall **significance** of potential environmental impacts from installation activities on sediment quality is rated as **low**.*

5.3.3.2 *Drilling*

As mentioned in the preceding section on water quality (*Section 5.3.2*), the Apsara wells will be drilled in several sections, using different mud systems. The mud and cuttings from the surface section will be disposed directly at the seafloor. The mud and cuttings from the remaining sections will be brought to the surface and cuttings drilled with WBM or NAF will be treated on the drilling rig. The separated mud will be reused for subsequent drilling. The cuttings and residual mud bound to the cuttings (drilling waste) will be discharged approximately 3 m below the seawater surface. WBM – if used - will also be discharged through the cuttings chute. The drilling discharges released in the water will disperse and settle on the sediment. Deposition of drilling discharges may alter benthic habitat (toxicity, enrichment, and substrate); and/or lead to smothering of benthic invertebrates.

Potential Sediment Quality Reductions (Drilling discharges Deposition)

Several of the muds are not regarded as harmful to the environment; some may be considered toxic to some aquatic biota when used at high concentrations (**Table 5-22**). There are no specific sediment guidelines for these chemicals. Any potential effect on sediment may result in potential toxicity to benthic biota. The potential effect of mud chemicals is therefore addressed for aquatic biota in *Section 5.4*.

Sediment Disturbance (Drilling & Well Completion, Drilling discharges Deposition)

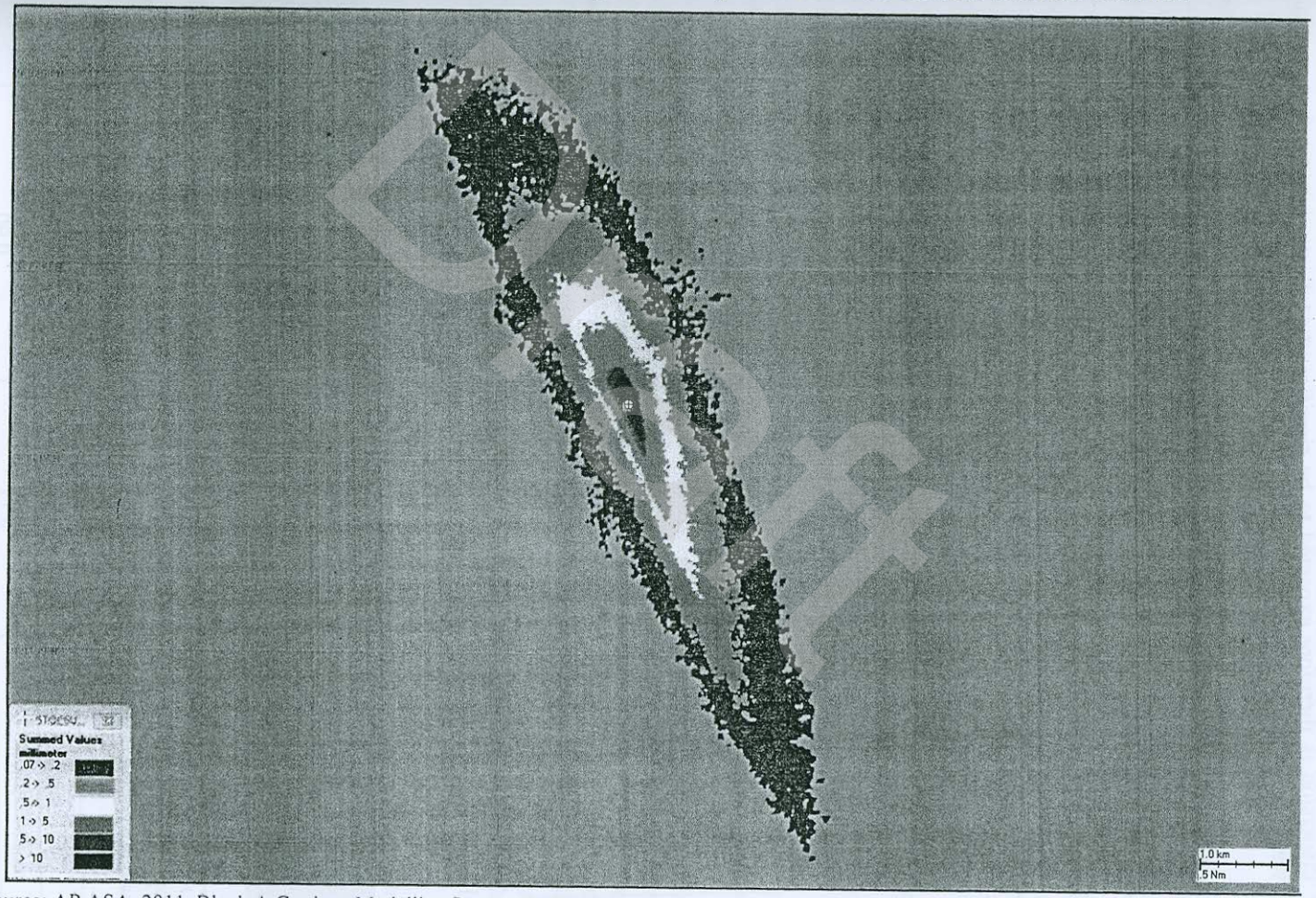
The expected dispersion and settling of discharged drill mud and cuttings material were modelled by Asia-Pacific Applied Science Associates (AP ASA) using the computer model MUDMAP. MUDMAP has been extensively validated and applied for discharge operations in coastal and offshore waters (Burns *et. al.*, 1999; King and McAllister, 1998, 1997; Livingston *et al.*, 2002). The modelling report is included as **Appendix 9**.

The transport and settlement of the drill cuttings and spent drilling mud was simulated in two stages. In the first stage, the circulation (or current patterns) of the receiving waters was estimated using a validated ocean/coastal model, HYDROMAP. In the second stage, the generated current data were used as input into the discharge model, MUDMAP, to predict the movement and ultimate fate of the discharged mud and cuttings. The drilling waste deposition of the initial 24 wells from platform A was modelled.

