Annex K

The Hong Kong Electric Co. Ltd.

Baseline Marine Ecological Monitoring for Lamma Power Station Extension

Contract number 00/9446

December 2000



Oceanway Corporation Limited 20B Shan Liu Village Sai Kung Hong Kong (SAR) Telephone 2818 4400 Facsimile 2818 4411

Executive summary

- A subtidal survey carried out in 1998 with the use of an ROV showed that the proposed reclamation site and adjacent seawall of the ash lagoon supported an abundant assemblage of soft corals and gorgonians. The soft coral assemblage comprised a high abundance of sea whips (*Euplexaura* sp.) and soft corals (*Dendrophthya* sp.).
- A baseline seabed survey detailing the soft coral assemblages was subsequently carried out and the results are herein reported upon. Three zones, i..e., Reclamation Site, Ash Lagoon Seawall and Ash Lagoon Base Zones, were identified for ecological assessment and a Rapid Ecological Assessment (REA) methodology used to describe and quantitatively document the soft coral assemblages of each zone.
- Soft corals and gorgonians were predominately recorded on hard substrate, particularly boulders, at a depth of between -8 to -11 m C.D. within each zone. A total of nine gorgonian species from three genera, i.e., *Euplexaura, Echinogorgia* and *Muricella* were recorded, five species of soft corals from the genera *Dendronephthya, Scleronephthya* and *Alcyonium* and one sea pen species, *Virgularia* were also recorded. Two genera of ahermatypic corals were recorded, i.e., *Tubastrea* and *Dendrophyllia*.
- The soft coral abundance within each zone was:
 - 1. The Ash Lagoon Seawall Zone = 10.076 ± 4.949 colonies. m⁻².
 - 2. The Ash Lagoon Base Zone = 4.558 ± 1.897 colonies. m⁻².
 - 3. The Reclamation Site Zone = 2.682 ± 2.526 colonies. m⁻².
- The soft coral assemblages of all three zones all possessed a high abundance of one particular whip coral species (*Euplexaura* sp.) and the highest numbers were recorded within the Ash Lagoon Seawall Zone (9.922 ± 4.166 colonies. m⁻²).
- Field observations and recorded video footage of the area suggest that the availability of hard substrate and particle transport for soft coral suspension feeding by strong tidal currents were important physical parameters for the establishment of the soft coral assemblages recorded for the subtidal areas in the vicinity of the power station.

CONTENTS

1.	Introduction	1
2.	Methodology	1
	2.1. Baseline survey	1
	1. Reclamation Zone	2
	2. Ash Lagoon Seawall Zone	2
	3. Ash Lagoon Base Zone	2
	2.1.1. Rapid Ecological Assessment methodology	3
	2.1.2. Data compilation and analyses	4
3.	Results	7
	3.1. Substratum attributes	7
	3.2. Ecological attributes	7
	3.2.1. Soft coral, gorgonian and hermatypic coral abundance	9
	A. Reclamation Site Zone	9
	B. Ash Lagoon Seawall Zone	9
	C. Ash Lagoon Base Zone	9
	3.2.2. Total and partial mortality of <i>Euplexaura</i> sp.	12
	3.2.3. Records of fish life within the three surveyed zones	12
	3.2.4. Abundance of other epifaunal organisms	13
4.	Discussion	14
5.	References	16
6.	Colour plates	17
	Appendices	
	1 GPS locations of transects in the three survey zones	24
	2 Rapid Ecological Assessment (REA) survey data	25
	3 Dive survey details on gorgonian and soft coral colony counts	32

1. Introduction

Baseline marine ecological monitoring was required to establish the status of scleractinian and soft coral assemblages prior to the commencement of the reclamation works which are part of the proposed Lamma Power Station Extension. One area in the vicinity of the power station was identified for survey assessment prior to the present study as the seabed at this location was to be permanently lost due to the reclamation associated with the proposed extension works. The Reclamation Site Zone (Fig. 1) was evaluated in terms of ecological status using comprehensive surveys conducted with a Remotely Operated Vehicle (ROV). The surveys revealed a localised assemblage of soft corals and gorgonians at a distance of ~ 50-100 m to the south and west of the seawall of the ash lagoon (Fig. 1) (ERM 1999). The subtidal assessment carried out in 1998 resulted in the compilation of an extensive database on the abundance and diversity of the soft coral and gorgonian assemblages in the vicinity of the power station and it was concluded that the proposed reclamation site and adjacent seawall of the ash lagoon supported an abundant assemblage of gorgonians and soft corals, particularly common were sea whips (Euplexaura spp.) and soft corals (Dendronphthya spp.). The presence of the soft coral assemblage was thought to be in part due to the lack of trawling by fishing vessels in this area (ERM 1999).

In order to update this baseline information a detailed evaluation of the subtidal areas in the reclamation site and adjacent seawall and base were carried out. The main objectives of the baseline monitoring survey were (1), describe and quantitatively document the soft coral assemblages of three identified zones, i.e., Reclamation Site Zone, Ash Lagoon Seawall Zone and Ash Lagoon Base Zone; and (2), for subsequent use of data during Post-Construction Monitoring to ascertain the extent of recolonisation of soft corals adjacent to the Reclamation Site Zone, and the extent of colonisation on the rubble mound seawalls.

2. Methodology

The baseline monitoring consisted of subtidal dive surveys in the proposed Reclamation Site Zone and the adjacent Ash Lagoon Seawall and Ash Lagoon Base Zones (Fig. 1). It should be noted that the methodology was a variation from that specified in the EIA Report (ERM 1999) and agreement was given by the Agriculture, Fisheries and Conservation Department, Hong Kong SAR Government prior to the commencement of the surveys¹. The dive surveys were conducted by local experienced coral specialists over a three day period (21-22 and 23 November 2000).

2.1. Baseline Survey

In the EIA Report (ERM 1999), it was recommended that an ROV should be used for the baseline survey and the exact methodology presented in the EIA was to be

¹ Email correspondence with Mr Alan Chan, Marine Conservation Division, Agriculture, Fisheries and Conservation Department, Hong Kong SAR Government on 16 November 2000.

followed. The ROV that was used to conduct the original survey as part of the EIA, however, was no longer available and a revised methodology for the baseline dive survey using SCUBA was used.

Quantitative dive surveys were undertaken within three zones as indicated in Figure 1. These zones were termed Reclamation Site Zone, Ash Lagoon Seawall Zone and Ash Lagoon Base Zone. Details of the location of each transect with Global Positioning System (GPS) is presented in Appendix 1.

1. Reclamation Site Zone

Within the Reclamation Site Zone ten randomly placed 100 m transects (Fig. 2) were surveyed to assess hard and soft coral coverage using the Rapid Ecological Assessment methodology adapted from DeVantier *et al.* (1998). A measuring tape was laid down in the middle of each transect and an area 0.5 m wide either side of the tape surveyed for it's entire length. This resulted in a "belt" transect. Photographs of representative coral species located within the belt transect were taken using either a Nikon F90 in an underwater Ikelite housing, a Kodak DC290 for general landscape shots or a Sony DSC-F505 for wide-angle and macro with strobes and video lights. Each transect was also videoed, with each transect filmed at approximately 50 cm above the transect tape and at a constant speed in compliance with standard protocols for coral surveys (no more than 10 metres per minute). The video camera was held at a 45° angle to provide a landscape view of the survey area as observed by the surveyors and provided a permanent record of the site. Video footage was only used to confirm the composition of epifauna on each transect and not used for data analyses.

