

EP-167/2003/B

**Proposed Submarine Gas Pipelines from Cheng Tou Jiao
Liquefied Natural Gas Receiving Terminal, Shenzhen to
Tai Po Gas Production Plant, Hong Kong**

**Baseline Monitoring Report – Part B
(Final)**

Meinhardt Mouchel Limited

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	Name	Position	Signature	Date
Prepared by	Dr Shaun Nicholson	Project Manager		18 August 2005
	Dr So Chi-Ming	Environmental Scientist		18 August 2005
	Mr Hui Yuk-Hung	Benthic Ecologist		18 August 2005
Checked by	Helen Cochrane	Project Director / Environmental Team Leader		18 August 2005
Certified by	Helen Cochrane	Project Director / Environmental Team Leader		18 August 2005
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BASELINE MONITORING REPORT – PART B

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EXECUTIVE SUMMARY - TOLO CHANNEL

The baseline water quality monitoring was conducted between February and March 2005 in accordance with the requirements stipulated in the *EM&A Manual*. A total of 12 surveys were undertaken over a 4-week period with water samples and *in situ* measurements taken at 3 water depths during mid-flood and mid-ebb tides. Statistical analysis of the data indicated that there were generally only minor differences in levels of suspended solids, turbidity and dissolved oxygen between Impact and Control stations in different Zones. No unusual phenomena and activities which might have influenced the monitoring results were observed during the monitoring period. It is concluded that the water monitoring results are representative of the baseline conditions before commencement of the construction activities. The Action and Limit Levels for SS and turbidity derived from the baseline data are appropriate for use in the subsequent impact and post-project monitoring.

The baseline ecological survey at Chek Chau and the Tolo Channel was conducted at 8 selected hard, soft and black coral areas (1 Control and 7 Impact stations) between February and April 2005 in accordance with the *EM&A Manual*. A total of 344 coral colonies (hard, soft and black) were tagged for future impact monitoring. The baseline survey established the status of the coral communities prior to commencement of works. The results also indicate that the Control station is suitable as a reference area for the subsequent impact monitoring. It should, however, be noted that the coral communities previously recorded in the deeper areas of Tolo Channel had largely been extirpated (most likely as a consequence of a hypoxia event in 2004) and prevailing hydrological conditions must be considered during the Impact monitoring.

1. INTRODUCTION

1.1 Background

The Hong Kong and China Gas Company Limited (Towngas) conducted a feasibility study for the development of a natural gas supply system from the Cheng Tou Jiao Liquefied Natural Gas Receiving Terminal (GRT), Shenzhen, People's Republic of China (PRC), to the Towngas Gas Production Plant (GPP) located in the Tai Po Industrial Estate, Hong Kong Special Administrative Region (HKSAR). The system comprises two natural gas pipelines which convey the liquefied natural gas (LNG) from Shenzhen to Tai Po and associated facilities include a launching station at the GRT and a gas receiver station at the GPP.

An EIA study (ERM, 2003a) was undertaken for this project and an Environmental Permit (EP-167/2003) was issued on 30 May 2003 with detailed monitoring requirements stipulated in the *EM&A Manual* (ERM, 2003b) for ensuring compliance with mitigation measures specified for amongst others water quality and marine ecological impacts. It is noted that an application for the variation of the EP (VEP) was submitted on 30 December 2004, which was approved with the amended EP (EP-167/2003/A) issued on 24 January 2005. Another VEP application was submitted on 26 April 2005, which was approved with the amended EP (EP-167/2003/B) issued on 13 May 2005, and EP-167/2003/B is the current EP of the captioned project.

1.2 Objectives of the Baseline Monitoring

Condition 4.2(a) of the Environmental Permit (EP-167/2003/A) requires baseline monitoring for water quality and marine ecology (corals) before commencement of any construction activities. Representative data for water quality and corals were gathered from the key areas along the pipelines alignment ([Figure 1.2a](#)) in accordance with the requirements in the *EM&A Manual*. The baseline water quality data are also used to derive Action and Limit Levels to be used as numeric criteria of compliance in the subsequent impact and post-project water quality monitoring. This report is a required submission under Condition 4.4 of the EP and presents the results of the baseline monitoring in Tolo Harbour and Channel.

1.3 Structure of the Baseline Monitoring Report

This report (Part B) forms the second part of the baseline monitoring report which presents the baseline water quality and ecological monitoring results for the Tolo Harbour and Channel areas. (Part A of the baseline report which covers the Tung Ping Chau area has already been issued.) The contents of this report are as follows:

Section 1 Introduction

- provides the background of the project and the objectives of the monitoring.

Section 2 Water Quality Monitoring

- reports and analyses the water quality monitoring results in Zone A, B and D and establishes the Action and Limit Levels for water quality parameters.

Section 3 Marine Ecological Monitoring

- reports and analyses the monitoring results for hard, soft and black corals and describes the baseline conditions of the coral communities in Tolo Channel.

Section 4 Conclusions

- provides conclusions of the baseline monitoring.

1.4 References

EP-167/2003 Environmental Permit for the Proposed Submarine Gas Pipelines from Cheng Tou Jiao Liquefied Natural Gas Receiving Terminal, Shenzhen to Tai Po Gas Production Plant, Hong Kong.

ERM (2003a). *Proposed Submarine Gas Pipelines from Cheng Tou Jiao Liquefied Natural Gas Receiving Terminal, Shenzhen to Tai Po Gas Production Plant, Hong Kong – EIA Study. Environmental Impact Assessment Report.*

ERM (2003b). *Proposed Submarine Gas Pipelines from Cheng Tou Jiao Liquefied Natural Gas Receiving Terminal, Shenzhen to Tai Po Gas Production Plant, Hong Kong – EIA Study. Environmental Monitoring and Audit (EM&A) Manual.*

2. WATER QUALITY MONITORING

Baseline water quality monitoring was conducted between February and March 2005 in accordance with the requirements stipulated in the *EM&A Manual*. Water samples and *in situ* measurements were taken at different water depths during mid-flood and mid-ebb tides over a 4-week period. The monitoring data were analysed to establish the water quality baseline conditions along the gas pipeline alignment before works commencement. Any significant differences in the key water quality parameters between the Impact and Control stations were also identified statistically. The Action and Limit Levels for suspended solids and turbidity were derived from the baseline data in accordance with the *EM&A Manual* for use in the subsequent impact and post-project monitoring. The following sections report on the baseline water quality in Zone A, B and D in Tolo Harbour and Channel.

2.1 Monitoring Methodology

2.1.1 Monitoring Locations and Depths

Monitoring locations during the baseline work were set up to provide representative water quality data for the key areas along the pipelines alignment. The locations of the water quality monitoring stations in the Tolo Harbour and Channel comprised zones A, B and D and are shown in [Figure 1.2a](#) (see Section 1 above). The station coordinates are provided below in [Table 2.1a](#).

Table 2.1a *Baseline Monitoring Stations*

Station Code	Nature of Station	Location	Coordinates X (HK Grid)	Coordinates Y (HK Grid)
Zone A				
A1	Control Station	Centre Island	840701.71	832767.91
A2	Control Station	Inner Tolo Harbour	837040.38	834316.23
A3	Impact Station	Fish Culture Zone	839270.9	834848.23
A4	Impact Station	Excavation site (WSD Intake)	837507.55	834575.95
Zone B				
B1	Control Station	Hoi Ha	851764.08	838090.46
B2	Gradient Station	Tolo Channel	846733.08	836317.45
B3	Control Station	Mirs Bay	852845.94	841657.46
B4	Control Station	Sham Chung Kok	846234.67	834058.42
Zone D				
D1	Impact Station	Pak Sha Tau	843974.84	834766.98

At each station, measurements and samples were taken at three depths: 1m below the sea surface, mid depth and 1m above the seabed. Where water depth was less than 6m the mid-depth measurements and samples were omitted. If water depth was less than 3m, only the mid-depth was monitored. At each depth, *in situ* measurements and water samples were both taken in duplicate.

2.1.2 Monitoring Frequency and Duration

Baseline monitoring was conducted over a 4-week period (14 February to 12 March 2005) prior to the commencement of the construction works. Monitoring was undertaken three days per week at all baseline stations using two survey vessels. In each event, monitoring was conducted over both mid-flood and mid-ebb tides. Each set of monitoring was completed

within a 3 hour time window of 1.5 hours before and after mid-flood or mid-ebb tides. The time interval between two consecutive monitoring events was at least 36 hours. *Table 2.1b* summarises the date and time of all baseline water quality monitoring events.

Table 2.1b Timing of Baseline Water Quality Monitoring Events

Date	Tidal State	Duration of Monitoring
14 Feb 2005	Mid-flood	7:58 – 10:18
	Mid-ebb	15:24 – 17:41
16 Feb 2005	Mid-flood	8:41 – 10:55
	Mid-ebb	15:31 – 17:37
18 Feb 2005	Mid-flood	9:05 – 11:40
	Mid-ebb	18:08 – 20:42
22 Feb 2005	Mid-flood	15:30 – 18:12
	Mid-ebb	10:12 – 12:38
24 Feb 2005	Mid-flood	15:35 – 18:07
	Mid-ebb	10:48 – 13:13
26 Feb 2005	Mid-flood	7:17 – 9:48
	Mid-ebb	12:51 – 15:20
1 March 2005	Mid-flood	6:44 – 9:06
	Mid-ebb	14:53 – 17:20
3 March 2005	Mid-flood	8:53 – 11:09
	Mid-ebb	15:35 – 17:52
5 March 2005	Mid-flood	8:24 – 10:28
	Mid-ebb	18:07 – 20:21
8 March 2005	Mid-flood	13:46 – 16:06
	Mid-ebb	9:44 – 12:00
10 March 2005	Mid-flood	15:34 – 17:46
	Mid-ebb	10:37 – 12:50
12 March 2005	Mid-flood	5:48 – 8:04
	Mid-ebb	12:52 – 15:09

2.1.3 Parameters Monitored

The parameters measured *in situ* included:

- dissolved oxygen (DO) (% saturation and mg/L)
- temperature (°C)
- turbidity (NTU)
- salinity (ppt)

The only parameter determined in the laboratory was:

- suspended solids (SS) (mg/L)

In addition to the above water quality parameters, other relevant data and information were also recorded, including the location of the sampling stations, water depth, sampling time, weather conditions, sea conditions, tidal state, as well as any special phenomena and activities around the monitoring area that might have influenced the monitoring results.