The model was configured to simulate:

- The drilling of wells in three separate batches over a six month period,

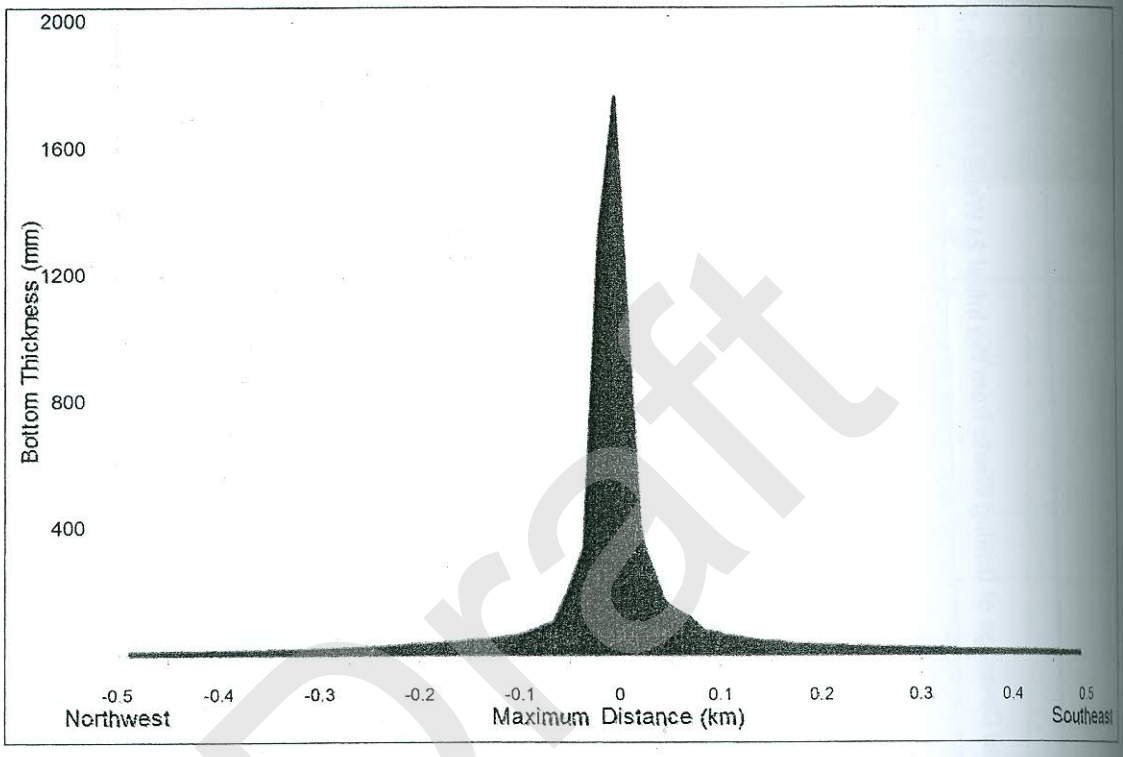
Figure 5-3: Estimated Thickness and Coverage of Drilling Waste from the Initial 24 Wells at Platform A



Source: AP ASA. 2011. Block A Cuttings Modelling Report (**Appendix 9**).

The modelling does not take into account the planned infill wells (approximately 16 wells per platform) that will be drilled later once oil production from the initial production wells tapers off. These infill wells will likely be drilled as sidetracks, which will generate fewer cuttings and residual mud than the original wells as they do not require a new surface section to be drilled. The extent of dispersion is therefore expected to be significantly less than that from the drilling of the initial 24 wells.

Figure 5-4: Estimated Total Deposition of Drilling Waste along the NW-SE (long) Axis



Source: Drill Cuttings and Drilling Mud Dispersion Modelling Report (**Appendix 9**).

Table 5-24: Estimated Coverage of Drilling Waste from Drilling the Initial 24 Wells at Platform A

Thickness range (mm)	Area of Coverage (km^2)	Percentage of Area Covered	Maximum distance (km) from the release site to the contour extent
0.07 - 0.2	6.88	54.84	5.70
0.2 - 0.5	3.57	28.46	3.92
0.5 - 1	1.14	9.05	2.40
1 - 5	0.75	6.01	1.56
5 - 10	0.09	0.73	0.60
>10	0.11	0.90	0.43
Total	**12.54**	**100**	

The cuttings pile consists mostly of cuttings with residual water based mud from the top well sections: these cuttings with residual mud are deposited directly onto the seafloor. Cuttings with residual water-based mud are less cohesive than oil-based mud and cuttings. In addition, slow bottom currents, storm surface waves, internal waves and eddies near the platform structure and possibly tides are expected to erode the cuttings pile (Black et. al.).

During the time between drilling the initial wells and the infill wells, the cuttings pile is expected to decrease. However, there might be some overlap of the initial drilling waste deposition and the drilling waste deposition of the infill wells. The combined height of the drilling waste pile could therefore increase slightly beyond 1.8 m and extend beyond the distance provided in **Table 5-24**.

Cuttings piles will be formed at each wellhead platform. The shortest distance between platforms is 2.6 km between Platform C and Platform D. Mud and cuttings could potentially involve overlap of the 1-mm contour (which extends 1.5 km; **Table 5-24**) if the cuttings piles align and overlap in the same direction due to tides and currents. This potential overlap is insignificant. Therefore there will be no significant overlap of the cuttings piles from the various platforms.

Drilling discharge may potentially result in impacts to the seabed sediment due to low levels of metals and hydrocarbons (from reservoir section) in the cuttings and metals and chemicals in the mud. Common mud constituents and their environmental hazard information are summarized in **Table 5-22**; many compounds are not regarded as harmful to the environment.

As discussed, the seabed drilling discharge deposition is expected to have a localised effect on ocean sediments with no demonstrated value for conservation (low sensitivity). Upon cessation of drilling activities, metal / hydrocarbon concentrations in surface sediments would be expected to gradually return to within the range of background conditions: the main mechanisms include redistribution, biodegradation, dissolution and re-suspension and transport by currents. The effectiveness of these mechanisms is supported by seabed sediment quality data obtained during post drilling monitoring programs conducted in the Gulf of Thailand in similar environments, which show that low levels of metals and hydrocarbons were recorded in seabed sediment with little variation around wellhead platforms (TetraTech 2009). The exception was Barium, which however is regarded as an indicator of drilling activities having taken place and is considered to be relatively persistent in the marine environment. However, barium sulphate (Barite) present in drilling fluids is not bioavailable nor is it toxic.

The potential environmental impacts from the disposal of mud and cuttings on ocean sediment:

- May result in medium, temporary and reversible changes in sediment quality;
- Affect a small area (i.e. impact limited to within 500 m radius of the drilling areas);
- May result in small, temporary changes in sediments with no demonstrated value for conservation (low sensitivity).

The potential impact from drilling waste deposition is likely to only result in a small change in sediment quality and is unlikely to change the value of the environment. *Therefore, the* ***significance*** *of potential impacts associated with mud and cuttings disposal on ocean sediments is rated as* ***low***.

5.3.3.3 Production

During production, no changes in ocean sediments are expected from the project's activities.