2. Ash Lagoon Seawall Zone

Five permanently marked 100 m transects were surveyed (Fig. 2). Each transect within the Ash Lagoon Seawall Zone was placed on the seawall and marked with a steel stake inserted into the wall and the start and end locations noted by shoreline features and handheld Global Positioning System (GPS). A reconnaissance dive survey prior to the baseline surveys revealed no hermatypic scleractinian assemblages on the Ash Lagoon Seawall Zone and so instead of a quantitative video transect technique the REA methodology as carried out for the Reclamation Site and Ash Lagoon Base Zones was employed. Representative photos of soft corals and ahermatypic corals were taken.

3. Ash Lagoon Base Zone

Since the establishment of permanent markers in the sand substratum were not feasible five, randomly place 100 m transects were established in line with the seawall transects (Fig. 2) and the Rapid Ecological Assessment methodology used to assess coverage of soft corals and other epifauna. Each transect was videoed as for the Reclamation Site Zone and Ash Lagoon Seawall Zone and photographs taken of representative soft coral species.

2.1.1. Rapid Ecological Assessment methodology

Data were recorded by observers experienced in the field identification of sessile benthic taxa, swimming down-current along selected areas using scuba gear. Ten 100 m transects were surveyed. Start- points of transects were determined with a portable Global Positioning System (GPS) unit. A dive survey before the actual gathering of quantitative data revealed the predominance of soft corals on hard substrate in each zone. The use of a side-scan sonar map of the Reclamation Site Zone provided by Hong Kong Electric Co. Ltd. in a report of the geo-physical surveys (EGS 2000) aided the location of scattered hard substrate areas and these were targeted for transect placement with the use of GPS within this zone.

A 100 m transect was laid out and an assessment of the benthic cover (tier I) and taxon abundance (tier II) in a swathe ~ 1 m wide, 0.5 m either side of each transect complimented with landscape photographs (dependent on visibility) were then carried out. The transect survey was then completed by video footage taken of the epifauna along the transect. Due to the extremely low visibility encountered during the survey period the belt transect was reduced to a width of 0.5 m either side of the transect². Torches and powerful underwater strobes were employed for all survey collection dives, video footage and photography. Even using this method the two outer transects of the Reclamation Zone were not recorded by video due to strong currents disturbing seabed sediment.

Tier I: Categorisation of benthic cover

At the completion of each transect, six ecological and seven substratum attributes (Table 1a) were assigned to one of six standard ranked (ordinal) categories (Table 1b).

Table 1. Categories used in the surveys: (a) benthic attributes, (b) ordinal ranks of percentage cover.

(a) Attributes	
Ecological	Substratum
1. Hard coral	1. Bedrock
2. Dead standing coral	2. Boulders
3. Soft coral (including gorgonians)	2. Sediment – sand/ mud/fine, soft sand
4. Anemone beds	3. Rubble - dead coral fragments/shell
5.Other benthos: sponges, zoanthids, ascidians and bryozoans	4. Cobbles
6. Macro-algae	

 $^{^{2}}$ The REA methodology was modified. The standard transect width of 2 m was reduced to 1 m due to poor underwater visibility.

(b) Cover	
Rank	Percentage
0	None recorded
1	1-10
2	11-30
3	31-50
4	51-75
5	76-100

Tier II: Taxonomic inventories to define types of benthic communities

An inventory of benthic taxa was compiled during each swim (transect). Taxa were defined *in situ* to the following levels: (1.) Scleractinian corals to species wherever possible. (2.) Soft corals, anemones and conspicuous macro-algae were identified to genus. (3.) Other benthos (including sponges, zoanthids, ascidians and bryozoans) were identified to genus level wherever possible but more typically to phylum plus growth form. At the end of each swim, each taxon in the inventory was ranked in terms of abundance in the community (Table 2). These broad categories rank taxa in terms of relative abundance of individuals, rather than the contribution to benthic cover along each transect. The ranks are subjective assessments of abundance, rather than quantitative counts of each taxon.

Table 2. Ordinal ra	anks of taxon	abundance
---------------------	---------------	-----------

1 Taxon abundance Rank	Abundance
0	Absent
1	Rare
2	Uncommon
3	Common
4	Abundant
5	Dominant

2.1.2. Data compilation and analyses

Data on percentage cover and colony abundance of soft corals and gorgonians, were extracted from (1), dive surveys on the belt transects for all three zones, i.e., the Reclamation Site Zone and Ash Lagoon Seawall Zone and Ash Lagoon Base Zone. The REA methodology employed for soft coral surveys allowed for the presentation of abundance as (1), individual colony counts of soft corals and gorgonian species recorded, (2), a ranked ordinal category assignment based on the counts of individual organisms, i.e., soft corals and gorgonians and (3), a percentage cover estimate of ecological and substratum attributes.

The results are presented for each zone with a mean number of soft corals and gorgonians per m^2 . Total and partial mortality of the dominant gorgonian (*Euplexaura* sp.) were also recorded along transects carried out within each survey zone.





Figure 2. Location of the transects within each survey zone

3. Results

3.1. Substratum attributes

Details of the substratum composition of the individual transects within each surveyed zone is presented in Appendix 2, section C. The Reclamation Zone was comprised of a fine, soft sand sediment (~ 90 % cover) with scattered small boulders (0-10 % cover) on the majority of transects. Transects eight and ten possessed 100 % fine, soft sand sediment. Construction debris including discarded metal structures, e.g., scaffolding, and pipes were recorded on several transects (particularly transect five). Transect five possessed a higher coverage of boulders (11-30 % cover). The base of the Ash Lagoon Seawall Zone consisted of large boulders with scattered sand patches. The five transects were comprised of ~ 90 % boulder cover with 0-10 % sand cover. The Ash Lagoon Base Zone located ~ 10-20 m distance from seawall comprised of fine, soft sand sediment (~ 90 % cover) with scattered small boulders and rocks (0-10 % cover). Exceptions were transects TA2 which had a higher boulder coverage (11-30 % cover) and TD2 with 100 % sand cover.

3.2. Ecological attributes

The three zones, i.e., Reclamation Site, Ash Lagoon Seawall and Ash Lagoon Base Zones, were all composed of soft coral assemblages generally associated with the hard substratum. Details of the general epifaunal composition of each transect for each zone is presented in Appendix 2, section B. The Reclamation Site Zone contained the lowest estimated percentage cover of soft corals (the majority of transects = 0-10 % cover), with the Ash Lagoon Base Zone consisting of intermediate soft coral coverage (all transects = 11-30 % cover) and the Ash Lagoon Seawall Zone possessing the highest percentage cover of soft corals (all transects = 31-50 % cover). The soft coral coverage of each zone was concentrated on boulders and other hard substrate such as the discarded metal structures, although a number of soft coral coverage Zones. Ahermatypic corals, e.g., *Tubastrea* sp., were also recorded on the boulders within the Reclamation Site and Ash Lagoon Seawall Zones.