2.1.4 Equipment and Laboratory Method

2.1.4.1 In situ Measurement and Sampling Equipment

The equipment used for the measurement of water quality parameters are summarised below in *Table 2.1c*. Water depth was measured by an echo sounder (Eagle Magna III) while horizontal positioning was determined by a handheld GPS (Garmin GPS II Plus). All water samples were stored in clean high density polythene bottles, packed in ice chest (cooled at ~ 4°C without being frozen), and immediately delivered to the laboratory for analysis.

Table 2.1c Equipment for In situ Measurement and Sampling

Equipment	Brand/Model	Accuracy
DO Meter	YSI 58	±0.03 mg/L ±0.3% saturation
Thermometer (combined with DO meter)	YSI 58	±0.3°C
Salinometer	YSI 33	±0.1 ppt
Turbidimeter	HACH 2100P	± 2%
Water sampler	Kahlsico 135WB153	n/a

All instruments used were checked, calibrated and certified by a HOKLAS accredited laboratory (Fugro Technical Services Limited - MaterialLab Division) before use and subsequently re-calibrated as per requirements in the *EM&A Manual*.

2.1.4.2 Laboratory Method

Analysis of suspended solid in water samples was conducted by a HOKLAS accredited laboratory (MaterialLab) using the standard method APHA 2540D with a detection limit of 1mg/L. QA/QC procedures were in line with the HOKLAS requirements.

2.1.5 Data Analysis

The data for all water quality parameters monitored (depth-averaged and bed layer only) were analysed and summary statistics as mean and range determined. Any statistically significant differences in levels of suspended solids (SS), turbidity and dissolved oxygen (DO) between the Impact and Control stations for each Zone were identified by ANOVA (SPSS for Windows, Version 10). Individual stations in all Zones were also compared using the Student-Newman-Keuls test following an ANOVA test. The 95th percentiles of the SS and turbidity data for specific Zones and water depths (see also *Table 2.3a*) were determined to establish the Action and Limit Levels in accordance with the *EM&A Manual*.

2.2 Monitoring Results

2.2.1 Data Summary

A summary of the baseline water quality monitoring data for stations in Zone A, B and D at different depths is presented below in *Table 2.2a*. The dataset for the baseline water quality monitoring in the Tolo Harbour and Channel areas is included in *Annex A*. A statistical analysis by ANOVA was also performed to determine if there were any significant differences in SS, turbidity and DO between the Impact and Control stations in each Zone. (statistical analysis was not performed for Zone B as only control stations in this zone were monitored in the baseline monitoring.) Results of the ANOVA tests are summarised below in

Table 2.2b. Comparisons for the water quality parameters among individual stations in all Zones (A, B and D) were performed by ANOVA followed by the Student-Newman-Keuls test and the results are also presented in *Table 2.2b*. Full details of all the statistical analyses are included in *Annex B*. Further discussions on particular water quality parameters are provided in the following sub-sections.

2.2.2 Suspended Solids (SS)

In Zone A, depth averaged and bed layer SS concentrations at the Impact stations (A3-A4) were significantly lower than those at the Control (A1-A2; *Table 2.2b*) but the differences among these stations were minor (*Table 2.2a*). In Zone D, depth-averaged and bed layer SS concentrations at the Impact station (D1) were significantly higher than the Control (B2; *Table 2.2b*) although the differences were minor (*Table 2.2a*). When individual stations in all Zones were compared statistically, significantly lower SS concentrations (depth-averaged and bed layer) were observed mostly at the stations in Zone B while slightly higher concentrations were found at those in Zone A (*Table 2.2b*). The depth-averaged and bed layer SS concentrations at each station in all zones were, however, generally similar (*Table 2.2a*).

2.2.3 Turbidity

In Zone A, depth averaged and bed layer turbidity levels at the Impact stations (A3-A4) were significantly lower than those at the Control (A1-A2; *Table 2.2b*) but the differences among these stations were minor (*Table 2.2a*). In Zone D, both depth-averaged and bed layer turbidity levels at the Impact station (D1) were significantly higher than the Control (B2; *Table 2.2b*) although the differences were minor (*Table 2.2a*). When individual stations in all Zones were compared statistically, significantly lower turbidity levels (depth-averaged and bed layer) were observed mostly at the stations in Zone B while slightly higher levels were measured at those in Zone A (*Table 2.2b*), a pattern consistent with that for SS (see *Section 2.2.2* above). The depth-averaged and bed layer turbidity levels at each station in all zones were, however, generally similar (*Table 2.2a*).

2.2.4 Dissolved Oxygen (DO)

In Zone A, depth averaged DO concentrations at the Impact stations (A3-A4) were significantly lower than those at the Control stations (A1-A2; *Table 2.2b*) but the differences among them were minor (*Table 2.2a*). No significant difference in bed layer DO was detected between the Impact (A3-A4) and Control (A1-A2) stations (*Table 2.2b*). In Zone D, depth-averaged and bed layer DO levels at the Impact station (D1) were significantly lower than the Control (B2; *Table 2.2b*) although the differences were minor (*Table 2.2a*). When individual stations in all Zones were compared statistically, significantly lower DO concentrations (depth-averaged and bed layer) were observed mostly at the stations in Zone A while slightly higher concentrations were measured at those in Zone B (*Table 2.2b*). The depth-averaged and bed layer DO concentrations at each station in all zones were generally similar (*Table 2.2a*).

2.2.5 Temperature and Salinity

The depth-averaged water temperature and salinity were similar among all stations within each Zone (*Table 2.2a*). There were also only minor differences evident between the depth-averaged and bed layer temperature and salinities at each station (*Table 2.2a*), generally indicating no water column stratification typical of the dry season (February and March) conditions.

Table 2.2a Summary of Baseline Water Quality Monitoring Results in the Tolo Harbour and Channel (February – March 2005)

Station	Water Depth	SS (mg/L) ¹	Turbidity (NTU) ²	DO (mg/L) ²	Temperature (°C) ²	Salinity (ppt) ²
A1 (Control)	Depth-averaged	4 (2 - 7)	1.9 (1.0 - 3.9)	7.3 (6.2 - 10.5)	16.5 (14.8 - 18.5)	32.0 (28.8 - 32.6)
	Bed layer	4 (2 - 7)	2.0 (1.1 - 3.9)	7.1 (6.2 - 8.6)	16.3 (15.0 - 18.1)	32.2 (29.8 - 32.6)
A2 (Control)	Depth-averaged	5 (3 - 13)	2.9 (1.4 - 5.3)	7.0 (4.8 - 10.4)	17.1 (15.0 - 19.3)	31.7 (28.5 - 32.5)
	Bed layer	5 (3 - 7)	3.0 (1.4 - 5.3)	7.0 (4.8 - 10.4)	17.1 (15.1 - 19.0)	31.8 (29.5 - 32.5)
A3 (Impact)	Depth-averaged	3 (2 - 5)	1.7 (0.8 - 2.8)	6.7 (5.2 - 9.6)	16.7 (14.9 - 19.4)	31.9 (29.4 - 32.5)
	Bed layer	3 (2 - 5)	1.7 (0.9 - 2.6)	6.7 (5.3 - 9.2)	16.6 (15.1 - 18.3)	32.0 (30.0 - 32.5)
A4 (Impact)	Depth-averaged	4 (2 - 6)	2.5 (1.3 - 4.4)	6.9 (5.0 - 10.2)	17.0 (14.8 - 19.2)	31.7 (28.8 - 32.6)
	Bed layer	4 (2 - 6)	2.5 (1.3 - 4.3)	6.9 (5.5 - 9.8)	16.9 (15.0 - 18.7)	31.9 (29.7 - 32.6)
B1 (Control)	Depth-averaged	3 (2 - 5)	1.3 (0.4 - 3.1)	7.9 (6.7 - 9.5)	15.9 (14.9 - 17.5)	32.4 (31.9 - 32.8)
	Bed layer	3 (2 - 5)	1.4 (0.5 - 3.1)	7.8 (6.8 - 9.3)	15.8 (14.9 - 17.2)	32.4 (31.9 - 32.8)
B2 (Control)	Depth-averaged	3 (2 - 5)	1.3 (0.5 - 2.3)	7.8 (6.4 - 9.7)	16.2 (15.0 - 17.7)	32.4 (32.0 - 32.8)
	Bed layer	3 (2 - 5)	1.3 (0.6 - 2.3)	7.7 (6.4 - 9.1)	16.0 (15.0 - 17.5)	32.5 (32.2 - 32.8)
B3 (Control)	Depth-averaged	3 (2 - 5)	1.3 (0.3 - 3.6)	8.1 (6.8 - 11.3)	15.9 (14.8 - 17.8)	32.4 (32.0 - 32.8)
	Bed layer	3 (2 - 5)	1.3 (0.4 - 3.5)	7.9 (6.8 - 9.5)	15.8 (14.8 - 17.3)	32.5 (32.0 - 32.8)
B4 (Control)	Depth-averaged	3 (2 - 6)	1.7 (0.4 - 4.2)	7.5 (6.4 - 9.7)	16.4 (15.0 - 18.3)	32.2 (29.3 - 32.7)
	Bed layer	3 (2 - 6)	1.7 (0.8 - 4.2)	7.4 (6.4 - 8.9)	16.2 (15.2 - 17.8)	32.3 (30.1 - 32.7)
D1 (Impact)	Depth-averaged	3 (2 - 5)	1.6 (0.7 - 2.9)	7.5 (6.4 - 9.5)	16.4 (14.8 - 18.4)	32.2 (29.1 - 32.7)
	Bed layer	3 (2 - 5)	1.6 (0.9 - 2.8)	7.4 (6.4 - 9.1)	16.3 (15.1 - 17.9)	32.3 (30.1 - 32.7)

Notes: Results are mean (min. – max.) ¹ Values were rounded as reporting limit for SS was 1 mg/L. ² Values were rounded to 1 decimal place.