Sediment Quality

The flaring of natural gas from Platform A may release mercury into the environment where it may fall into the sea and eventually sink to the seafloor. The potential impact of mercury release from

flaring on air quality was rated as insignificant (*Section 5.3.1.3*) and therefore the potential impact on sediment quality is rated as insignificant.

5.3.3.4 Abandonment

Sediment Disturbance

The potential effects of well suspension and production facilities decommissioning during the abandonment phase of the project on ocean sediments are similar to the potential effects discussed under the Seawater Quality section (*Section 5.3.3*).

The potential environmental impacts of well suspension and production facilities decommissioning on ocean sediments:

- May result in medium, temporary and reversible changes in sediment quality;
- Affect a small area (i.e. impact limited to within 500 m radius of the drilling areas);
- May result in small, temporary changes in sediments with no demonstrated value for conservation.

The potential impact from abandonment activities is likely to only result in a small change in sediment quality and is unlikely to change the value of the environment. *Therefore, the **significance** of potential impacts associated with abandonment activities on ocean sediments is rated as **low**.*

5.4 Assessment of Potential Impacts on Ecological Resources

COPCL implements strict operational procedures to prevent accidental releases. An accidental release is therefore considered an unplanned event and any potential impact of accidental releases on ecological resources is discussed under unplanned events.

5.4.1 Marine Biota

5.4.1.1 Installation

Noise

Table 5-25 shows the typical underwater noise levels for activities associated with offshore oil production. It is assumed that the noise levels for the project activities fall within the typical ranges shown in **Table 5-25**.

Surface noise can potentially directly and indirectly impact seabirds while underwater noise can potentially directly and indirectly impact fish and marine mammals. Seabirds and marine mammals in close proximity to the noise source would likely be disturbed; injury could also occur from underwater noise depending on the noise levels, proximity of the marine mammals and sensitivity of the species to noise.

Surface noise effects on birds may include hearing loss, increased heart rate, and increased time for egg-hatching. Also, noise can result in behavioural changes, such as fright reactions, altered mating behaviour, flushing and desertion of nests (Dufour 1980) but many of these effects do not apply in offshore settings and any seabirds in the area would likely react to noise by a fright reaction resulting in avoidance of the area The potential effect of surface (air borne) noise is therefore not further assessed as the potential impact is not considered significant.

Table 5-25: Typical Underwater Noise Levels from Offshore Oil Installation Activities

Project Activity	Source	Noise Level	Reference
Vessels (installation, crew, material transport, rig transportation etc)	Vessel	110 dB(A) (Engine Room) Frequencies: 20-1000 Hz	Bahtiarian (1998)
Piling activities	Installation – piling	160-262 dB at 1m	as collated in BP (2010)

The use of sound by marine animals is widespread and may involve passive listening and/or active communication or echolocation systems. Sound is used by most marine animals (ranging from invertebrates to the great whales) and is far more common among tropical species of invertebrates and fishes than generally perceived. Many marine animals can produce very intense focused sounds. The highest source level yet measured is within the beam of a bottlenose dolphin *(Tursiops truncatus)* echolocation click, at 229 dB re 1 μPa-m (peak-peak value) over a broad band up to 120 kHz (McCauley, 1994).

Fish are able to detect low-level noise up to several km from its source, and normally avoid noise levels greater than 160 dB. Pathological damage is possible at noise levels greater than 230 dB (McCauley, 1994). Potential effects from noise on marine mammals include changes in hearing sensitivity and behavioural patterns, including changes in vocalization behaviour, breathing, diving patterns, and active avoidance of noise sources (Ocean Studies Board, 2003).

The main source of underwater noise during the installation phase is from piling activities (JNCC, 2008). Pile driving activities will be required to install the platforms legs, and potentially the moorings of the FSO. Noise levels from pile driving in the marine environment without mitigation are likely to result in adverse avoidance reactions, hearing impairment and possible death of marine mammals that are in very close proximity (JNCC, 2010).

The following mitigation measures will be implemented to verify that marine mammals are not at close proximity of the piling activities:

- The mitigation zone will be monitored visually by Marine Mammal Observers for 30 min prior to the commencement of piling.
- Piling will not be commenced if marine mammals are detected within the mitigation zone (500 m radius around piling site) or until 20 minutes after the last visual or acoustic detection.
- The soft-start is the gradual ramping up of piling power, incrementally over a set time period, until full operational power is achieved. The soft-start duration will be a period of 20 minutes. It is believed that by initiating piling at a lower power this will allow for any marine mammals to move away from the noise source, and reduce the potential for exposing the animal to sounds which can cause injury.

With implementation of mitigation measures, it is expected that the likelihood of marine mammals being at close proximity of the sound source be small. The potential environmental impacts of noise resulting from installation activities on marine biota:

- May result in small effects on and temporary avoidance reactions by marine biota;
- Affect a small area (i.e. impact limited to within 500 m radius of the piling areas);
- May result in small and temporary changes in species and diversity.

With implementation of mitigation measures, the ***significance*** *of potential noise impacts during installation on marine biota is therefore rated as* ***low****.*

Operational Discharges (Wastewater)

Disposal of wastewater into seawater could affect seawater quality and thus marine biota. The effects of intentional discharges on seawater quality were discussed in *Section 5.3.2.1*, and were rated of low significance.

*Thus, the **significance** of potential impacts from operational discharges of wastewater during installation on marine biota is rated as **low**.*

Sediment Disturbance

The effects of rig placement, production platform and wellhead platform installation and FSO installation will result in increased turbidity and disturbance of sediments. This may affect marine biota. These effects on seawater and sediment quality were discussed in *Sections 5.3.2.1 and 5.3.3.1*, and were rated of low significance.