A total of three soft coral genera from one family Alcyoniidae, three gorgonian genera from two families Acanthogorgiidae and Plexauridae and one seapen genus from the family Virgulariidae were recorded from the three zones (Table 1). A total of 16 species including soft and ahermatypic corals was recorded for the Reclamation Site Zone, 12 species for the Ash Lagoon Seawall Zone and 11 species for the Ash Lagoon Base Zone (Table 2).

Table 1. A list of soft coral,	gorgonian and	sea-pen families	and genera	recorded for
all survey zones.				

	FAMILY	GENERA
Soft corals	Alcyoniidae	
		Dendronephthya
		Scleronephthya
		Alcyonium
Gorgonians	Acanthogorgiidae	Muricella
	Plexauridae	Euplexaura
		Echinogorgia
Sea-pens	Virgulariidae	Virgularia
(Pennatulacea)	-	

Table 2. Species list for each survey zone recorded at the Lamma Power Station

Species	Reclamation	Seawall	Base
	Zone	Zone	Zone
Gorgonians			
Euplexaura curvata (White whip coral)			
<i>Euplexaura</i> sp. (Orange whip coral)			
<i>Euplexaura</i> sp. (Brown/red whip coral)			
<i>Euplexaura</i> sp. (Purple whip coral)			
Echinogorgia lama			
Echinogorgia sp. (Orange)			
Echinogorgia sp. (Red)			
Echinogorgia sp. (large fan coral)			
Muricella sp. (orange)			
Soft corals			
Dendronephthya sp. A			
Dendronephthya sp. B			
Dendronephthya sp. C			
Scleronephthya sp.			
Alcyonium sp.			
Sea pens			
Virgularia sp.			
Ahermatypic corals			
<i>Tubastrea</i> sp.			
Dendrophyllia sp.			

3.2.1. Soft coral, gorgonian and ahermatypic coral abundance

A. Reclamation Site Zone

Azooxanthellate ocotocorals (gorgonians) were an abundant component of the soft coral assemblage of the Reclamation Site Zone. Table 3 shows the total species richness and mean density (number of colonies. m^2) for each species of gorgonian, soft coral, sea pen and ahermatypic coral recorded and the total density of soft corals (including gorgonians) was 2.682 ± 2.524 colonies. m^2 . One species of gorgonian (*Euplexaura* sp. a white whip coral) (Section 6: Colour Plates 1-3) was the most abundant component of the epifaunal assemblage recorded in this zone with a mean density of 2.600 ± 1.106 colonies. m^2 . Records of the soft corals *Scleronephthya* sp. (Section 6: Colour Plate 9) and *Alcyonium* sp. (both of low density and percentage cover, i.e., =/<0.005 m² and <10 %) in addition to the one record of the ahermatypic species. The colony counts of all soft coral organisms and ahermatypic corals are presented in Appendix 3. The estimated percentage cover of each species based on recorded abundance is presented in Section A, Appendix 2 and again shows the common occurrence of the gorgonian *Euplexaura* sp.

B. Ash Lagoon Seawall Zone

Azooxanthellate ocotocorals (gorgonians) were the main composition the soft coral assemblage of the Ash Lagoon Seawall Zone. Table 4 shows the total species richness and mean density (number of colonies. m^2) for each species of gorgonian, soft coral and ahermatypic coral recorded. The total density of soft corals (including gorgonians) was 10.076 ± 4.949 colonies. m⁻². One species of gorgonian (*Euplexaura* sp. a white whip coral) was of high abundance and the main component of the epifaunal assemblage recorded in this zone $(9.922 \pm 4.166 \text{ colonies. m}^2)$. Field observations revealed that the occurrence of soft corals was primarily concentrated on the available hard substratum, i.e., boulders, suitable for coral settlement and growth. No sea pens were recorded within this zone. Soft corals (*Dendronephthya* spp.) were recorded (Table 4) and the majority of colonies recorded exhibited signs of sub-lethal stress in the form of bleaching and a general unhealthy appearance (Section 6: Colour Plates 7 and 8). The ahermatypic coral *Tubastrea* sp. was also recorded within this zone (Section 6: Colour Plates 10 and 11). The estimated percentage cover of each species based on recorded abundance is presented in Section A, Appendix 2 and again shows the high abundance of the *Euplexaura* sp.

C. Ash Lagoon Base Zone

Azooxanthellate ocotocorals (gorgonians) were the most abundant component of the soft coral assemblage of the Ash Lagoon Base Zone. Table 5 shows the total species richness and mean density (number of colonies. m^2) for each species of gorgonian, soft coral and ahermatypic coral recorded and a total density for the soft corals (including gorgonians) of 4.558 ± 1.897 colonies. m^2 was recorded. One species of gorgonian (*Euplexaura* sp. a white whip coral) was the main component of the soft coral assemblage recorded in this zone (4.496 ± 1.869 colonies. m^{-2}). No ahermatypic corals were recorded within this zone. The estimated percentage cover

of each species based on recorded abundance is presented in Section A, Appendix 2 and again shows the common occurence of the *Euplexaura* sp.

Table 3. Total species richness and density (number of colonies. $m^2 \pm S.E.$) for each genus of soft coral, gorgonian, sea pen and ahermatypic coral for the Reclamation Site Zone.

	Reclamation
	Site
	Zone
Species richness (total	16
number)	
Density of Euplexaura	2.600±1.106
Density of	0.035±0.009
Echinogorgia	
Density of Muricella	0.006±0.013
Density of	0.048 ± 0.006
Dendronephthya	
Density of	0.003±0.006
Scleronephthya	
Density of Alcyonium	0.005 ± 0.004
Density of Virgularia	0.001±0.003
Total density of soft	2.682±2.524
corals (including	
gorgonians)	
Density of Tubastrea	0.024±0.046

Colour plates of the common soft corals, gorgonians are shown in Section 6.

Table 4. Total species richness and density (number of colonies. $m^2 \pm S.E.$) for each genus of soft coral, gorgonian, sea pen and ahermatypic coral for the Ash Lagoon Seawall Zone.

	Ash Lagoon
	Seawall Zone
Species richness (total	12
number)	
Density of Euplexaura	9.922±4.166
Density of	0.062±0.019
Echinogorgia	
Density of Muricella	0.008 ± 0.008
Density of	0.084 ± 0.018
Dendronephthya	
Density of	0
Scleronephthya	
Density of Alcyonium	0
Density of Virgularia	0 (recorded within
	zone)*
Total density of soft	10.076±4.949
corals (including	
gorgonians)	
Density of <i>Tubastrea</i>	0.006 ± 0.008

* Not recorded on the survey transects but observed within the zone.

Table 5. Total species richness and density (number of colonies. $m^2 \pm S.E.$) for each genus of soft coral, gorgonian, sea pen and ahermatypic coral for the Ash Lagoon Base Zone.