Table 2.2b Statistical Analyses (ANOVA) for Differences between Impact and Control Stations in Zone A, B and D and Comparison among Individual Stations in All Zones

Zone	Stations Compared	Water Depth	SS (mg/L)	Turbidity (NTU)	DO (mg/L)
A	A3-A4 (Impact) vs A1-A2 (Control)	Depth averaged	I<C ***	I<C **	I<C ***
		Bed layer	I<C **	I<C **	NS
B	Not applicable ¹				
D	D1 (Impact) vs B2 (Control)	Depth-averaged	I>C ***	I>C ***	I<C **
		Bed layer	I>C *	I>C **	I<C *
All	All individual stations ²	Depth-averaged	A2 > A4 > <u>A1</u> <u>D1</u> <u>B4</u> <u>A3</u> B2 B3 B1	A2 > A4 > A1 > <u>A3</u> B4 D1 > <u>B3</u> B2 B1	<u>B3</u> B1 B2 > <u>B4</u> D1 A1 > <u>A2</u> A4 A3
		Bed layer	A2 > A4 > <u>A1</u> <u>B4</u> <u>D1</u> <u>A3</u> B2 B1 B3	A2 > A4 > A1 > <u>A3</u> B4 D1 B1 B3 B2	<u>B3</u> B1 B2 <u>B4</u> <u>D1</u> <u>A1</u> <u>A2</u> <u>A4</u> A3

Notes: I = Impact stations; C = Control stations; “<”: significantly lower; “>”: significantly higher; NS: no significant difference ($P \geq 0.05$); * = $P < 0.05$; ** = $P < 0.01$; *** = $P < 0.001$. ¹ No Impact station was monitored in Zone B during the baseline monitoring. ² Multiple comparisons among individual stations were based on the Student-Newman-Keuls *post hoc* test, stations underlined are not significantly different

2.2.6 Other Activities and Weather Conditions during Monitoring

The baseline monitoring was undertaken before commencement of any works and no major activities were being carried out during the monitoring period. No unusual phenomena or activities that might have influenced the monitoring were observed during the baseline surveys. The weather conditions were generally cloudy and occasionally foggy and rainy (see *Annex A* for records of weather conditions).

2.2.7 QA/QC

All field equipment were calibrated in accordance with the requirements in the *EM&A Manual*. All QC results for the SS analysis were acceptable based on the QA/QC requirements of the HOKLAS accredited laboratory. Calibration records for the field equipment and QA/QC results for the SS analysis are appended in *Annex C*.

2.3 Determination of Action and Limit Levels

In accordance with *Section 3.3* of the *EM&A Manual*, baseline water quality data are to be used to derive the Action and Limit Levels for SS and turbidity for application to various sensitive receivers in different areas. The derivation methods and the values of the Action and Limit Levels thus derived are presented below in *Table 2.3a*. Based on the results in Part B of the Baseline Monitoring Report, a summary of all the Action and Limits Levels applicable in all zones in the subsequent impact and post-project water quality monitoring is provided below in *Table 2.3b*.

2.4 Summary

Baseline water quality monitoring was conducted from February to March 2005 based on the requirements stipulated in the *EM&A Manual*. A total of 12 surveys were undertaken over 4 weeks with water sampling and *in situ* measurements taken at 3 water depths (where appropriate) during mid-flood and mid-ebb tides. Statistical analyses of the dataset was undertaken using one-way ANOVA.

Analysis of the data indicated that although statistically significant differences in suspended solids, turbidity and dissolved oxygen were detected between certain Impact and Control stations in various zones, the differences were minor. No unusual phenomena and activities which might have influenced the monitoring results were observed during the whole monitoring period. It is concluded that the water monitoring results are representative of the baseline conditions before commencement of the construction activities. The Action and Limit Levels for SS and turbidity derived from the baseline data are appropriate for use in the subsequent impact and post-project monitoring.

2.5 References

ERM (2003). *Proposed Submarine Gas Pipelines from Cheng Tou Jiao Liquefied Natural Gas Receiving Terminal, Shenzhen to Tai Po Gas Production Plant, Hong Kong – EIA Study. Environmental Monitoring and Audit (EM&A) Manual*.

Table 2.3a Derivation of Action and Limits Levels from Water Quality Baseline Data for Zone A, B and D¹

Parameter	Area	Sensitive Receiver	Water Depth	Action Level Derivation Method	Value of Action Level	Limit Level Derivation Method	Value of Limit Level
SS (mg/L)	Zone A	WSD Intake	Depth-averaged	95 percentile of baseline data (stations A1 – A4)	6 mg/L	N/A ²	N/A ²
		Fish Culture Zone	Depth-averaged	95 percentile of baseline data (stations A1 – A4)	6 mg/L	Mean value from baseline data obtained at all of the stations plus 10 mg/L.	14 mg/L
	Zone B	Fish Culture Zone	Depth-averaged	95 percentile of baseline data (stations B1 – B4)	4 mg/L	Mean value from baseline data obtained at all of the stations plus 10 mg/L.	13 mg/L
		Corals	Bed layer	95 percentile of baseline data (stations B1 – B4)	4 mg/L	Mean value from baseline data obtained at all of the stations plus 10 mg/L.	13 mg/L
	Zone D	Corals	Bed layer	95 percentile of baseline data (stations D1 and B2)	4 mg/L	Mean value from baseline data obtained at all of the stations plus 10 mg/L.	13 mg/L
Turbidity (NTU)	Zone A	WSD Intake	Depth-averaged	95 percentile of baseline data (stations A1 – A4)	3.9 NTU	N/A ²	N/A ²
		Fish Culture Zone	Depth-averaged	95 percentile of baseline data (stations A1 – A4)	3.9 NTU	Mean value from baseline data obtained at all of the stations plus 10 NTU.	12.2 NTU
	Zone B	Fish Culture Zone	Depth-averaged	95 percentile of baseline data (stations B1 – B4)	2.5 NTU	Mean value from baseline data obtained at all of the stations plus 10 NTU.	11.4 NTU
		Corals	Bed layer	95 percentile of baseline data (stations B1 – B4)	2.5 NTU	Mean value from baseline data obtained at all of the stations plus 10 NTU.	11.4 NTU
	Zone D	Corals	Bed layer	95 percentile of baseline data (stations D1 and B2)	2.4 NTU	Mean value from baseline data obtained at all of the stations plus 10 NTU.	11.5 NTU

Notes: ¹Only the Action and Limit Levels to be derived from the baseline data are presented. For a full description of all the Action and Limit Levels see *Table 2.3b* below. ²Not derived from baseline data (see the *EM&A Manual*).

Table 2.3b Action and Limit Levels for Water Quality Monitoring

Parameter	Sensitive Receiver	Depth	Action Level	Limit Level
Zone A – Tai Po Landing Area				
DO (mg/L)	WSD Intake	Surface, Middle, Bottom	Data from impact stations (A3 and A4) show a depletion of 30% compared with corresponding data from control stations.	DO levels are <5 mg/L at the surface and middle depths or are <2 mg/L for the bottom depth.
	Fish Culture Zone			
SS (mg/L)	WSD Intake	Depth-averaged	Impact stations exceed 6 mg/L or 120% of the control station's SS at the same tide of the same day.	Exceedance of the Limit Value = 10 mg/L
	Fish Culture Zone	Depth-averaged	Same as above.	Exceedance of the Limit Value = 14 mg/L
Turbidity (NTU)	WSD Intake	Depth-averaged	Impact stations exceed 3.9 NTU or 120% of the control station's turbidity at the same tide of the same day.	Exceedance of the Limit Value = 10 NTU.
	Fish Culture Zone	Depth-averaged	Same as above.	Exceedance of the Limit Value = 12.2 NTU
Zone B – Jetting within Tolo Channel				
DO (mg/L)	Fish Culture Zone	Surface, Middle, Bottom	Data from impact station (LFW1) shows a depletion of 30% compared with corresponding data from control station (B4). If gradient station (B2) reports higher DO values than LFW1 the Action Level is not exceeded.	DO levels are <5 mg/L at the surface and middle depths or are <2 mg/L for the bottom depth.
SS (mg/L)	Fish Culture Zone	Depth-averaged	Impact stations exceed 4 mg/L or 120% of control station's SS at the same tide of the same day. If gradient stations report lower SS values than impact stations then Action Level is not exceeded.	Exceedance of the Limit Value = 13 mg/L
	Corals	Bed layer	Impact stations exceed 4 mg/L or 120% of control station's SS at the same tide of the same day. If gradient stations report lower SS values than impact stations then Action Level is not exceeded.	Exceedance of the Limit Value = 13 mg/L
Turbidity (NTU)	Fish Culture Zone	Depth-averaged	Impact stations exceed 2.5 NTU or 120% of control station's turbidity at the same tide of the same day. If gradient stations report lower NTU values than impact stations the Action Level is not exceeded.	Exceedance of the Limit Value = 11.4 NTU
	Corals	Bed layer	Impact stations exceed 2.5 NTU or 120% of control station's turbidity at the same tide of the same day. If gradient stations report lower NTU values than impact stations the Action Level is not exceeded.	Exceedance of the Limit Value = 11.4 NTU
Zone D – Jetting works within 2 km either side of Pak Sha Tau				
SS (mg/L)	Corals	Bed layer	Impact station (D1) exceeds 4 mg/L or 120% of control station (B2) SS at the same tide of the same day.	Exceedance of the Limit Value = 13 mg/L
Turbidity (NTU)	Corals	Bed layer	Impact station (D1) exceeds 2.4 NTU or 120% of control station (B2) turbidity at the same tide of the same day.	Exceedance of the Limit Value = 11.5 NTU