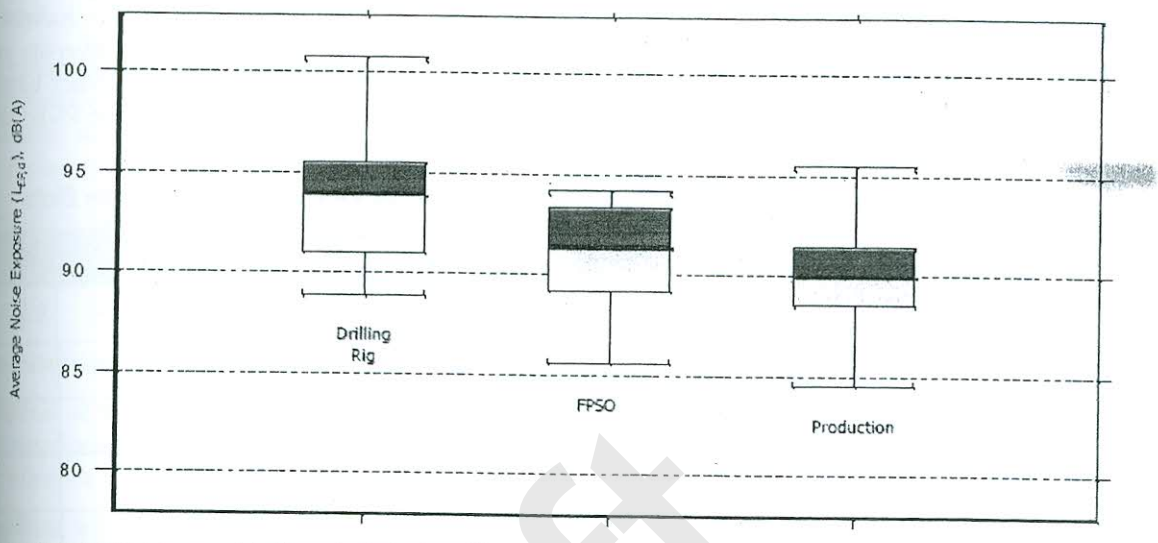
*Thus, the **significance** of potential impacts from sediment disturbance during installation on marine biota is rated as **low**.*

5.4.1.2 Drilling

Noise

Drilling activities have the potential to generate underwater noise resulting in potential disturbance of marine biota (JNCC, 2008). **Figure 5-5** shows average noise levels from offshore oil and gas operations. The median noise level for drilling rigs is below 95 dB(A). In addition, Evans and Nice (2006) indicated a noise level of 85-127 dB(A) (at source) and <25 dB(A) at 100 m from a drilling rig during the installation of wells. The noise level from drilling activities is much less than the noise level from piling activities (160-262 dB(A)), discussed in *Section 5.4.1.1* and rated of low significance. Furthermore, drilling noise is considered to be of low concern in terms of disturbance to cetaceans (JNCC, 2008). At the expected noise levels, pathological damage to fish (230 dB; McCauley, 1994) is unlikely. Studies of short-term behavioural responses of gray whales to underwater noise from offshore oil and gas activities indicate that some whales usually change their swimming course when continuous sound exceeds ca 120dB and when intermittent noise exceeds ca 170dB (Moore and Clarke 2002). Some of the higher noise levels may result in avoidance reactions by fish, seabirds and marine mammals. Thus, noise levels during drilling are not expected to significantly impact marine biota.

Figure 5-5: Average Noise Levels on Offshore Drilling Rigs, FPSO and Production Platform



Source: http://www.hse.gov.uk/offshore/noise/noise.pdf

The potential environmental impacts of noise resulting from drilling activities on marine biota:

- May result in small effects on and temporary avoidance reactions by marine biota;
- Affect a small area (i.e. impact limited to within 500 m radius of the drilling areas);
- May result in small and temporary changes in species and diversity.

*Thus, the **significance** of potential noise impacts during drilling on marine biota is rated as **low**.*

Operational Discharges (Wastewater)

Disposal of wastewater into seawater could affect seawater quality and thus marine biota. The effects of discharges on seawater quality were discussed in *Section 5.3.2.1*, and were rated of low significance.

*Thus, the **significance** of potential impacts from operational discharges during drilling on marine biota is rated as **low**.*

Operational Discharges (Drilling Mud and Cuttings)

Drilling discharges disposal may affect marine biota through exposure to potentially toxic chemicals in the residual drilling mud, an increase in suspended sediments in the water column, and smothering of benthic organisms/fish eggs by physical deposition of mud and cuttings on bottom sediments.

The concentration of mud chemicals in the sediment will be low through: dilution in the drilling mud itself, further dilution with cuttings, removal by the treatment system on the drilling rig, dilution/dispersion once released in seawater. Information on most sensitive toxicity to aquatic organisms and concentration in drilling mud are summarized in **Table 5-26**. The concentration in the undiluted, untreated drilling mud is well below that which could result in potential toxic effects; the concentration in treated drilling waste will be even lower.

The most significant potential impact drilling discharges may have is the smothering effect on benthos communities on the seabed in vicinity of the discharges.

A study of environmental effects, monitoring data, and literature review indicate that benthic organisms are commonly affected by drilling discharges through changes in diversity and abundance, most common within 50 to 500 m of the drill site. Cuttings piles could smother benthic organisms within 100 m of the drill site, although no quantification of the effect could be found. Mobile species are likely to avoid the area (Hurley and Ellis, 2004).

Table 5-26: Potential Toxicity of Drilling Mud Chemicals to Marine Biota

Mud Chemical	Most Sensitive Toxicity[1]	Max Mud Concentration[2]	Potential Toxicity in Drilling Waste
Barite	Rainbow trout 4-d LC50 76,000 mg/L	44 µg/L	minimal
Xanthan Gum	Fish: rainbow trout 96-hr TLM 320-560 mg/L	2.5 ppb	minimal
PAC	Fish: golden orfe 96-hr TLM >500 mg/L	2 µg/L	minimal
DESCO	Crustacean: *Acartia tonsa* 48-hr EC50 73.2 mg/L	0.5 µg/L	minimal
Primary Emulsifier	Algae: EC50: 8.4 mg/l (Skeletonema costatum)	18 µg/L	Expected to be minimal
Secondary Emulsifier	Crustaceans:TLM48: 199.4 mg/l (Acartia tonsa)	8 µg/L	Expected to be minimal
Gilsonite	Crustaceans:TLM96: 717,000 ppm (Mysidopsis bahia) SPP @ 20 ppb	8 µg/L	Expected to be minimal
Pliolite	Non-hazardous to waters	2.5 µg/L	Expected to be minimal
Organophylic Clays	NA	1.5 µg/L	Expected to be minimal
Lime	Fish: Atlantic silverside 4-d LC50 37 µg/L Crustacean: *Acartia tonsa* 1-d LC50 <50 µg/L	8 µg/L	minimal
Calcium Chloride	Fish: inland silverside 7-d IC25 growth 0.0397 M Crustacean: opossum shrimp 2-d NOEC mortality 260 mg/L	20 µg/L	minimal
Saraline 185v	Non toxic to aquatic organisms	0.7 ppb	minimal

Note: [1]lowest values from Table 5-22; [2] highest concentrations in drilling mud from Table 2-8

Peterson et al (1996) also found that the impacts from mud and cuttings on benthic vertebrates around platforms in the Gulf of Mexico were confined to within 100 to 200 m of the platforms.