	Ash Lagoon
	Base Zone
Species richness (total	11
number)	
Density of Euplexaura	4.496±1.869
Density of	0.004 ± 0.001
Echinogorgia	
Density of Muricella	0.004 ± 0.008
Density of	0.048 ± 0.006
Dendronephthya	
Density of	0
Scleronephthya	
Density of Alcyonium	0
Density of Virgularia	0
Total density of soft	4.558±1.897
corals (including	
gorgonians)	
Density of Tubastrea	0

3.2.2. Total and partial mortality of *Euplexaura* sp. (white whip coral)

Whole colony mortality for the abundant white whip coral (*Euplexaura* sp.) was recorded within each survey zone. Total mortality was highest for the Ash Lagoon Seawall Zone and Ash Lagoon Base Zone with a mean number of dead colonies of 24.00 ± 18.28 and 23.00 ± 6.78 per 100 m², respectively. The lowest total mortality was recorded for the Reclamation Site Zone (7.60 \pm 9.51 colonies). Both large adult and juvenile colonies were affected.

Partial mortality was a common observation for the large adult white whip coral colonies within each survey zone (Section 6: Colour Plate 12). Partial mortality was lowest for the Ash Lagoon Base Zone with 16.00 ± 8.00 % of the total number of colonies exhibiting 0-30 % partial mortality of the upper branches and bases. One reason for the partial death of colonies was possibly due to the strong current and wave motion, which caused colonies upper branches to drag across the sand seabed either smothering and/or abrading polyps. The recorded partial mortality of the dominant white whip coral within the Reclamation Site Zone comprised 19.50 \pm 16.80 % of total colonies with 0-30 % partial death particularly affecting the bases and upper branches and 7.00 \pm 15.52 % of total colonies with 31-60 % partial death and again affecting the bases, and upper and lower branches. Sediment accumulation appeared to be a plausible reason for the die-off of tissue at the bases of colonies. Highest partial mortality was recorded within the Ash Lagoon Seawall Zone with 30.00 ± 17.89 % of total number of colonies recorded with 0-30 % partial death affecting bases and upper branches. Remnants of discarded gill nets, rubbish and accumulated sediment appeared to be the main reasons for the tissue die-off and a causative factor contributing to the partial death of *Euplexaura* sp. within the Ash Lagoon Base Zone. Seven gill nets were encountered in a 500 m stretch of shoreline at the Ash Lagoon Seawall Zone and four fishing boats worked this area in one day. Gill net fishing activity appeared to be high within this zone given the observations made in the three days of field work

3.2.3. Records of fish life within the three surveyed zones

Underwater visibility was poor throughout the dive surveys and few fish were General observations are made, however, no quantitative data are observed. presented as this was not part of the survey. The majority fish were observed along the Ash Lagoon sea wall and around patches of boulders out from the sea-wall and on the sea-bed in the area to be reclaimed, i.e., wherever there was hard substrate. Such fish included Chinese demoiselle (Neopomacentrus bankieri), Marbled rockfish (Sebastisicus marmoratus) and Weedy stingfish (Scorpaenopsis cirrhosa), all common local reef species. Two species of commercial importance were also observed, a 30 cm length Yellowfin seabream (Acathopagrus latus) and a number of sub-adult Yellow grouper (*Epinephelus awoara*). Juveniles of the latter species often inhabit isolated boulders and other hard substrate in predominantly sandy, silty areas in the depth range 5 - 10 m, a common substrate around the power station. The only fish observed to specifically use soft corals as shelter were juvenile Threadsail filefish (Stephanolepis cirrhifer), which were fairly abundant. A number of fishes which predominantly inhabit soft substrata, including gobies and sillagos were observed but

could not be identified to species. A single individual of the rare sandperch *Parapercis sexfasciatus* and moray eel (*Gymnothorax reticularis*) were also seen.

3.2.4. Abundance of other epifaunal organisms

Encrusting sponges were recorded on boulders within the three survey zones, particularly an unidentified white encrusting sponge (Section 6: Colour Plate 13). Percentage cover was estimated to be between 11-30 % (Appendix 2, section A). The sea cucumber *Colochirus crassus* was abundant within all survey zones (Section 6: Colour plate 2) and observed on gorgonians and boulders. Mussels (*Perna viridis*) were observed on artificial substrate close to the outfall/intake pipes within the Reclamation Site Zone. Several species of sea urchin including *Diadema setosum* were recorded particularly along the Ash Lagoon Seawall Zone. One adult and one juvenile spiny lobster (*Panulirus* sp.) were recorded along the Ash Lagoon Seawall Zone. Several unidentified species of ovulids (snails) were recorded in association with the gorgonians. Hydroids (*Aglaophenia* sp.) were abundant on boulders within all survey zones.

4. Discussion

The ahermatypic and octocorallian communities of Hong Kong's inshore waters have been reported from the relatively deeper waters of the southeast islands and mainland coastline including Cape d'Aguilar Marine Reserve (Scott 1984; Zou and Scott 1982; Clark 1997). The limited documentation of octocorals all conclude that the greatest diversity and abundance are recorded from the southeast waters of Hong Kong. Octocorals from the orders Gorgonacea and Alcyonacea were, however, the dominant epifauna of the subtidal assemblages recorded on the western side of Lamma Island at identified Thermal Plume sites (T2-T6) (ERM 1999). More recent records by two internationally renowned soft coral scientists Dr Katharine Fabricius (Australian Institute of Marine Science) and Professor Hudi Benayahu (University of Tel Aviv) for twenty hard substrate sites (November 1999, unpublished report for the Swire Institute of Marine Science) revealed azooxanthellate octocorals were predominately recorded on hard substrate in deeper areas with moderately high sediment deposits. They did, however, record a rich soft coral assemblage mainly based on shallow (<6 m depth), artificial substrate at Junk Bay.

Soft coral assemblages dominated by azooxanthellate gorgonians were the primary epifaunal component of the three subtidal survey zones at the Lamma Power Station. All three zones contained one abundant *Euplexaura* sp. (white whip coral). The Ash Lagoon Seawall and Ash Lagoon Base Zones possessed all gorgonian species recorded within the Reclamation Site Zone, however, two species of soft coral, i.e., *Scleronephthya* sp. and *Alcyonium* sp. were only recorded from the Reclamation Site Zone.

Comparison of results obtained by the ROV survey carried out within the Reclamation Site Zone in 1998 (ERM 1999) revealed recordings of similar arborescent, octocoral genera although there are some differences in identification when compared with results presented here. It should be noted that the study of soft corals (globally) has been hindered by the requirements necessary for species identification which include electron microscopy work and there are only five taxonomic experts operating at this level worldwide. In this report octocorals were identified to genus level. The high abundance of *Euplexaura* recorded from the ROV surveys is consistent with the SCUBA surveys undertaken in the present survey work. It was noted that four *Echinogorgia* and one *Muricella* gorgonian species were recorded during the present study. SCUBA surveys allowed for the assessment of a wider area of seabed within each zone and more representative colony counts within each zone despite the extremely low visibility experienced.

Studies of soft coral abundance on the Central Great Barrier Reef (Fabricius 1997) revealed the importance of physical parameters such as exposure and water flow and these parameters exert a strong control on soft coral distribution. Soft corals are passive suspension feeders and are dependent on water flow for particle transport. A strong tidal current occurs in the area of the three survey zones and it is thought the availability of suitable hard substrate and water flow facilitate the colonisation and maintenance of the rich soft coral assemblages recorded from a depth of $\sim 8-11$ m with the Reclamation Site Zone, Ash Lagoon Seawall Zone and Ash Lagoon Base Zone. ERM (1999) noted the absence of trawling activity also aided the

establishment of the soft coral epifauna, however, high gill netting activity was observed during fieldwork and discarded nets were implicated as a causative factor of the high levels of partial mortality recorded for *Euplexaura* sp. within the Ash Lagoon Seawall Zone.