3. MARINE ECOLOGICAL MONITORING

3.1 Introduction

Hong Kong's coastal waters support high-latitude coral communities, predominately in eastern waters but with scattered coral colonies recorded from most relatively shallow, rocky shores throughout the region (Oceanway 2002a). These coral assemblages are known as incipient reefs (Oceanway 2002b). Over 80 different species of hard coral occur locally (Oceanway 2002a). It is acknowledged that these communities occur at near their tolerance limits for the survival and growth of reef-building scleractinian corals and many of the species recorded have a low tolerance to high turbidity and sediment loading (Scott 1984; Oceanway 2002a). Unfortunately, both anthropogenic and natural stresses are threatening many of these corals and reef communities can be affected by impacts from development. The impacts to corals in Hong Kong are reasonably well described and corals recorded in surveys in the mid 1980's had often disappeared by the end of the 1990's (Scott 1984; Binnie 1995; Oceanway 2002a). Recent surveys confirm that the majority of Hong Kong's hard coral communities occur in the north-eastern waters.

Hong Kong has a diverse community of soft and black corals. Soft corals (including gorgonians) and black corals are generally recorded in deeper waters in areas of high current flow. Most species have been shown to be more tolerant to turbid conditions and low light intensities than hard corals. Surveys have shown that large populations of gorgonians exist in the eastern and southern waters of Hong Kong (Oceanway 2002a, Oceanway 2004). Surveys have recorded black corals in most of the suitable areas below 8m depth in eastern waters, with some areas having healthy colonies as shallow as 3m depth. This includes areas around East Ping Chau, Hoi Ha Wan, Tolo Channel and Long Harbour (Scott and Cope 1982; Oceanway 2002a).

The Hong Kong Government has recognised the importance of the local coral communities and is proactive in protecting these communities from further degradation. Under the existing Animals and Plants (Protection of Endangered Species) Ordinance (CAP. 187) all corals are protected in Hong Kong. A program of gazetting Marine Parks was initiated in the 1990's with three areas set up in the coral community rich north-eastern waters of Hong Kong; around East Ping Chau Island, Hoi Ha Wan and Yan Chau Tong. All of these areas were established to preserve the rich coral communities present.

In 1995, a proposal to construct a dual submarine gas pipeline between the natural gas receiving terminal at Cheng Tou Jiao, Shenzhen to the gas production plant at Tai Po in Hong Kong was investigated. A detailed study was carried out (ERM 2003a) and the project was approved by the Hong Kong Environmental Protection Department (EPD) in 2003. The Environmental Monitoring and Audit (EM&A) Manual (ERM 2003b) was approved on the 23rd April 2003. This manual details the need for a Baseline Study and Impact Monitoring of the coral areas near to the affected works area. The *EM&A Manual* isolated 9 coral areas that required monitoring during the works period. Two control (reference) sites are also monitored to determine any water quality/ecological alterations that are not associated with pipeline laying and associated marine works. The route of the pipeline and the locations of the monitoring and control sites are presented in *Figure 3.1a*. For the Tolo Harbour and Channel area, a total of eight locations were monitored comprising seven impact and one control stations.

Past research has shown that Hong Kong's corals are sensitive to changes in salinity, turbidity and water temperature (Scott 1984; Morton and Morton 1983). The typical stress response is a change in colour, with the most severe indication being total bleaching. The impact monitoring required at the coral areas includes the detection of bleaching and blanching that occur on specific tagged hard corals. The detection of any impacts attributable to the works

will be assessed by coral specialists and audited against action limits set by the EM&A for this project.

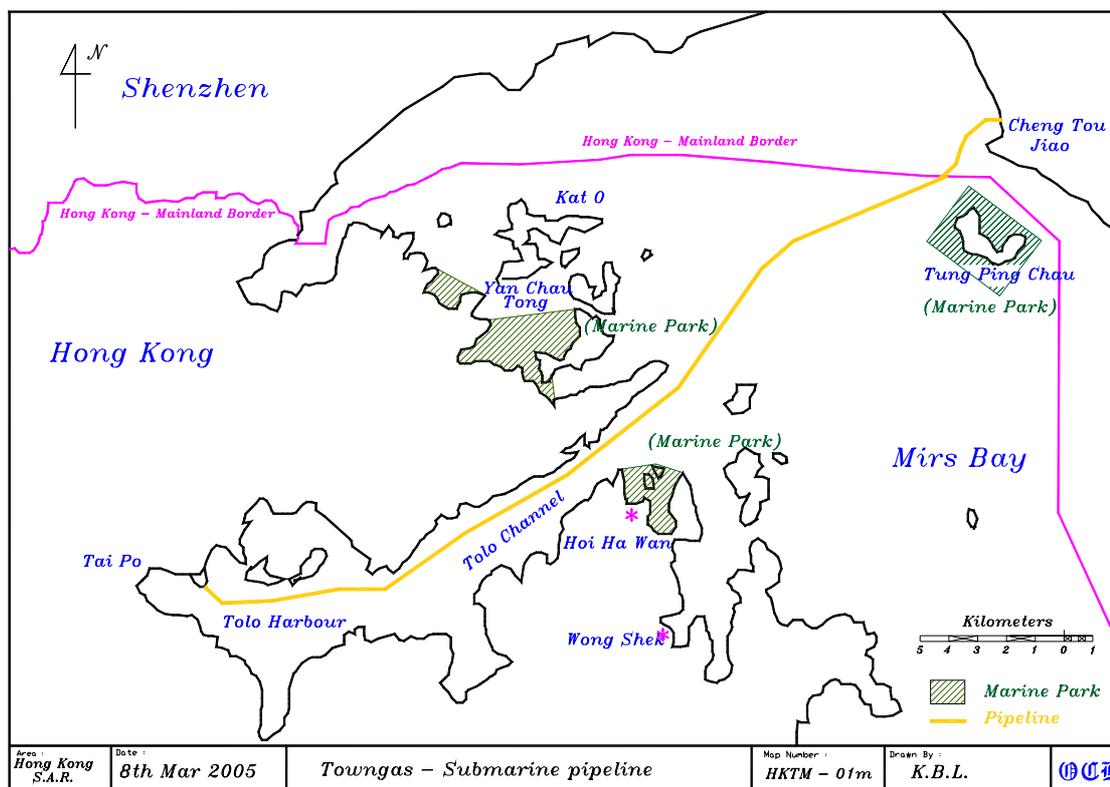


Figure 3.1a. Map showing the run of the pipeline and the locations of the surrounding marine parks.

3.2 Monitoring Methodology

The *EM&A Manual* for this project (ERM 2003b) requires two different types of survey to be carried out. One survey is primarily for the shallow water where hard corals are dominant. The other method is for the deeper sections of the selected areas that predominantly contain the black and soft corals. The methodology below details both of the techniques required as specified in the approved *EM&A Manual* for this project. All coral monitoring was conducted by qualified marine biologists with specialist knowledge of corals and curriculum vitae are attached in *Appendix F* of *Annex D*. The marine biologists/coral specialists responsible for the surveys were approved prior to survey conduct. For consistency, the same divers surveyed each site for each survey.

A total of eight areas in Tolo Channel were surveyed and the results are presented in this baseline report (Part B). *Appendix A* of *Annex D* provides the coordinates of the surveyed transects in each area. *Appendix B* of *Annex D* is a map showing the location of the surveyed areas. All areas were surveyed using the same techniques as stipulated in the *EM&A Manual* for this project. The depth of each of the sites surveyed and techniques used were as stipulated in the *EM&A Manual* for this project. The field procedures are detailed below.

3.2.1 Shallow Water Coral Community Surveys (<5m Depth)

The *EM&A Manual* required a video survey to be carried out for the shallow water coral communities. The survey methodology used was the standard procedure of collecting video data with ten numbers of 10m transects laid haphazardly and parallel to the shore in each coral area. Corals were tagged along 20m transects and specific information recorded on all colonies tagged.

3.2.1.1 Quantitative Underwater Video Transect Survey

The baseline status of the corals in each area was determined by the use of a quantitative underwater video transect method (Wachenfeld 1996; Oceanway 2002a; 2002b). This method allows any community changes to be ascertained (if any) over time and any damage encountered along video transects quantified. This methodology is a standard coral survey technique refined for local coral communities and has been used as part of the marine park coral-monitoring programme in the past.

Field Procedures

Each site was delineated by natural physical features and the survey area standardised to ~200 (shoreline length) ~10m width. Ten by 10 metre transects were laid haphazardly within the boundaries of each site. Transects were laid parallel to the shore wherever possible. Species richness was calculated for the total number of transects since communities with lower coral cover were expected to have lower *S* per transect simply because fewer colonies are sampled (Magurran 1988; Aronson *et al.*, 1994).