A search for effect data for smothering or burial on marine biota resulted in a data set containing 39 effect values for 32 species (24 molluscs, 5 crustaceans, and 3 polychaetes). For burial the 50% and 5% hazardous levels were determined at 5.4cm (3.7–7.9) and 0.63cm (0.31–1.06) cm, respectively. The effect data were based on instantaneous and complete burial. However, drilling discharges settle formation of the burying layer is a slow process. Normally, non-sessile species are slowly covered by over time and marine biota are expected to have time to escape burial and move upwards at a rate equal to the deposition rate (Smit et al. 2008). This will allow some mobile marine biota to escape. Deposition of mud and cuttings thicker than 1 cm affects 0.11 km^2 and is contained within 430 m from the release site. Deposition of 5 cm is contained within about 110 m (**Figure 5-3**). Some marine biota, and especially non mobile ones, are however expected to be smothered. No sensitive species have been found during the surveys, therefore the sensitivity of the smothered fauna is expected to be low.

Re-colonization by benthic communities can be extremely rapid. Studies have shown maximum abundance, total biomass, diversity of benthic organisms after 20 to 24 weeks and the same quantity as background after 4 to 8 months (Diaz-Castaneda et al., 1989).

Re-colonization is expected for most of the cuttings pile. As outlined in *Section 5.3.2.2*, the significance of potential impacts associated with the deposition of drilling mud and cuttings on sediment was rated as low and the expected overall potential impacts on marine biota are expected to be similar for most of the affected area.

*Therefore, the **significance** of potential impacts associated with mud and cuttings on marine biota is rated as **low**.*

5.4.1.3 Production

Operational Discharges (Wastewater and Cooling water)

Disposal of wastewater into seawater could affect seawater quality and thus marine biota. The effects of operational discharges on seawater quality were discussed in *Section 5.3.2.1*, and were rated of low significance.

Seawater will be taken to serve as process cooling water and for use in the freshwater maker. The intake will be designed to exclude large debris and living organisms. Fish are expected to swim at speeds that would prevent their intake into the system. Some insignificant amount of fish may be drawn in, however, that would not result in perceptible impacts to fish populations.

Free floating organisms such as plankton may be entrained into the intake. Once entrained into the open loop cooling water system, some organisms are likely to be killed by the change of temperature, while some others (e.g.: some zooplankton species) may have higher survival rates. Organisms drawn in into the water that goes to the fresh water system are expected to have a 100% mortality rate as the water will be treated to be desalinated.

The relative intake is not significant with regards to the overall mass of seawater and habitat available. The overall impact will be localized to the FSO area and is not expected to result in perceptible impact to plankton populations.

The significance of the potential effects of cooling water on marine biota is therefore rated as low.

*Thus, the **significance** of potential impacts from operational discharges during production on marine biota is rated as **low**.*

Operational Releases (Flaring)

The flaring of natural gas from Platform A may release mercury into the environment where it could fall into the sea and eventually sink to the seafloor. Mercury in seawater and sediments may impact marine biota. In aquatic organisms, mercury binds to proteins and alters protein production or synthesis. Resulting toxicological effects include reproductive impairment, growth inhibition, developmental abnormalities, and altered behavioural responses (NOAA, 2003).

Toxicity of mercury is influenced by the form of mercury (inorganic mercury is less acutely toxic to aquatic organisms than methylmercury), the environmental media, environmental conditions (toxicity was found to be greater at elevated temperatures, lower oxygen content, reduced salinities in marine environments, and in the presence of metals such as zinc or lead), the sensitivity or tolerance of the organism, and the life history stage (NOAA, 2003).

Mercury is accumulated by fish, invertebrates, mammals and aquatic plants. And the concentration tends to increase with increasing trophic level (mercury biomagnifies). Although inorganic mercury

Re-colonization by benthic communities can be extremely rapid. Studies have shown maximum abundance, total biomass, diversity of benthic organisms after 20 to 24 weeks and the same quantity as background after 4 to 8 months (Diaz-Castaneda et al., 1989).

Re-colonization is expected for most of the cuttings pile. As outlined in *Section 5.3.2.2*, the significance of potential impacts associated with the deposition of drilling mud and cuttings on sediment was rated as low and the expected overall potential impacts on marine biota are expected to be similar for most of the affected area.

*Therefore, the **significance** of potential impacts associated with mud and cuttings on marine biota is rated as **low**.*

5.4.1.3 Production

Operational Discharges (Wastewater and Cooling water)

Disposal of wastewater into seawater could affect seawater quality and thus marine biota. The effects of operational discharges on seawater quality were discussed in *Section 5.3.2.1*, and were rated of low significance.

Seawater will be taken to serve as process cooling water and for use in the freshwater maker. The intake will be designed to exclude large debris and living organisms. Fish are expected to swim at speeds that would prevent their intake into the system. Some insignificant amount of fish may be drawn in, however, that would not result in perceptible impacts to fish populations.

Free floating organisms such as plankton may be entrained into the intake. Once entrained into the open loop cooling water system, some organisms are likely to be killed by the change of temperature, while some others (e.g.: some zooplankton species) may have higher survival rates. Organisms drawn in into the water that goes to the fresh water system are expected to have a 100% mortality rate as the water will be treated to be desalinated.

The relative intake is not significant with regards to the overall mass of seawater and habitat available. The overall impact will be localized to the FSO area and is not expected to result in perceptible impact to plankton populations.

The significance of the potential effects of cooling water on marine biota is therefore rated as low.

*Thus, the **significance** of potential impacts from operational discharges during production on marine biota is rated as **low**.*

Operational Releases (Flaring)

The flaring of natural gas from Platform A may release mercury into the environment where it could fall into the sea and eventually sink to the seafloor. Mercury in seawater and sediments may impact marine biota. In aquatic organisms, mercury binds to proteins and alters protein production or synthesis. Resulting toxicological effects include reproductive impairment, growth inhibition, developmental abnormalities, and altered behavioural responses (NOAA, 2003).

Toxicity of mercury is influenced by the form of mercury (inorganic mercury is less acutely toxic to aquatic organisms than methylmercury), the environmental media, environmental conditions (toxicity was found to be greater at elevated temperatures, lower oxygen content, reduced salinities in marine environments, and in the presence of metals such as zinc or lead), the sensitivity or tolerance of the organism, and the life history stage (NOAA, 2003).

Mercury is accumulated by fish, invertebrates, mammals and aquatic plants. And the concentration tends to increase with increasing trophic level (mercury biomagnifies). Although inorganic mercury

is the dominant form of mercury in the environment and is easily taken up, it is also eliminated relatively quickly. Methylmercury accumulates quickly, eliminates very slowly, and therefore biomagnifies in higher trophic species. The percentage of methylmercury as compared to total mercury also increases with age in both fish and invertebrates (NOAA, 2003).