At the present time there is an immense lack of knowledge on distribution and composition of soft coral assemblages within Hong Kong's inshore waters. Scientific surveys have documented the existence of octocorals at deeper, hard substrate sites in the southeast region of Hong Kong and consultancy surveys are expanding the known locations of soft coral sites, however, a baseline from which to compare the present results with is not available. The results of the present study indicate that soft corals can exist at shallower depths when physical parameters are suitable. Although physical parameters suitable for soft coral growth are known, the specific levels of such parameters have not yet been defined for Hong Kong's soft corals. Water flow for particle transport, suitable hard substrate and moderate sediment loading are important factors and these parameters would appear to be primary contributing factors to the existence of the soft coral assemblages of the Reclamation Site Zone, Ash Lagoon Seawall Zone and Ash Lagoon Base Zone of Lamma Power Station. The dominant Euplexaura sp. (white whip coral) appears to be an opportunistic, weed-like organism and with the provision of suitable hard substratum recolonisation after the construction works should be possible. There is no information on the reproductive strategies of local soft coral species, however, research in the Red Sea and the Great Barrier Reef has indicated that many gorogonians and species of the family Alcyoniidae, i.e., Dendronephthya sp., are broadcast spawners and may have annual or diffuse spawning periods (Babcock et al. 1986; Ben-David-Zaslow and Benayahu 1998). Soft coral larval sources for the three survey zones are not known, however, the role of the area as a seeding source for the recolonisation of soft corals after construction works may be important in combination with larval sources from further away.

5. References

Babcock, R.C., Bull, J.D., Harrison, P.L., Heyward, A.J., Oliver, J.K., Wallace, C.C. and Willis, B.L. 1986. Synchronous spawning of 105 scleractinian coral species on the Great Barrier Reef. *Marine Biology* **90**:379-94.

Ben-David-Zaslow, R. and Benayahu, H. 1998. Competence and longevity in planular of several species of soft corals. *Marine Ecology Progress Series* **163**:235-43.

Clark, T.H. 1997. The distribution of ahermatypic corals at Cape d'Aguilar, Hong Kong. In *The Marine Flora and Fauna of Hong Kong and Southern China IV* (ed. B. Morton). Proceedings of the Fourth International Marine Biological Workshop: The Marine Flora and Fauna of Hong Kong and Southern China, Hong Kong 1995. Hong Kong: Hong Kong University Press.

DeVantier, L.M., G. De'ath, T.J. Done and Turak, E. 1998. Ecological assessment of a complex natural system: a case study from the Great Barrier Reef. *Ecological Applications* **8**:480-96.

EGS 2000. Marine archeological investigation Lamma Power Station Extension. Geophysical (side scan) survey final report. Survey Report for The Hong Kong Electric Co Ltd.

Environmental Resources Management Ltd. 1999. Environmental Impact Assessment of a 1800 MW Gas-Fired Power Station at Lamma Extension: Final Report - Volume 1. Survey Report for The Hong Kong Electric Co Ltd.

Fabricius, K.E. 1997. Soft coral abundance on the Central Great Barrier Reef: effects of *Acanthaster planci*, space availability and aspects of the physical environment. *Coral Reefs* **16**:159-67.

Scott, P.J.B. 1984. *The Corals of Hong Kong*. Hong Kong: Hong Kong University Press.

Zou, R.L. and Scott, P.J.B. 1982. The Gorgonacea of Hong Kong. In *The Marine Flora and Fauna of Hong Kong and Southern China I* (ed. B. Morton and C.K. Tseng). Proceedings of the First International Marine Biological Workshop: The Marine Flora and Fauna of Hong Kong and Southern China, Hong Kong 1980. Hong Kong: Hong Kong University Press.

6. Colour plates



Plate 1. The three common *Euplexaura* spp. Left side of photograph shows the dominant *Euplexaura* sp. (white whip coral), centre right shows the common red/brown *Euplexaura* sp. (distinct white polyps are usually visible and to the far right, just in the photograph is the orange whip coral, another species of *Euplexaura*.



Plate 2. The common white whip *Euplexaura* sp. observed with the abundant sea cucumber *Colochirus crassus* attached.



Plate 3. The dominant gorgonian *Euplexaura* sp. (white whip coral) recorded from all three survey zones.



Plate 4. Close-up photograph of the distinct white polyps of a *Euplexaura* sp. (Brown/red body). This species was common although abundance was low with one-two colonies recorded amongst the dense stands of the white whip corals (*Euplexaura* sp.) observed on boulders.



Plate 5. Common fan gorgonian *Echinogorgia lama* recorded within all three survey zones.



Plate 6. Fan shaped gorgonian *Echinogorgia* sp. (red) recorded from the Ash Lagoon Seawall Zone only.



Plate 7. *Dendronephthya* sp. (white body, red spicules/polyps) colony. This species was recorded from all three zones



Plate 8. A bleached colony of *Dendronephthya* sp. photographed within the Reclamation Site Zone. It was noted that the majority of soft coral colonies recorded within the Ash Lagoon Seawall Zone were observed to be partially bleached and/or with an unhealthy appearance (colonies in a semi-collapsed state).



Plate 9. A colony of *Scleronephthya* sp. recorded from the Reclamation Site Zone only, seen here behind the common white whip coral (*Euplexaura* sp.).



Plate 10. The common ahermatypic coral *Tubastrea* sp. recorded on boulders within the Reclamation Site Zone and Ash Lagoon Seawall Zone.



Plate 11. Dense aggregation of *Tubastrea* sp. (ahermatypic coral) recorded from the Reclamation Site Zone.



Plate 12. The dominant white whip coral (*Euplexaura* sp.) showing the commonly observed partial mortality of the upper branches. Partial mortality was recorded for colonies of this species within all three zones.



Plate 13. Common unidentified white encrusting sponge recorded on boulders within the Reclamation Site Zone and Ash Lagoon Seawall.

Appendix 1

Global Positioning System (GPS) locations for the transects within the three survey zones.

Transact	Deg	CDC N				Max
Transect	Deg	GPS N	GPS E	MAP N	MAPE	Depth
	100	40.004	0.040	000004	000050	(M)
T1	120	12.991	6.243	808384	829056	8.3
T2	100	12.893	6.268	808207	829100	8.7
T3	100	13.012	6.175	808421	828940	7.5
T4	90	13.041	6.210	808474	829001	8.1
T5	95	13.050	6.076	808490	828771	8.3
T6	95	12.854	6.134	808138	828869	8.5
T7	30	12.782	6.274	808008	829110	10.1
T8	100	12.811	6.047	808059	828721	10.3
T9	30	12.923	6.065	808262	828751	8.3
T10	60	12.925	6.154	808265	828904	9.5
TA1	140	12.990	6.399	808382	829324	7.3
TB1	100	12.953	6.441	808315	829396	7.5
TC1	80	12.949	6.520	808309	829532	6.5
TD1	60	12.963	6.564	808333	829608	7.1
TE1	30	12.983	6.610	808370	829686	6.8
TA2	130	12.971	6.382	808348	829295	10.6
TB2	100	12.931	6.444	808275	829401	10.3
TC2	60	12.931	6.521	808275	829533	10.1
TD2	70	12.948	6.582	808306	829638	9.8
TE2	50	12.973	6.619	808352	829702	9.3

Notes : GPS figures shown above are minutes & seconds only. I.e.,

12.973 = N22.12.973

6.619 = E114.06.619

All coordinates use the Hong Kong 1963 reference.