The Videoing Process

Video equipment used in the field included a Sony digital video camera recorder in an underwater housing. Standard operating procedures were adopted (Page *et al.*, 2001). Before videoing each transect, a 10 m measuring tape was orientated parallel to the shore and unwound over the coral community. The tape followed the contours of the coral colonies as closely as possible and care was taken to prevent bowing of the tape by tidying up any slack. At each site, three procedures were carried out in the videoing process, i.e., compilation of a video data sheet, a panoramic shot and the perpendicular videoing of the transects. Each transect was filmed at approximately 40cm above the substratum and at a rate of approximately 90 seconds (a rate of 6-9 m min⁻¹). Each video transect recorded a 40 cm swathe of coral (seabed). The video camera was held perpendicular to the substratum to minimise parallax error and to keep it in focus. A reference bar attached to the underwater video housing was used when necessary to standardise the height from which filming was undertaken. Once the videoing of a transect was completed, another panoramic shot was taken. The purpose of the panoramic shots was to allow the viewer to obtain a general idea of the coral area being surveyed before and after each transect.

Data Analysis

Digital video footage was converted into VCD format and played back on a standard computer using Microsoft media player. Each transect was paused at individual video frames at fixed timed intervals of three seconds and a number of points sampled. The video transects were sampled using a *regular linear point* sampling method (Ohlhorst *et al.*, 1988), i.e., regular pauses with fixed point placement. An acetate sheet with fixed random co-ordinates marked as 10mm circles was placed in front of the 14 inch TV screen. The points were used as reference marks from which to identify hard coral species abundance. The number of points used had been determined by a recent study. The three second fixed time interval ensures no overlap between frames, i.e., a new, non-overlapping position. In this way, a standard number of video frames per transect can be obtained.

Data Results

Results are presented in table form and comprise the parameters detailed below.

Substratum type parameters

1. Percentage cover of live coral species, dead coral, bare boulder/rock, other invertebrates, e.g., oysters and anemones, and sand. As the number of points in each category is directly proportional to the planar area covered by that particular attribute, percentage cover was 100x the proportion of the total number of sampling points (Carleton and Done 1995).
2. Percentage of broken and damaged corals.

3. Percentage of rubbish (if any).
4. Any other relevant details observed on the video footage.

Univariate indices

Percentage cover estimates were determined by assigning items underlying sampling points on paused images to an appropriate category of benthos, e.g., hard coral, dead coral, boulders and sand. All live scleractinian corals were identified to the lowest possible taxonomic level. Since this and similar sampling methods tend to be biased against the inclusion of rare species, presence-absence data were also gathered for coral species by viewing the entire videotape of each transect (Chiappone and Sullivan 1991). Counts of the total number of coral colonies were also made and presented as mean number of colonies per site.

The following univariate indices were estimated:

1. Total species / taxa.
2. Species richness.
3. The Shannon-Wiener diversity index (H') is the most frequently used diversity index in coral reef studies (Tomascik and Sander 1987). The index was calculated using coral cover data (H').
4. To assess the homogeneity of the scleractinian coral community, Pielou's evenness index, J' (Pielou 1966) was computed.
5. Number of colonies per transect.
6. Percentage damaged coral.
7. Percentage of bleached coral.

3.2.1.2 Baseline Survey/Coral Tagging Requirement

In areas where a shallow water coral community are present, 20 colonies of hard coral and 20 colonies of soft/black corals were tagged for individual coral colony monitoring where possible (Section 4.2.1 and 4.2.3 of the *EM&A Manual*). These included hard, soft and black coral colonies in $\leq 5\text{mCD}$ depth. The selection process is detailed below and included colonies that were deemed suitable for monitoring for sediment response.

The Baseline Survey

1. Two or more 20m transects were laid out parallel to the shore in an area with a high population density of the corals being investigated.
2. Each transect was videoed with a 1m swath on either side of the tape where possible.
3. Along each transect, a minimum of 20 colonies of hard coral and 20 colonies of soft/black corals were examined in detail. Transect lengths were extended as necessary in order to achieve the number of colonies required. The following parameters were recorded for each selected colony:
 - Maximum height.
 - General condition.
 - Health status.
 - Each colony was photographed.
4. The transects were replaced with rope transects to allow for repeat survey of the same transect during future dive survey assessment.

From this information, selected colonies will be tagged on a future area visit. The criteria for selection were as follows:

1. Priority was given to the largest undamaged colonies.
2. The most suitable growth forms and coral species were tagged.
3. Corals with long polyp type were avoided as they are often less responsive to sedimentation impact.

The selected colonies were reviewed by the ET team leader and have to be approved before being finally selected for impact monitoring. Other information was also recorded such as survey date, time, meteorological, sea and tidal conditions.

Data Results

The results are presented in table format for each colony. This facilitates selection and comparison of the status of the corals during baseline, construction and post-works of the project.

The Tagging Survey

Once the selected monitoring colonies are agreed, the area will be revisited for the purpose of permanent tagging the agreed colonies. The tagging will be achieved by assigning a unique number to each colony. A permanent mark using either a concrete nail tag or a rebar marker will be used. All such tags will be removed after the final survey.

For each of the tagged colonies the following data will be recorded:

1. The name of the colony to species level if possible.
2. A photograph record shall be taken.
3. Specific location, size and general condition.
4. Sediment cover (>10%), thickness, colouration and texture on the colony.
5. Sediment cover (>10%), thickness, colouration and texture on the adjacent bedrock.
6. Health status of each tagged colony:
 - Percentage sediment cover (hard corals only).
 - Percentage bleached tissue (hard corals only).
 - Percentage dead – total or partial mortality (hard, soft and black corals only).

Each parameter will be assessed as a percentage of the total colony area. To aid in the estimates, a 50cm x 50cm quadrat (with 10cm lined grid) will be used. General health (condition) of the colonies will be assessed through parameters including the tissue distension, mucus production and any other coral colony factors relevant at the time the survey is conducted.

Sediment cover will be recorded as well as information about the sediment. The colouration and the texture will be described as well as the thickness on the colony and any surrounding bedrock. Any patches >10% will be counted around the colony.

For all hard colonies tagged, bleaching will be recorded as two categories. Bleached or pale and totally bleached. Bleached refers to a total loss of zooxanthellae. Bleached refers to the partial loss of zooxanthellae or photosynthetic pigments.

Total or partial mortality will be recorded as a percentage of the total coral. Bleached recently killed areas and algae covered previously killed areas will be recorded differently. The colony will be photographed so that any future mortality may be recorded on the baseline photographs. Other information will also be recorded such as survey date, time, meteorological, sea and tidal conditions.

Data Results

The results will be presented in table format. This will allow for an individual colony comparison at the end of this project in the Post Works Survey. The locations of the start of the transects are included in *Appendix A* of *Annex D*.

3.2.2 Deep Water Coral Community Surveys (>5m Depth)

The *EM&A Manual* is very detailed in the requirement for these communities. Since they are deeper, they are more likely to be affected by any sediment plume generated by the jetting works. A deep area was defined as a coral area with a depth greater than 5m. This area was

divided into two zones. A middle zone with a depth greater than 5m but less than 12m. A deep zone with a depth greater than 12m.

3.2.2.1 Quadrat Survey Procedure

The baseline status of the corals in each area will be determined by a quadrat sampling method along a suitably placed 20m transect.

Field Procedures

Suitable areas of deep water hard / soft and hard coral communities were located within the areas selected for impact and control area surveys. This was carried out by reconnaissance dives. The main criteria for selection were more than 20 colonies of hard coral and 20 colonies of soft/black corals within an area of approximately 20m x 1m. Once a suitable area had been located:

1. Two by 20m transects were laid out parallel to the shore within this high population density area of black / soft / hard corals.
2. Each transect was videoed (if possible) with an approximately 1m swath on either side of the transect tape.
3. Along each transect twenty 1m x 1m quadrants, ten on one side, and ten on the other were placed randomly so that individual benthic taxa could be enumerated and recorded. The following area information was recorded:
 - Diversity.
 - Abundance.
 - Health status (bleaching, live / dead coral ratio and siltation coverage)
4. Along each transect, and where possible a minimum of 20 colonies of hard coral and 20 colonies of soft/black were examined in detail. The following parameters were recorded for each selected colony:
 - Maximum height.
 - General condition.
 - Health status.
 - Each colony was then photographed.
5. The tape transects were then replaced with rope transects to allow for the relocation of the corals recorded in this survey.

Data Analysis

The analysis of the data collected involved calculating the densities of the different corals recorded in the quadrat survey. Other basic information including the standard error of the results was also calculated.

Data Results

The results are presented in table format for each colony. This will allow for a comparison after the completion of the project. The locations of the start of the transects are included in *Appendix A of Annex D*.

3.2.2.2 Baseline Survey /Coral Tagging Requirement

The Baseline Survey

The baseline survey was carried out in deep water coral areas (i.e. >5m). A visual quantitative estimate for the black / soft coral communities was conducted *in situ*. A video record of the area along the proposed transect was carried out when possible. From this information, selected colonies were tagged. The criteria for selection were as follows:

1. Priority was given to the largest undamaged colonies.
2. The most suitable growth forms and coral species were tagged.

3. Corals with long polyp type were avoided as they are often less responsive to sedimentation impact.

The selected colonies were reviewed by the ET team leader and approved before being finally selected for monitoring. Other information will also be recorded such as survey date, time, meteorological, sea and tidal conditions.

Data Results

The results will be presented in table format for each colony. This will allow for a comparison / assessment of coral condition after the completion of the project. The locations of the start of the transects are included in *Appendix A* (in Annex D).

The Tagging Survey

Once the colonies to be tagged have been agreed, the area will be revisited for the purpose of tagging the required colonies. A total of at least 20 colonies will be tagged in each area where possible. The tagging will be achieved by assigning a unique number to each colony. Coloured rocks will be used where suitable, however this will be reinforced either by a more permanent mark using either a concrete nail tag or a rebar marker (rocks are often removed by divers). All such tags will be removed after the final survey.