The potential impact of mercury release from flaring on seawater and sediment quality was rated as insignificant (*Sections 5.3.2.3* and *5.3.3.3*) and therefore the potential impact on marine biota is rated as insignificant.

5.4.1.4 Abandonment

Noise

Decommissioning activities (including well abandonment) have the potential to generate underwater noise resulting in potential disturbance of marine biota (JNCC, 2008). When offshore installations (however small or large) reach the end of their useful life the installation will be removed from the seabed. This could involve cutting of the structure using a variety of tools or the use of explosives. Non-explosive cutting technology produces relatively little noise production, while explosive use can potentially result in disturbance, injury and even death to a cetacean.

At the time of writing, details on decommissioning activities are not available. Chevron will submit a separate EIA dealing with decommissioning of the Apsara production field. This decommissioning EIA will outline decommissioning details and address potential noise impacts from these activities. Mitigation measures outlined for piling activities will be implemented if warranted.

*With implementation of mitigation measures, the **significance** of potential noise impacts during decommissioning on marine biota is therefore rated as **low**.*

Operational Releases (Wastewater)

At the time of writing, details on decommissioning activities are not available; therefore no estimated emissions resulting from that phase can be presented. Emissions are expected to be in the same order of magnitude as those during installation, which were discussed in *Section 5.3.2.1*, and were rated of low significance.

*Thus, the **significance** of potential impacts from operational releases during abandonment on marine biota is rated as **low**.*

Sediment Disturbance

The potential effects of well suspension and production facilities decommissioning during the abandonment phase of the project on marine biota are similar to the effects discussed under the Seawater and Sediment Quality sections (*Section 5.3.2.4* and *5.3.3.4*).

The potential impact of abandonment activities on seawater and sediment quality was rated as low (*Section 5.3.2.4* and *5.3.3.4*) and therefore the potential impact on marine biota is rated as low.

5.4.2 Endangered Species

Endangered species potentially present in the project area include dugongs, dolphins, whales, and turtles.

The endangered dugong (*Dugong dugong*) typically inhabits shallow coastal areas where seagrass is abundant. Chapter 3 contains the known locations of major seagrass beds along the Cambodian coastline. The seagrass bed closest to the concession block is at least 140 km to the northeast.

Twenty-one species of dolphins, porpoises and whales have been found in the Gulf of Thailand (Lekagul and McNeely 1988). Although little information on dolphins and whales in Cambodian

waters is available or documented, it is conceivable that dolphins and whales could occasionally traverse the project area.

Four of the five turtle species in the Gulf are endangered. Marine turtles live mostly in the open sea. Several nesting areas have been identified in Cambodian seas. Green turtles frequent shallow seas with abundant seagrass; the seagrass bed closest to the concession block is at least 140 km to the northeast.

Fishers have reportedly sighted crocodiles, probably Saltwater Crocodiles (*Crocodylus porosus*), in Koh Kong estuaries and Prek Toek Sap (UP-MSI, ABC, ARCBC, DENR, ASEAN, 2002). The estuary with sighted crocodiles closest to the concession block is at least 140 km to the northeast.

Endangered species potentially affected by project activities are therefore the occasional individuals travelling through the project area and endangered species in areas near transportation routes.

5.4.2.1 All Project Phases

Noise

All project phases activities generate noise (**Table 5-25** and **Figure 5-5**), which could affect marine biota and endangered species. The effects of noise on marine biota and endangered species were discussed in *Sections 5.4.1.1* and *5.4.1.2*, and the potential impact on marine biota was rated of low significance.

Two areas have been identified where endangered species could potentially be affected by project noise:

- The occasional endangered species travelling through the project area would be exposed to noise from project activities (Table 5-25 and Figure 5-5).
- The endangered species within sensitive areas such as seagrass beds or estuaries may be exposed to noise from the occasional vessel transporting crew and materials travelling near these areas.

Avoidance reactions because of project noise are likely (*Section 5.4.1.1 and 5.4.1.2*). Furthermore, the presence of endangered species in the project area is rare. Mitigation measures during pile driving activities will be employed to reduce the likelihood that sensitive endangered species are at close proximity.

Vessels will only be near shallow waters when approaching Sihanoukville, which is already a busy port. The potential extent and duration of exposure to noise is therefore extremely small. The incremental noise associated with project traffic close to shore is not expected to be significant.

*The **significance** of potential noise impacts during all project phases on endangered species is rated as **low**.*

Operational Discharges (Wastewater and Hydrotest Water)

Disposal of wastewater into seawater during all project phases and hydrotest water during the commissioning phase could affect marine biota and thus endangered species. The effects of operational discharges on marine biota were discussed in *Section 5.4.1.1*, and were rated of low significance.

Sewage from the FSO will be treated before being discharged therefore is not expected to result in any potential impacts to marine species. Discharges of cooling water is not expected to impact endangered species.

*Thus, the **significance** of potential impacts from operational discharges during all project phases on endangered species is rated as **insignificant**.*

Operational Discharges (Drilling Mud and Cuttings)

Drilling discharges disposal during the drilling phase may potentially affect endangered species through exposure to potentially toxic chemicals in the drilling mud and an increase in suspended sediments in the water column. The effects of drilling discharges on marine biota were discussed in *Section 5.4.1.1*, and were rated of low significance.

The occasional endangered species travelling through the project area during drilling could be exposed to drilling discharges. Avoidance reactions because of the drilling noise are likely; the potential extent and duration of exposure to drilling discharges is therefore considered insignificant.

Areas most likely to have endangered species are seagrass, wetlands, nesting areas, and estuaries. The location of seagrass, wetlands, nesting areas, and estuaries is located at least 140 km to the north-east of the project area. The extent of drilling waste deposition is only 5.7 km from the release site (**Table 5-24**). The areas most likely to have endangered species would therefore not be impacted.

*Thus, the **significance** of potential impacts from drilling waste releases on endangered species is rated as **insignificant**.*

5.5 Assessment of Potential Impacts on Human Use of Resources

COPCL implements strict operational procedures to prevent accidental releases. An accidental release is therefore considered an unplanned event and any potential impact of accidental releases on human use of resources is discussed under unplanned events.

5.5.1 Fishing

The potential impacts on fish are discussed under Marine Biota (*Section 5.4.1*). This section focuses on the potential impacts related to the capture and sale of fish.