Angle of transect: 50 Deg = 50Deg Magnetic.

Appendix 2

Rapid Ecological Assessment (REA) results for all transects within the three zones surveyed.

Substratum and ecological attributes are based on estimated percentage covers for each transect:

Cover Rank	Percentage
0	None recorded
1	1-10
2	11-30
3	31-50
4	51-75
5	76-100

All soft coral, gorgonian and ahermatypic coral species are presented as ordinal ranks based on taxon abundance:

Taxon abundance	
Rank	Abundance
0	Absent
1	Rare
2	Uncommon
3	Common
4	Abundant
5	Dominant

Surveys carried out on 21-22 and 24/11/00 by Oceanway Corporation Ltd.

section A SOFT CORAL SPECIES FAMILY PLEXAURIDAE

Euplexaura

Echinogorgia Echinogorgia lama Echinogorgia sp. (orange) Echinogorgia sp. (red)

Euplexaura curvata (white whip coral) *Euplexaura* sp. (orange) *Euplexaura* sp. (brown/red body with distinct white polyps) *Euplexauara* sp. (purple whip coral) Rapid Ecological Assessment (REA) of the sea-bed at the three identified zones at Lamma Power Station

RECLAMATION ZONE

Transect

T1 T2 T3 T4 T5 T6 T7 T8 T9 T10

5	5	3	5	5	4	4	3	5	0
2	2	0	0	0	2	0	0	3	0
0	2	0	3	3	0	0	0	2	0
0	0	0	0	2	0	0	0	0	0

0	3	2	3	3	0	0	0	0	0
0	0	2	3	3	0	0	0	2	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	1	0	0	0	0	0

Echinogorgia sp. (large fan coral)

FAMILY ACANTHOGORGIIDAE Muricella

Muricella sp. (orange)

FAMILY ALCYONIIDAE Dendronephthya

Dendronephthya sp. A (white body and white spicules (=D in ERM 1999 report)) *Dendronephthya* sp. B (white body and purple spicules)

Dendronephthya sp. C (white body and red spicules (=B ERM 1999 report))

Scleronephthya

Scleronephthya sp.

Alcyonium

Alcyonium sp. (brown body, orange polyps)

0	3	0	0	2	0	0	0	0	0

0	2	0	3	3	0	0	0	0	0
0	2	0	2	3	0	0	0	0	0
0	0	0	0	2	0	0	0	0	0





Seapen

Virgularia sp. Cavernularia sp.

1	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0

AHERMATYPIC CORALS

Tubastrea

Section B

Tubastrea sp.

Dendrophyllia

Dendrophyllia sp.

|--|

Other benthic organisms

sponges zoanthids Anemone beds bryozoans Macro-algae

2	2	2	2	2	2	0	2	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0

econori B											
Ecological attributes											
Hard coral	0)	0	0	1	1	0	0	0	1	0
Dead standing coral	0)	0	0	0	0	0	0	0	0	0
Soft coral	1		2	1	2	2	1	1	1	2	0
Anemone beds	0)	0	0	0	0	0	0	0	0	0
Macroalgae	0)	0	0	0	0	0	0	0	0	0
Substratum attributes - Section C											
Hard substrate	0)	0	0	0	0	0	0	0	0	0
Continuous pavement	0)	0	0	0	0	0	0	0	0	0
Bedrock/boulders	1		1	1	1	2	1	1	0	1	0

Rubble	
Cobbles	
Sand or sand and gravel	

DEPTH (m) MAXIMUM

T1	T2	Т3	Т4	Т5	Т6	T7	Т8	Т9	T10
8.3	8.7	7.5	8.1	8.3	8.5	10	10.3	8.3	9.5

LAMMA - HEC SEABED SURVEY

ZONE: ASH LAGOON SEAWALL

Section A SOFT CORAL SPECIES FAMILY PLEXAURIDAE

Euplexaura

Euplexaura curvata (white whip coral) Euplexaura sp. (orange) Euplexaura robusta (brown/red body with distinct white polyps) Euplexauara sp. (purple whip coral)

Transect TA1	TB1	TC1	TD1	TE1
5	5	5	5	5
3	3	3	2	3
3	3	3	0	3
1	0	1	1	2

Echinogorgia

Echinogorgia lama Echinogorgia sp. (orange) Echinogorgia sp. (red) Echinogorgia sp. (large fan coral)

FAMILY ACANTHOGORGIIDAE

Muricella

Muricella sp. (orange)

FAMILY ALCYONIIDAE

Dendronephthya

Dendronephthya sp. A (white body and white spicules (=D in ERM 1999 report)) *Dendronephthya* sp. B (white body and purple spicules) *Dendronephthya* sp. C (white body and red spicules (=B ERM 1999 report))

Scleronephthya

Scleronephthya sp.

Alcyonium

Alcyonium sp. (brown body, orange polyps)