For each of the tagged colonies the following data shall be recorded:

1. Taxonomic identity to species level if possible.
2. A photograph record shall be taken.
3. Specific location, size and general condition.
4. Sediment cover (>10%), thickness, colouration and texture on the colony.
5. Sediment cover (>10%), thickness, colouration and texture on the adjacent bedrock.
6. Health status of each tagged colony:
 - Percentage sediment cover (hard corals only).
 - Percentage bleached tissue (hard corals only).
 - Percentage dead – total or partial mortality (hard, soft and black corals only).

Each parameter will be assessed as a percentage of the total colony area. To aid in the estimates, a 50cm x 50cm quadrat (with 10cm lined grid) will be used.

General health of the colonies will include the tissue distension, mucus production and any other coral colony factors relevant at the time the survey is conducted.

Sediment cover will be recorded as well as information about the sediment. The colouration and the texture will be described as well as the thickness on the colony and any surrounding bedrock. Any patches >10% will be counted around the colony.

Bleaching will be recorded as two categories. Blanched or pale and totally bleached. Bleached refers to a total loss of zooxanthellae. Blanched refers to the partial loss of zooxanthellae or photosynthetic pigments. Since the depth will be >5m, underwater torches will be required.

Total or partial mortality will be recorded as a percentage of the total coral. Bleached recently killed areas and algae covered previously killed areas will be recorded differently. The colony will be photographed so that any future mortality may be recorded on the baseline photographs. Other information will also be recorded such as survey date, time, meteorological, sea and tidal conditions.

Data Results

The results will be presented in table format. This will allow for an individual colony comparison at the end of this project in the Post Works Survey. The locations of the start of the transects are included in *Appendix A* of *Annex D*.

3.3 Results

In agreement with the results of previous surveys (Oceanway 2001; ERM 2003a), the baseline results show that a highly diverse coral community exists along the shoreline of the areas that require jetting. The map coordinate locations of the survey sites is presented in *Appendix A of Annex D*. Maps of locations of all the survey sites are appended in *Appendix B of Annex D*. The raw data are presented in *Appendix C of Annex D*. *Appendix E of Annex D* contains general photographs of the surveyed areas taken during the survey period.

This baseline survey started on the 22nd February 2005, with the last dive carried out on the 15th April 2005. The diving for this survey totalled 186 dives carried out over 7 days, with an average of 6 people diving on each day. The total dive time was summed to be 196 hours. Decompression diving was not required by the tagging team during this survey.

During the February and March surveys, the sea was mild, air temperature was 7–12°C with the sea temperature at 11°C at 10m depth. During the April survey, the sea was also mild (19°C at 10m) and the air temperature 19°C. The surveyed areas consisted of two community types. A shallow hard coral area (<5m depth) and a middle coral area (5–12m depth). Twenty six different species of hard corals were recorded during the shallow hard coral survey reconnaissance dive with several species of black and the occasional soft corals observed in the shallow water. This was consistent with the pre-EM&A survey results (ERM 2003a).

A massive die-off of the sessile benthos was recorded in all areas of the Tolo Channel below 5m. This affected all impact stations I1–I7. All of the black coral previously recorded (ERM 2003a) in the deep areas of I1–I6 were observed with 100% mortality. The soft corals recorded in the pre-EM&A survey (ERM 2003a) at sites I3, I5 and I6 were not located during the course of the present baseline surveys. These areas were photographed to show the remains of the colonies. Two numbers of 250m x 1m transect were surveyed at I2 and I5 to determine the extent of this phenomena. Along one of these transects, at I5, a total of 230 dead black coral colonies were recorded.

3.3.1 Southern Control Site (CCC) – Chek Chau

This area was surveyed on the 26th February, 4th March and 15th April 2005. During February the sea was mild, air temperature was ~7°C with the sea temperature at 12°C at 10m depth. During March, the air temperature was ~9°C and water temperature 12°C at 10m depth. April had an air temperature of 21°C with water temperature of 19°C at 10m depth. The surveyed areas consisted of two community types: a shallow hard coral area (<5m depth) and a middle black and hard coral area (5–12m depth). There were no soft corals in this area and this result is consistent with the pre-EM&A survey carried out in 2003 (ERM 2003a). Thirty-nine different species of hard corals were recorded during the reconnaissance dive of the shallow hard coral area. Seventeen species of coral were recorded during the video transects. Four different hard coral species were also recorded in the middle depth zone community; i.e. *Cyphastrea* sp., *Porites* sp., *Goniopora* sp. and *Favia* sp. This deep coral area also had a significant population of *Antipathes* sp. and *Cirripathes* sp. colonies.

3.3.1.1 Shallow Water Coral Community (<5m)

The hard coral community area selected was as proposed in the EM&A, and in the shallow semi-protected bay of Tai Wan. A map showing the location of the area is in *Annex D*.

Quantitative Underwater Video Transects

This coral area was found to have a high percentage cover of hard coral, i.e., $64.57 \pm 2.93\%$ (mean \pm SE) with the measured proportion of live coral at $63.05 \pm 2.79\%$ and dead coral at $1.52 \pm 0.37\%$. The percentage of un-occupied hard substratum was calculated to be $11.79 \pm 1.10\%$. The amount of area covered by sand was measured as $20.46 \pm 1.41\%$. The hard coral community was dominated by three genera, i.e., *Favia* spp., *Favites* spp. and *Platygyra* spp. in terms of both percentage cover and number of colonies. The substrate and univariate

parameters are listed in *Tables 2a* and *2b*, respectively. Hard coral taxa density breakdown is given in *Table 2c*.

Table 2a. A summary of substrate type parameter estimates for CCC

Substrate	% Baseline
Hard Coral (inc. dead)	64.57 ± 2.93
Dead Coral (inc. damage)	1.52 ± 0.37
Live Coral	63.05 ± 2.79
Rubble	7.02 ± 0.85
Invert. Life forms	2.65 ± 1.02
Bare rock/boulders	4.57 ± 0.53
Sand	20.46 ± 1.41

Data are mean ± SE. n=10

Table 2b. A summary of univariate type parameter estimates for CCC

Univariate community parameters	% Baseline
Total species/taxa	17
Species richness	12.700 ± 0.634
Diversity	2.109 ± 0.091
Evenness	12.527 ± 0.644
No. of colonies per transect	95.200 ± 4.216

Data are mean ± SE. n=10

Table 2c. Taxa density of CCC, Baseline

Coral Taxa	% 2005
<i>Echinophyllia</i> sp.	1.6
<i>Montipora</i> spp.	1.3
<i>Psammocora</i> spp.	1.2
<i>Pavona</i> sp.	2.6
<i>Porites</i> spp.	2.9
<i>Goniopora</i> spp.	6.4
<i>Favia</i> spp.	18.0
<i>Favites</i> spp.	25.3
<i>Goniastrea</i> spp.	2.5
<i>Platygyra</i> spp.	12.2
<i>Plesiastrea</i> sp.	2.3
<i>Stylocoeniella</i> sp.	1.7
<i>Leptastrea</i> spp.	6.5
<i>Lithophyllon</i> sp.	1.5
<i>Cyphastrea</i> sp.	5.9
<i>Hydnophora</i> sp.	3.6
<i>Turbinaria</i> sp.	2.7
Total (%) live hard coral cover :	63.05 ± 2.79

Shallow Water Coral Tagging Results (<5m)

A total of 40 suitable corals were selected for the shallow water monitoring. They were selected along the 40m transect as being suitably large colonies that would show sedimentation stress. The list of the selected corals is provided in *Table 3*.

- **Hard Corals**

The *EM&A Manual* requires that 20 hard corals be tagged in the shallow water area (<5m). For the CCC site, however, a total of 40 suitable hard corals were selected for the shallow water tagging. This is to allow sufficient number of tagged corals for monitoring due to the absence of soft and black corals for tagging (see bullet point below).

- **Soft and Black Corals**

The *EM&A Manual* requires that 20 soft and black corals be tagged in the shallow water area (<5m). There were, however, no soft or black corals recorded in this area. Instead, additional hard coral colonies were selected for tagging in the shallow area of the CCC site (see bullet point above).

Table 3. Recommended shallow area coral colonies selected for monitoring at site CCC.

Coral Number	Species	Coral Number	Species
1	<i>Leptastrea</i> sp.	21	<i>Platygyra</i> sp.
2	<i>Pavona</i> sp.	22	<i>Platygyra</i> sp.
3	<i>Porites</i> sp.	23	<i>Platygyra</i> sp.
4	<i>Leptastrea</i> sp.	24	<i>Hydnophora</i> sp.
5	<i>Cyphastrea</i> sp.	28	<i>Hydnophora</i> sp.
6	<i>Pavona</i> sp.	32	<i>Plesiastrea</i> sp.
7	<i>Porites</i> sp.	33	<i>Psammocora</i> sp.
8	<i>Plesiastrea</i> sp.	34	<i>Psammocora</i> sp.
9	<i>Porites</i> sp.	35	<i>Turbinaria</i> sp.
10	<i>Montipora</i> sp.	36	<i>Turbinaria</i> sp.
11	<i>Turbinaria</i> sp.	37	<i>Turbinaria</i> sp.
12	<i>Platygyra</i> sp.	38	<i>Porites</i> sp.
13	<i>Platygyra</i> sp.	39	<i>Hydnophora</i> sp.
14	<i>Platygyra</i> sp.	40	<i>Porites</i> sp.
15	<i>Platygyra</i> sp.	41	<i>Hydnophora</i> sp.
16	<i>Platygyra</i> sp.	42	<i>Favia</i> sp.
17	<i>Platygyra</i> sp.	43	<i>Cyphastrea</i> sp.
18	<i>Hydnophora</i> sp.	44	<i>Cyphastrea</i> sp.
19	<i>Platygyra</i> sp.	45	<i>Montipora</i> sp.
20	<i>Hydnophora</i> sp.	46	<i>Porites</i> sp.