5.5.1.1 All Project Phases

Exclusion Area

To prevent collisions, an exclusion zone around Chevron's facilities and activities will be enforced. No fishing will be allowed in these areas for safety reasons.

The installation, drilling, production and abandonment phase of the project will result in a closure of a 500m "Safety Zone" around all Platforms and around the FSO/Calm Buoy.

The total loss of fishing area as a result of the fishing exclusion zones in the Apsara production field will amount to a total of approximately 8.6 km^2 (**Table 5-27**).

Table 5-27: Calculated Areas of Fishing Exclusion Zones that will be Implemented Around Infrastructure of the Apsara Production Field

Infrastructure	Fishing Exclusion Zone (km^2)
Platform A and FSO	1.58
Platform B	0.79
Platform C	0.79
Platform D	0.79

Infrastructure	Fishing Exclusion Zone (km^2)
Platform E	0.79
Platform F	0.79
Platform G	0.79
Platform H	0.79
Platform I	0.79
Platform J	0.79
Total Area	**8.6**

This will reduce the current available fishing area, limit fishing traffic, could potentially result in the removal of fishing equipment, thereby affecting the income and employment of those involved in fishing. Block A is 157km from shore. Few fishing vessels are fishing in this remote area. In addition, the potentially impacted area is small, compared to the total remaining available area (approx. 6,264 km^2) in Block A that will have no such exclusions on fishing. The exclusion zone is a paramount safety feature.

Therefore the ***significance*** *of potential impacts from installation and production activities on fishing is rated as* ***low*** *in terms of a reduced fishing area.*

It should be noted that the fishing exclusion zones that will be implemented will essentially function as marine reserves which may have a positive ecological impact from the standpoint that marine life population within the fishing exclusion zones could actually flourish in the absence of fishing.

Operational Discharges

Wastewater, Hydrotest Water - Fishing may be affected if fish coming into contact with released wastewater and testing chemicals. The potential toxicity impacts on fish are discussed under Marine Biota (*Section 5.4.1*), and the effects were rated of low significance.

Taint however is an aspect which may hamper the sale of fish or other seafood. Taint of fish and seafood is an odour or flavour that is foreign to marine biota. The specific compounds responsible for petroleum taint in seafood have not been unequivocally determined. However, elevated levels of polycyclic aromatic hydrocarbons (PAHs) (such as naphthalene) and derivative products have associated with tainting (Yender et al. 2002).

Testing water and domestic wastewater does not contain petroleum hydrocarbons and would therefore unlikely to result in tainting. Deck drainage is treated through the oil-water separator. Any amount of oil released from deck drainage would be quickly diluted and would therefore unlikely to result in tainting.

The ***significance*** *of potential impacts from the discharge of wastewater and hydrostatic test water on fishing is rated as* ***negligible****.*

Food Waste - Food waste will be macerated before being discharged from the FSO in accordance with MARPOL 73/78 requirements.

Releases of food waste are known to attract fish around platforms. This could be a beneficial/ positive impact on fish and indirectly fishing as it will contribute to increase in fish stocks.

Drilling Waste - Fishing may be affected if fish coming into contact with released drilling discharges, become tainted as a result and difficult for fishermen to sell.

An overview of potential environmental effects of non-aqueous drilling fluids however indicated that these fluids did not result in tainting of fish, mussels or scallops (OGP, 2003). In addition, several extensive studies indicated no evidence of tainting from drilling waste:

- Studies in the North Sea to evaluate the effect of oil and gas operations on fish have not found evidence of hydrocarbon taint (CAPP, 2001).
- Environmental effects monitoring of drilling discharges near production installation did not find any tainting or toxicity (Buchanan et al., 2003).
- Taint was not detected for any of the species tested within nine Canadian environmental effects monitoring (EEM) programs, except for blue mussels at COPAN (which discharged more toxic low toxicity mineral oil mud; Hurley and Ellis, 2004).

As discussed under seawater quality and marine biota (*Sections 5.3.2* and *5.4.1*), released drilling waste would only affect the local area over a short-term period. No oil-based mud or low toxicity mineral oil will be used for drilling the wells. Therefore, release of drilling waste is not expected to result in tainting and will therefore not affect fishing.

*The **significance** of potential impacts from the discharge of drilling waste on fishing is rated as **negligible**.*

5.5.2 Shipping

5.5.2.1 All Project Phases

Exclusion Area

To prevent collisions, an exclusion zone around Chevron's facilities and activities will be enforced. No shipping will be allowed in these areas for safety reasons.

This will limit the areas available for shipping traffic during all phases of the project. This could potentially result in slight detours for shipping. All platform locations will be marked on nautical charts.

The total impacted area however is small (8.6 km^2, **Table 5-27**), compared to the total remaining available area (approx. 6,264 km^2) in Block A that will have no such restrictions on shipping.

*Therefore the **significance** of exclusion areas on shipping is rated as **low.***

Increased Shipping

Crew/materials transport will result in increased shipping, as outlined in **Table 5-28**. The maximum number of vessels operating at any one time is expected to be of 4 during installation of Platform A. The only regular shipping traffic will be during production when 2 vessels will regularly travel between Sihanoukville and the project location. These few additional vessels will not significantly affect shipping traffic or shipping routes.

Table 5-28: Marine Transport for Apsara Project

	Project Phase	Activity	Vessels
Installation	Phase 1a	Platform A Installation	DLB*, 2xTransport Tug + support vessel, supply vessel 2 trips
		Hook-up and Commissioning	Crew Boat, support vessel, supply vessel 4 trips
		Pipeline Installation	DLB, 1xTransport Tug, supply vessel 2 trips
	Phase 1b&c	Flowline installation	DLB, 1xTransport Tug per platform

	Project Phase	Activity	Vessels
		Platform Installation	DLB, 1xTransport Tug + Support vessel supply vessel 1 trip per platform
		Hook-up and Commissioning	Crew Boat, Support Vessel supply vessel 3 trips per platform
Drilling	Phase 1a,b,c		Tender or Jack Up rig, 2 supply vessels
Production	Phase 1a,b,c		1 supply vessel 1 crew boat

*DLB Derrick Lay Barge

*Therefore the **significance** of increased transport on shipping is rated as **negligible**.*

5.5.3 Tourism

5.5.3.1 All Project Phases

Operational Discharges (Wastewater, Hydrotest Water, Drilling Cuttings and Water Based Mud)

Operational discharges are rapidly diluted once released into seawater. The largest discharge is drilling waste. As discussed in Section 5.3.2.2, drilling waste discharges are diluted to very low concentrations usually within 1-2 km down current of the release.