2	0	1	0	0
3	2	2	0	0
0	1	0	0	0
0	0	0	0	0

2	1	1	0	0

3	2	0	0	1
2	2	0	0	0
2	0	0	0	0

0	0	0	0	0

0	0	0	0	0

Seapen

<i>Virgularia</i> sp. <i>Cavernularia</i> sp.	0	0	0	0	0
AHERMATYPIC CORALS Tubastrea					
Tubastrea sp.	2	0	1	0	0
Dendrophyllia					
Dendrophyllia sp.	0	0	0	0	0
Other benthic organisms					
sponges	3	3	3	3	3
zoanthids	0	0	0	0	0
Anemone beds	0	0	0	0	0
bryozoans	0	0	0	0	0
Macro-algae	0	0	0	0	0
Section B					
Section B Ecological attributes			-		
Section B Ecological attributes Hard coral	1	0	1	0	0
Section B Ecological attributes Hard coral Dead standing coral	1 0	0	1 0	0	0
Section B Ecological attributes Hard coral Dead standing coral Soft coral	1 0 3	0 0 3	1 0 3	0 0 3	0 0 3
Section B Ecological attributes Hard coral Dead standing coral Soft coral Anemone beds	1 0 3 0	0 0 3 0	1 0 3 0	0 0 3 0	0 0 3 0
Section B Ecological attributes Hard coral Dead standing coral Soft coral Anemone beds Macroalgae	1 0 3 0 0	0 0 3 0 0	1 0 3 0 0	0 0 3 0 0	0 0 3 0 0
Section B Ecological attributes Hard coral Dead standing coral Soft coral Anemone beds Macroalgae Substratum attributes - Section C	1 0 3 0 0	0 0 3 0 0	1 0 3 0 0	0 0 3 0 0	0 0 3 0 0
Section B Ecological attributes Hard coral Dead standing coral Soft coral Anemone beds Macroalgae Substratum attributes - Section C Hard substrate	1 0 3 0 0	0 0 3 0 0	1 0 3 0 0	0 0 3 0 0	0 0 3 0 0
Section B Ecological attributes Hard coral Dead standing coral Soft coral Anemone beds Macroalgae Substratum attributes - Section C Hard substrate Continuous pavement	1 0 3 0 0	0 0 3 0 0 0	1 0 3 0 0	0 0 3 0 0	0 0 3 0 0
Section B Ecological attributes Hard coral Dead standing coral Soft coral Anemone beds Macroalgae Substratum attributes - Section C Hard substrate Continuous pavement Bedrock/boulders	1 0 3 0 0 0	0 0 3 0 0 0	1 0 3 0 0 0	0 0 3 0 0 0	0 0 3 0 0 0
Section B Ecological attributes Hard coral Dead standing coral Soft coral Anemone beds Macroalgae Substratum attributes - Section C Hard substrate Continuous pavement Bedrock/boulders Rubble	$ \begin{array}{c} 1 \\ 0 \\ 3 \\ 0 \\ 0 \\ 0 \\ 5 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0$	0 0 3 0 0 0 0 5 0	1 0 3 0 0 0 0 5 0	0 0 3 0 0 0 0 5 0	0 0 3 0 0 0 0 5 0
Section B Ecological attributes Hard coral Dead standing coral Soft coral Anemone beds Macroalgae Substratum attributes - Section C Hard substrate Continuous pavement Bedrock/boulders Rubble Cobbles	1 0 3 0 0 0 0 5 0 0	0 0 3 0 0 0 0 5 0 0 0	1 0 3 0 0 0 0 5 0 0 0	0 0 3 0 0 0 0 5 0 0 0	0 0 3 0 0 0 0 5 0 0 0
Section B Ecological attributes Hard coral Dead standing coral Soft coral Anemone beds Macroalgae Substratum attributes - Section C Hard substrate Continuous pavement Bedrock/boulders Rubble Cobbles Sand or sand and gravel	$ \begin{array}{c} 1 \\ 0 \\ 3 \\ 0 \\ 0 \\ 0 \\ 5 \\ 0 \\ 0 \\ 1 \\ \end{array} $	0 0 3 0 0 0 0 5 0 0 0 1	1 0 3 0 0 0 0 5 0 0 0 1	0 0 3 0 0 0 0 5 0 0 0 1	0 0 3 0 0 0 0 5 0 0 0 1
Section B Ecological attributes Hard coral Dead standing coral Soft coral Anemone beds Macroalgae Substratum attributes - Section C Hard substrate Continuous pavement Bedrock/boulders Rubble Cobbles Sand or sand and gravel	1 0 3 0 0 0 0 5 0 0 1 TA1	0 0 3 0 0 0 0 5 0 0 1 1 TB1	1 0 0 0 0 0 5 0 0 1 TC1	0 0 3 0 0 0 0 5 0 0 1 TD1	0 0 3 0 0 0 0 5 0 0 0 1 1 TE1

LAMMA - HEC SEABED SURVEY

ZONE: ASH LAGOON BASE Section A SOFT CORAL SPECIES FAMILY PLEXAURIDAE

Euplexaura

Euplexaura curvata (white whip coral) Euplexaura sp. (orange) Euplexaura robusta (brown/red body with distinct white polyps) Euplexauara sp. (purple whip coral)

Transect

0

0

TA2	TB2	TC2	TD2	TE2
5	5	5	4	4
2	2	3	2	2
2	2	3	2	3
2	1	1	0	2

Echinogorgia					
Echinogorgia lama	0	0	1	0	0
Echinogorgia sp. (orange)	0	0	0	0	1
Echinogorgia sp. (red)	0	0	0	0	0
Echinogorgia sp. (large fan coral)	0	0	0	0	0

FAMILY ACANTHOGORGIIDAE

Muricella

Muricella sp. (orange)

FAMILY ALCYONIIDAE

Dendronephthya

Dendronephthya sp. A (white body and white spicules (=D in ERM 1999 report)) *Dendronephthya* sp. B (white body and purple spicules) *Dendronephthya* sp. C (white body and red spicules (=B ERM 1999 report))

Scleronephthya

Scleronephthya sp.

Alcyonium

Alcyonium sp. (brown body, orange polyps)

Seapen

Virgularia sp. *Cavernularia* sp.

0	0	2	2	2
0	0	2	2	2
0	0	0	0	2

0

2

0

0	0	0	0	0

0	0	0	0	0

1	0	1	1	0
0	0	0	0	0

AHERMATYPIC CORALS	٦	Fransect				
Tubastrea		TA2	TB2	TC2	TD2	TE2
Tubastrea sp.	Γ	0	0	0	0	0
Dendrophyllia						
Dendrophyllia sp.	C	0	0	0	0	0
Other benthic organisms						
sponges	Г	2	2	0	0	0
zoanthids	F	0	0	0	0	0
Anemone beds	F	0	0	0	0	0
bryozoans	—	0	0	0	0	0
Macro-algae		0	0	0	0	0
Section B Ecological attributes						
Hard coral	Г	0	0	0	0	0
Dead standing coral	F	0	0	0	0	0
Soft coral	F	2	2	2	2	2
Anemone beds	F	0	0	0	0	0
Macroalgae		0	0	0	0	0
Substratum attributes - Section C	F					
Hard substrate	_	0	0	0	0	0
Continuous pavement	-	0	0	0	0	0
Bedrock/boulders		2	1	1	0	1
Rubble		0	0	0	0	0
Cobbles		0	0	0	0	0
Sand or sand and gravel		4	5	5	5	5
		TA2	TB2	TC2	TD2	TE2
DEPTH (m) MAXIMUM		10.6	10.3	10.1	9.8	9.3

Appendix 3

Survey data of gorgonian, soft corals and ahermatypic coral abundance for all transects within the three zone surveyed.