The species selected are those also recorded in the hard coral areas of the Tolo Channel impact sites. A full list of all tagged colony details is provided in *Appendix CIC* and *CID* of *Annex D*.

General Field Observations

During the survey, the amount of sediment on the corals was low or non-existent. All corals observed to be in a good condition. This statement is supported by the results of the video transect data with a value $1.52 \pm 0.37\%$ (mean \pm SE) calculated as the amount of dead and damaged corals for this area. This area is therefore considered suitable as a control for the impact areas I1 to I7 in the Tolo Harbour.

3.3.1.2 Deep Water Coral Community (>5m)

The soft and black coral community control survey area selected was located on the northern side of Tai Wan, Chek Chau. The area met the criteria stipulated in the *EM&A Manual* with regard to the type and number of colonies present. The majority of the corals present were black corals (*Antipathes* sp.) with the occasional hard coral being recorded. This area was a suitable area as a control for the black corals recorded in impact areas I1 to I7.

Results of the Quadrat Survey

A total of 40 quadrat surveys were carried out along a total of 40m of transect (2 x 20m). The most abundant animals recorded were black corals. The latter being represented by *Antipathes* sp. and *Cirripathes* sp. The whole area was recorded to have a cover of fine sediment. The origin of this is uncertain. Most (~80%) of the corals recorded were feeding with polyps extended at the time of the start of this survey. All corals except for three were recorded to be in a good condition. *Table 4a* contains the quadrat survey results. In accordance with the pre-EM&A survey there were no soft corals recorded in this area (ERM 2003a).

Table 4a. The results for the deep water coral quadrat survey carried out at CCC.

Parameter	Result	Remarks
Diversity	5 species	Black and hard corals
Abundance:		
- Hard corals (colonies/m ²)	0.88 ± 0.39	Hermatypic hard corals
- Hard corals (colonies/m ²)	0.00 ± 0.00	Ahermatypic hard corals
- Soft corals (colonies/m ²)	0.00 ± 0.00	Excludes gorgonians
- Gorgonians (colonies/m ²)	0.00 ± 0.00	
- Black Corals (colonies/m ²)	0.78 ± 0.15	Includes <i>Antipathes</i> sp. and <i>Cirripathes</i> sp.
Health :		
- Bleaching %	0%	
- Dead / live ratio %	<20%	
- Siltation coverage %	<10%	Colour Pantone CV448 (green-brown)
Substratum type	boulders	
Silt :		Colour Pantone CV448 (green-brown)
- Thickness	1mm	On all unoccupied hard substratum
- Type	Fine	Fine, talc like silt.

Note: Gorgonians are presented as a separate soft coral subgroup in this table to provide more information about their abundance in this area. It should be noted that the term "soft corals" used in the main text includes gorgonians and other soft corals.

Deep Water Coral Tagging Results (>5m)

Table 4b contains the recommended colonies for monitoring. *Appendix CIC* and *CID* of *Annex D* contain the details of all colonies tagged. Our selection has been based upon colonies that are sensitive to or will show sedimentation accumulation or species that need to be monitored (i.e. *Antipathes* sp.). We suggest that 14 colonies of hard coral and 42 colonies of black coral (*Antipathes* spp.) be monitored. This is to allow a good overlap with those species recorded at the impact sites.

- **Hard Corals**

The *EM&A Manual* requires that 20 hard corals be tagged in the deep water area (>5m). There were, however, only 14 hard corals suitable for tagging in this area (*Table 4b*).

- **Soft and Black Corals**

The *EM&A Manual* requires that 20 soft and black corals be tagged in the deep water area (>5m). For the CCC site, however, a total of 42 suitable black corals were selected for the deep water tagging. This allows sufficient number of tagged corals for monitoring given the limited number of suitable hard corals for tagging (see bullet point above).

Table 4b. Recommended deep area coral colonies selected for monitoring at site CCC.

Coral Number	Species	Coral Number	Species
1	<i>Antipathes</i> sp.	29	<i>Antipathes</i> sp.
2	<i>Antipathes</i> sp.	30	<i>Turbinaria</i> sp.
3	<i>Antipathes</i> sp.	31	<i>Cyphastrea</i> sp.
4	<i>Antipathes</i> sp.	32	<i>Antipathes</i> sp.
5	<i>Antipathes</i> sp.	33	<i>Antipathes</i> sp.
6	<i>Antipathes</i> sp.	34	<i>Antipathes</i> sp.
7	<i>Antipathes</i> sp.	35	<i>Antipathes</i> sp.
8	<i>Antipathes</i> sp.	36	<i>Antipathes</i> sp.
9	<i>Antipathes</i> sp.	37	<i>Antipathes</i> sp.
10	<i>Antipathes</i> sp.	38	<i>Antipathes</i> sp.
11	<i>Antipathes</i> sp.	39	<i>Antipathes</i> sp.
12	<i>Antipathes</i> sp.	40	<i>Antipathes</i> sp.
13	<i>Antipathes</i> sp.	41	<i>Antipathes</i> sp.
14	<i>Antipathes</i> sp.	42	<i>Antipathes</i> sp.
15	<i>Antipathes</i> sp.	43	<i>Antipathes</i> sp.
16	<i>Antipathes</i> sp.	44	<i>Antipathes</i> sp.
17	<i>Antipathes</i> sp.	45	<i>Antipathes</i> sp.
18	<i>Antipathes</i> sp.	46	<i>Antipathes</i> sp.
19	<i>Cyphastrea</i> sp.	47	<i>Cyphastrea</i> sp.
20	<i>Cyphastrea</i> sp.	48	<i>Turbinaria</i> sp.
21	<i>Antipathes</i> sp.	49	<i>Pavona</i> sp.
22	<i>Antipathes</i> sp.	50	<i>Favia</i> sp.
23	<i>Antipathes</i> sp.	51	<i>Cyphastrea</i> sp.
24	<i>Antipathes</i> sp.	52	<i>Turbinaria</i> sp.
25	<i>Antipathes</i> sp.	53	<i>Plesiastrea</i> sp.
26	<i>Antipathes</i> sp.	54	<i>Porites</i> sp.
27	<i>Antipathes</i> sp.	55	<i>Pavona</i> sp.
28	<i>Antipathes</i> sp.	56	<i>Cyphastrea</i> sp.

General Field Observations

This area is fairly typical of the mid depth range (5~12m) communities that exist on the hard substratum. The site is semi-sheltered from any currents and severe weather conditions.

3.3.2 Tolo Channel Impact Site 1 (I1) – Wong Wan Tsui West

This area was surveyed on the 1st March and the 16th April 2005. In March, the sea was mild; air temperature was 15°C with the sea temperature 12°C at 5m. In April, the sea was mild, air temperature at 21°C and sea temperature 19°C. The surveyed area consisted of one shallow water (<5m) coral community. Fifteen different species of hard corals, one species of soft coral (*Echinomuricea* sp.) and both *Antipathes* sp. and *Cirripathes* sp. were observed during a reconnaissance dive carried out immediately before the survey. Thirteen species of coral were recorded during the video transects. The main coral area was located in 2~5m of water along the edge of the rocky coastline. The seabed changed to mud and sand immediately after the rocky area. No live corals were recorded in this mud and sand area for more than 200m directly out from the shore. There were however many colonies of *Antipathes* sp. with 100% mortality observed in this area.

3.3.2.1 Shallow Water Coral Community (<5m)

The hard coral community comprised of a typical incipient reef structure with small colonies (generally < 20cm²). The area appeared quite exposed to currents.

Quantitative Underwater Video Transects

The data were collected in the shallow area (<5m). Both *Antipathes* sp. and *Cirripathes* sp. were recorded in this area. The surveyed area had a calculated hard coral cover of $21.73 \pm 5.38\%$ (mean \pm SE) with the measured proportion of live coral at only $2.09 \pm 0.60\%$ and dead coral at $19.64 \pm 5.42\%$. The measured cover of soft / black coral was $31.56 \pm 4.35\%$. The percentage of un-occupied hard substratum was calculated to be $30.32 \pm 4.13\%$. The amount of area covered by sand was measured as $12.86 \pm 1.48\%$. The hard coral community was dominated by three genera, i.e., *Montipora* spp., *Psammocora* spp. and *Cyphastrea* sp. in terms of percentage cover and the number of colonies. The latter species forming colonies large enough to be detected by video transects. Almost all (>90%) of the hard coral colonies recorded were small (<15cm²). The substrate and univariate parameters are listed in *Tables 5a* and *5b*, respectively. Hard coral taxa density breakdown is given in *Table 5c*.

Table 5a. A summary of substrate type parameter estimates for Site II

Substrate	% Baseline
Hard Coral (inc. dead)	21.73 ± 5.38
Dead Coral (inc. damage)	19.64 ± 5.42
Live Coral	2.09 ± 0.60
Soft /black Coral	31.56 ± 4.35
Rubble	6.11 ± 1.01
Invert. Life forms	3.48 ± 1.06
Bare rock/boulders	10.55 ± 2.13
Sand	12.86 ± 1.48

Data are mean \pm SE. n=10

Table 5b. A summary of univariate type parameter estimates for Site II

Univariate community parameters	% Baseline
Total species/taxa	13
Species richness	2.700 ± 0.944
Diversity	0.744 ± 0.275
Evenness	2.368 ± 0.973
No. of colonies per transect	3.900 ± 1.121

Data are mean \pm SE. n=10

Table 5c. Taxa density of the Site II, Baseline

Coral taxa	% 2005
<i>Porites</i> spp.	10.3
<i>Montipora</i> spp.	20.5
<i>Acropora</i> spp.	2.6
<i>Psammocora</i> spp.	7.7
<i>Goniopora</i> spp.	12.8
<i>Pavona</i> sp.	7.7
<i>Oulastrea</i> sp.	7.7
<i>Porites</i> spp.	10.3
<i>Montastrea</i> spp.	0.0
<i>Leptastrea</i> spp.	7.7
<i>Cyphastrea</i> sp.	15.4
<i>Lithophyllon</i> sp.	2.6
<i>Turbinaria</i> sp.	5.1
Total (%) live hard coral cover :	2.09 ± 0.60

Shallow Water Coral Tagging Results

A mixture of hard and black corals were recorded in this area, among them 20 hard corals and 20 black corals were tagged for the shallow water monitoring as required by the *EM&A Manual*. They were selected in the area as being suitably large colonies that would show sedimentation stress. The list of the selected corals is presented below in *Table 6*.