Tourist destinations would include areas with coral, seagrass and sensitive species; these would therefore be nearshore areas, in shallow waters.

The project location is 157 km from Sihanoukville and is therefore not a tourist destination. The closest island is Poulo Wai, 120km from Sihanoukville, and approximately 40km from Block A. The discharges affect only a small area around the drilling rig, platforms and FSO. The discharges would therefore not be seen by tourists nor affect tourist areas or livelihood.

*The **significance** of operational discharges on tourism is rated as **negligible**.*

Reduced Attractiveness (Noise, Traffic)

The location of the proposed shore base at Sihanoukville is likely to increased traffic volumes in the area from transportation of waste and crew and supplies.

Increased Traffic due to Waste Generation

The total amount of solid waste produced includes food waste, non-hazardous solid waste and hazardous solid waste.

Food Waste from kitchens and canteens will be kept separate from non-food waste (such as packaging). As per MARPOL Annex V regulation (Garbage), food waste will be macerated in an offshore macerator and discharged overboard. There will be no increased noise and traffic from food waste generation.

Non-Hazardous Waste includes packaging, paper, plastic, and other uncontaminated materials (e.g.: uncontaminated wood, scrap metal). Non hazardous waste will be generated from canteens, living quarters and offices, and process area. Non hazardous waste will be transferred from the drilling rig, supply vessels, platforms and FSO to the shorebase at Sihanoukville Autonomous Port and disposed of by a COPCL-approved licensed waste contractor. The total amount per year during production is

estimated as approximately 161 tonnes per year (**Table 2-36**). The number of trucks required to transport this waste are minor (estimated at approximately 16 trucks per year at 10 ton capacity).

Hazardous Waste includes the following: Oily rags; Used oil; Paint waste; Electronic waste; Spent lube oil, greases and hydraulic fluids; Batteries; Fluorescent Tubes; and Spent metallic filters. Hazardous waste will be recycled back to the process when feasible (e.g.: used oil), sludge will be reinjected if feasible (at the time of writing the feasibility of reinjection is under assessment) or segregated from non hazardous waste, brought back to shore and disposed of by a COPCL approved and licensed contractor. Waste streams that cannot be safely disposed of in Cambodia will be exported overseas for safe and environmentally acceptable treatment. The total amount per year during production could reach 108 tonnes per year at later stages of production (**Table 2-36**). The number of trucks required to transport this waste are minor (estimated at 11 trucks per year at 10 ton capacity).

Increased Traffic due to Crew and Supply Transport

Crew and supply vessels will travel to and from the production site. The number of vessels operating regularly at any one time is estimated at 2 during operation of Platform A (**Table 5-28**). Numbers are not expected to go significantly up during Phase 1b and Phase 1c. Considering that Sihanoukville is the main industrial sea port in Cambodia, the incremental two vessels from COPCL's project will not significantly affect shipping traffic or shipping routes.

The increase in traffic is small and would not significantly affect access to tourism infrastructure or livelihood.

*The **significance** of shore base support on tourism is rated as **low**.*

5.6 Quality-of-Life Values

5.6.1 Socio-Economy

5.6.1.1 All Project Phases

Many project activities are likely to benefit the local economy by creating employment, purchasing local goods/materials and through the engagement of local service providers or sub-contractors. The project may also benefit the Cambodian economy as a result of royalties paid to the Cambodian Government.

*Therefore the **significance** of the potential impacts on the socio-economy is rated as **beneficial**.*

5.6.2 Visual Aesthetics

5.6.2.1 All Project Phases

Operational Discharges (Wastewater, Hydrostatic Test Water, Drilling Discharges)

Operational discharges are rapidly diluted once released into seawater. The largest discharge is drilling waste (cuttings and mud). As discussed in Section 5.3.2.2, drilling discharges are diluted to very low concentrations, usually within 1-2 km down current of the release.

The project location is 157 km offshore and is not a tourist destination. The closest island is Poulo Wai, approximately 40 km from Block A. It is not an important tourist destination.

The discharges are likely to affect only a small area around the drilling rig, platforms and FSO. Because there are no to few visitors in the area, discharges would therefore not be seen by visitors or people on Poulo Wai island.

*The **significance** of operational discharges on visual aesthetics is rated as **negligible**.*

Reduced Attractiveness (Light, Noise, Traffic, Project Facilities)

The location of the proposed shore base at Sihanoukville is likely to increased traffic volumes in the area from transportation of supplies and solid waste as seen in Section 5.5.3.1. This would likely result in a minor increase in truck traffic.

Crew and supply vessels will travel to and from the production site as outlined in **Table 5-28**. The increase in traffic is small and is unlikely to significantly affect visual aesthetics in the area. The maximum number of vessels operating at any one time is 4 during operations of Platform A. These few additional vessels is unlikely significantly affect the aesthetics of the area.

The production platforms, wellhead platforms, FSO will have safety lights. In addition, the CPP will have a flare. The structures will be visible to boats passing at proximity. The project location is 157 km offshore and is therefore not visible from shore. The closest island is Poulo Wai, approximately 40 km from the Block and the project's lights and flare will not be visible from the island. Few people would visit the area and see the structures.

*The **significance** of reduced attractiveness on visual aesthetics is rated as **negligible**.*

5.7 Assessment of Potential Impacts on Health

COPCL implements strict operational procedures to prevent accidental releases. An accidental release is therefore considered an unplanned event and any potential impact of accidental releases on health and safety is discussed under unplanned events.

5.7.1 Public Health

5.7.1.1 All Project Phases

Important project-related health risks that could pose a risk to public health during all phases if the project are:

- Accidents resulting in injury or death
- Exposure to hazards.

Accidents

Marine and land transport of crew and materials to and from the shore base in Sihanoukville could potentially result in accidents, resulting in injuries or death to the public as a worst case. The 2009 Annual Report of Cambodia ,Road Crash and Victim Information System indicates that 21,519 road crashes casualties from 12,538 estimated crashes occurred during 2009. The number of fatalities was 1,717 with 7,022 severe injuries. The number of fatalities has almost doubled since 2004. Goods vehicles (similar to the trucks used for this project) were involved in 6% of road crashes in 2009, but accounted for 18% of fatalities (RCVIS 2009). The severity and likelihood of consequences of a road accident is therefore rated as high and medium, respectively.

The project will implement mitigation measures: this will consist in a robust safe driving program. The program tackles competency with a strong training program of drivers, as well as selection, maintenance and equipment of vehicles. This program is used in other locations and has proved effective.

With the mitigation measures in place, the probability of an impact on the communities is considered rare and the significance of potential health impacts on the community from accidents during transportation is rated as **low.**