LAMMA POWER STATION - HEC SEABED SURVEY SOFT CORAL COUNTS ZONE: RECLAMATION

ZONE: RECERIMATION									• •••			. 2	
CDD	Тı	тο	тэ	тл	TE	те	т7	то		nies T10		m ⁻ SE	
FAMILY PLEXALIRIDAE	11	12	13	14	15	10	17	10	0 19	110	WEAN	3E	
Euplexaura													
Euplexaura curvata (white whip coral)	209	486	26	700	339	127	95	7	7 579	0	256.80	242.17	
Euplexaura sp. (orange)	1	3	0	0	0	1	0	C) 9	0	1.40	2.69	
Euplexaura robusta (brown/red body with distinct white polyps)	0	1	0	10	12	0	0	C) 2	0	2.50	4.32	
Euplexauara sp. (purple whip coral)	0	0	0	0	1	0	0	0) ()	0	0.10	0.30	
	0	0	Ŭ	0		0	U	Ū	, 0	0	260.80	110.62	
											200.00	110.02	
Echinogorgia													
Echinogorgia lama	0	1	1	2	11	0	0	C) 0	0) 1.50	3.23	
Echinogorgia sp. (orange)	0	0	1	5	9	0	0	C) 5	0	2.00	3.03	
Echinogorgia sp. (red)	0	0	0	0	0	0	0	C) ()	0	0.00	0.00	
Echinogorgia sp. (large fan coral)	0	0	0	0	1	0	0	C) 0	0	0.10	0.30	
											3.50	0.85	
Muricella													
Muricella sp. (orange)	0	4	0	0	2	0	0	C) 0	0	0.60	1.28	
FAMILY ALCYONIIDAE													
Dendronephthya													
Dendronephthya sp. A (white body and white spicules (=D in ERM 1999 report))	0	1	0	9	3	0	0	С) 0	0	1.30	2.72	
Dendronephthya sp. B (white body and purple spicules)	0	3	0	1	4	0	0	C) 0	0	0.80	1.40	
Dendronephthya sp. C (white body and red spicules (=B ERM 1999 report))	0	0	0	0	2	0	0	C) 0	0	0.20	0.60	
Scleronenhthya													
Scleronephthya sp.	0	0	0	0	2	0	0	C) 1	0	0.30	0.64	
Alcyonium													
Alcyonium sp. (brown body, orange polyps)	0	0	0	0	5	0	0	С) 0	0	0.50	1.50	
											3.10	0.40	

RECLAMATION ZONE									Colo	nies	per 100	m²
	T1	T2	Т3	T4	T5	T6	Τ7	Τ8	Т9	T10	MEAN	SE
Seapen												
Virgularia	1	0	0	0	0	0	0	0	0	0	0.10	0.30
Cavernularia	0	0	0	0	0	0	0	0	0	0	0.00	0.00
TOTAL SOFT CORALS	211	499	28	727	391	128	95	7	596	0	268.20	252.40
AHERMATYPIC CORALS												
Tubastrea												
Tubastrea sp.	0	0	0	13	10	0	0	0	1	0	2.40	4.61
Dendrophyllia												
Dendrophyllia sp.	0	0	0	0	1	0	0	0	0	0	0.10	0.30
TOTAL AHERMATYPICS	0	0	0	13	11	0	0	0	1	0	2.50	4.78

LAMMA (HEC SEABED SURVEY)

ASH LAGOON SEAWALL (BASE OF WALL SURVEYED)				Colo	nies p	per 100 m ²	2
SPP	TA1	TB1	TC1	TD1	TE1	MEAN	SE
FAMILY PLEXAURIDAE							
Euplexaura							
Euplexaura curvata (white whip coral)	1724	829	1092	966	237	969.60	477.62
Euplexaura sp. (orange)	21	12	7	3	12	11.00	6.03
Euplexaura robusta (brown/red body with distinct white polyps)	14	16	9	0	11	10.00	5.55
Euplexauara sp. (purple whip coral)	1	0	1	2	4	1.60	1.36
						992.20	416.60
Echinogorgia							
Echinogorgia lama	5	0	1	0	0	1.20	1.94
Echinogorgia sp. (orange)	16	3	5	0	0	4.80	5.91
Echinogorgia sp. (red)	0	1	0	0	0	0.20	0.40
Echinogorgia sp. (large fan coral)	0	0	0	0	0	0.00	0.00
						6.20	1.93
Muricella							
Muricella sp. (orange)	2	1	1	0	0	0.80	0.75
FAMILY ALCYONIIDAE							
Dendronephthya							
Dendronephthya sp. A (white body and white spicules (=D in ERM 1999 report))	17	6	0	0	2	5.00	6.39
Dendronephthya sp. B (white body and purple spicules)	7	7	0	0	0	2.80	3.43
Dendronephthya sp. C (white body and red spicules (=B ERM 1999 report))	3	0	0	0	0	0.60	1.20
Scleronenhthya						8.40	1.80
Scleronephthya sp.	0	0	0	0	0	0.00	0.00
Alcyonium							
Alcyonium sp. (brown body, orange polyps)	0	0	0	0	0	0.00	0.00

H LAGOON SEAWALL (BASE OF WALL SURVEYED)				Colo	nies p	oer 100 m ²	
	TA1	TB1	TC1	TD1	TE1	MEAN	SE
seapen							
Virgularia	0	0	0	0	0	0.00	0.00
Cavernularia	0	0	0	0	0	0.00	0.00
TOTAL SOFT CORALS	1810	875	1116	971	266	1007.60	494.87
AHERMATYPIC CORALS							
Tubastrea							
Tubastrea sp.	2	0	1	0	0	0.60	0.80
Dendrophyllia							
Dendrophyllia sp.	0	0	0	0	0	0.00	0.00
TOTAL AHERMATYPICS	2	0	1	0	0	0.60	0.80

LAMMA - HEC SURVEY							
ASH LAGOON BASE							
SOFT CORAL COUNTS					Color	nies per	100 m ²
SPP	TA2	TB2	TC2	TD2	TE2	MEAN	SE
FAMILY PLEXAURIDAE							
Euplexaura							
Euplexaura curvata (white whip coral)	530	603	613	233	202	436.20	181.12
<i>Euplexaura</i> sp. (orange)	5	2	10	5	3	5.00	2.76
Euplexaura robusta (brown/red body with distinct white polyps)	17	3	11	4	1	7.20	5.95
Euplexauara sp. (purple whip coral)	2	0	1	1	2	1.20	0.75
					-	449.60	186.96
Echinogorgia							
Echinogorgia lama	0	0	1	0	0	0.20	0.40
Echinogorgia sp. (orange)	1	0	0	0	0	0.20	0.40
Echinogorgia sp. (red)	0	0	0	0	0	0.00	0.00
Echinogorgia sp. (large lan coral)	0	0	0	0	0	0.00	0.00
FAMILY ACANTHOGORGIIDAE						0.40	0.10
Muricella							
Muricella sp. (orange)	0	2	0	0	0	0.40	0.80
	C C	_	Ū	Ū	Ū	01.0	0.00
FAMILY ALCYONIIDAE							
Dendronephthya							
Dendronephthya sp. A (white body and white spicules (=D in ERM 1999 report))	2	3	4	0	0	1.80	1.60
Dendronephthya sp. B (white body and purple spicules)	3	4	4	0	0	2.20	1.83
Dendronephthya sp. C (white body and red spicules (=B ERM 1999 report))	4	0	0	0	0	0.80	1.60
Colorenenkthur						4.80	0.59
Scieronephthya sp	Δ	0	0	0	0	0.00	0.00
Sciencipininga sp.	0	0	0	0	0	0.00	0.00
Alcyonium							
Alcyonium sp. (brown body, orange polyps)	0	0	0	0	0	0.00	0.00
					-	9.60	0.59

ASH LAGOON BASE	TA2	TB2	TC2	TD2	Color TE2	nies per MEAN	100 m ² SE	
seapen Virgularia Cavernularia	0 0	1 0	1 0	0 0	1 0_	0.60 0.00 0.60	0.49 0.00 0.30	
TOTAL SOFT CORALS	564	618	645	243	209	455.80	189.74	
AHERMATYPIC CORALS Tubastrea Tubastrea sp.	0	0	0	0	0	0.00	0.00	
Dendrophyllia Dendrophyllia sp.	0	0	0	0	0	0.00	0.00	
TOTAL AHERMATYPICS	0	0	0	0	0	0.00	0.00	