Table 6. Recommended shallow area coral colonies selected for monitoring at Site II.

Coral Number	Species	Coral Number	Species
1	<i>Pavona</i> sp.	3	<i>Antipathes</i> sp.
2	<i>Leptastrea</i> sp.	5	<i>Antipathes</i> sp.
4	<i>Psammocora</i> sp.	6	<i>Antipathes</i> sp.
7	<i>Porites</i> sp.	8	<i>Antipathes</i> sp.
9	<i>Porites</i> sp.	10	<i>Antipathes</i> sp.
13	<i>Pavona</i> sp.	11	<i>Antipathes</i> sp.
14	<i>Cyphastrea</i> sp.	12	<i>Antipathes</i> sp.
15	<i>Cyphastrea</i> sp.	16	<i>Antipathes</i> sp.
18	<i>Psammocora</i> sp.	17	<i>Antipathes</i> sp.
20	<i>Psammocora</i> sp.	19	<i>Antipathes</i> sp.
29	<i>Plesiastrea</i> sp.	21	<i>Antipathes</i> sp.
41	<i>Psammocora</i> sp.	22	<i>Antipathes</i> sp.
42	<i>Pavona</i> sp.	23	<i>Antipathes</i> sp.
43	<i>Cyphastrea</i> sp.	24	<i>Antipathes</i> sp.
44	<i>Cyphastrea</i> sp.	25	<i>Antipathes</i> sp.
45	<i>Pavona</i> sp.	26	<i>Antipathes</i> sp.
46	<i>Pavona</i> sp.	27	<i>Antipathes</i> sp.
47	<i>Pavona</i> sp.	28	<i>Antipathes</i> sp.
48	<i>Cyphastrea</i> sp.	30	<i>Antipathes</i> sp.
49	<i>Psammocora</i> sp.	31	<i>Antipathes</i> sp.

The species selected are those also recorded in the shallow (<5m) and deep (<12m) zone at Chek Chau (CCC). A full list of all tagged colony details is in *Appendix C2C* and *C2D* of *Annex D*.

Results of the Quadrat Survey

A total of 40 quadrat surveys were carried out along a total of 40m of transect (2 x 20m). *Table 7* contains the quadrat survey results.

Table 7. The results for the shallow water coral quadrat survey carried out at Site II (<5m).

Parameter	Result	Remarks
Diversity	15 Species	Pre-survey reconnaissance dive
Abundance:		
- Hard corals (colonies/m ²)	0.36 ± 0.18	Hermatypic hard corals
- Hard corals (colonies/m ²)	0.00 ± 0.00	Ahermatypic hard corals
- Soft corals (colonies/m ²)	0.00 ± 0.00	Excludes gorgonians
- Gorgonians (colonies/m ²)	0.00 ± 0.00	
- Black Corals (colonies/m ²)	0.96 ± 0.23	Includes <i>Antipathes</i> sp. and <i>Cirripathes</i> sp.
Health :		
- Blanching	<10%	
- Bleaching %	<5%	
- Dead / live ratio %	<20%	
- Siltation coverage %	<15%	Colour Pantone CV410 (grey)
Substratum type	Boulders	
Silt :		Colour Pantone CV410 (grey)
- Thickness	<2mm	On all unoccupied hard substratum
- Type	Fine	Fine, talc like silt.

Note: Gorgonians are presented as a separate soft coral subgroup in this table to provide more information about their abundance in this area. It should be noted that the term "soft corals" used in the main text includes gorgonians and other soft corals.

General Field Observations

This area consisted of an assortment of large boulders down to a depth of 5mCD. The black coral community started at 4.5mCD. Most of the shallow water (<2m) benthos consisted of anemones and encrusting sponges. The hard corals in this area were nearly always (>90%) small (<15cm² area). Fine, grey sediment was recorded on all unoccupied substratum and some colonies in this area. The thickness on all substratum was < 2mm.

3.3.2.2 Deep Water Coral Community (>5m)

The *EM&A Manual* requires that 20 hard corals and 20 soft/black corals be tagged in the deep water area (>5m). There was, however, no live hard, soft or black coral observed or recorded below 5mCD. It appears that a large scale die-off has occurred in the deeper zone >5m. Only one colony of the hypoxia tolerant *Euplexaura* spp. was recorded near the impact area I1. Plates 5 and 6 of *Appendix E* of *Annex D* show the condition of the dead coral areas in the Tolo Channel. The video survey in the shallow area also indicated abundant dead hard coral in this area ($19.64 \pm 5.42\%$, mean \pm SE; *Table 5a*).

3.3.3 Tolo Channel Impact Site 2 (I2) – Wong Wan Tsui East

This area was surveyed on the 1st March and 15th April 2005. On the 1st March, the sea was mild; air temperature was 15°C with the sea temperature 11°C at 5m depth. On the 15th April, the air temperature was 21°C with the water temperature 19°C at 5m depth. The surveyed area consisted of one shallow water (<5m) coral community. Thirteen different species of hard corals, one species of soft coral (*Echinomuricea* sp.) and black coral *Antipathes* sp. were observed during a reconnaissance dive carried out immediately before the survey. Nine species of coral were recorded during the video surveys. The main coral area was located in 1.8~5m of water along the edge of the rocky shoreline. The seabed changed to mud and sand immediately after the rocky area. No live corals were recorded in this mud and sand area for more than 250m directly out from the shore. There were numerous colonies of *Antipathes* sp. with 100% mortality observed in the areas > 5mCD.

3.3.3.1 Shallow Water Coral Community (<5m)

The hard coral community comprised of a typical incipient reef structure predominately (>70%) composed of small (generally < 20cm²) colonies. The area appeared quite exposed to Tolo Harbour currents.

Quantitative Underwater Video Transects

The data were collected in the shallow area (<5m). Colonies of the black coral *Antipathes* sp. were also recorded in this area. The surveyed area had a calculated hard coral cover of $8.72 \pm 2.13\%$ (mean \pm SE) with the measured proportion of live hard coral at only $2.12 \pm 0.34\%$ and dead coral at $6.60 \pm 2.05\%$. The measured cover of soft / black coral was $34.74 \pm 3.24\%$. This value was similar to the Site I1 ($31.56 \pm 4.35\%$). The percentage of un-occupied hard substratum was calculated to be $25.90 \pm 2.85\%$. The amount of area covered by sand was $24.84 \pm 2.14\%$. The hard coral community was dominated by two genera, i.e., *Porites* spp. and *Oulastrea* sp. in terms of percentage cover and the number of colonies. Almost all (>95%) of the hard coral colonies recorded were small (generally < 20cm²). The substrate and univariate parameters are listed in *Tables 8a* and *8b*, respectively. Hard coral taxa density breakdown is given in *Table 8c*.

Table 8a. A summary of substrate type parameter estimates for Site I2

Substrate	% Baseline
Hard Coral (inc. dead)	8.72 ± 2.13
Dead Coral (inc. damage)	6.60 ± 2.05
Live Coral	2.12 ± 0.34
Soft/black Coral	34.74 ± 3.24
Rubble	7.16 ± 1.08
Invert. Life forms	5.54 ± 1.11
Bare rock/boulders	14.26 ± 1.34
Sand	24.84 ± 2.14

Data are mean ± SE. n=10

Table 8b. A summary of univariate type parameter estimates for Site I2

Univariate community parameters	% Baseline
Total species/taxa	9
Species richness	2.600 ± 0.371
Diversity	0.832 ± 0.145
Evenness	2.109 ± 0.436
No. of colonies per transect	3.400 ± 0.542

Data are mean ± SE. n=10

Table 8c. Taxa density of the Site I2, Baseline

Coral Taxa	% 2005
<i>Montipora</i> spp.	8.8
<i>Acropora</i> spp.	5.9
<i>Psammocora</i> sp.	14.7
<i>Pavona</i> sp.	5.9
<i>Porites</i> spp.	20.6
<i>Goniopora</i> spp.	5.9
<i>Favia</i> spp.	8.8
<i>Oulastrea</i> sp.	20.6
<i>Cyphastrea</i> sp.	8.8
Total (%) live hard coral cover :	2.12 ± 0.34

Shallow Water Coral Tagging Results

A total of 40 suitable corals were selected for the shallow water monitoring (i.e., 20 hard and 20 black corals as required by the *EM&A Manual*). They were selected in the area as being suitably large colonies that would show sedimentation stress. The list of the selected corals is presented in *Table 9*.

Table 9. Recommended shallow area coral colonies selected for monitoring at Site I2.

Coral Number	Species	Coral Number	Species
1	<i>Plesiastrea</i> sp.	2	<i>Antipathes</i> sp.
10	<i>Cyphastrea</i> sp.	3	<i>Antipathes</i> sp.
13	<i>Cyphastrea</i> sp.	4	<i>Antipathes</i> sp.
14	<i>Pavona</i> sp.	5	<i>Antipathes</i> sp.
15	<i>Cyphastrea</i> sp.	6	<i>Antipathes</i> sp.
19	<i>Psammocora</i> sp.	7	<i>Antipathes</i> sp.
21	<i>Cyphastrea</i> sp.	8	<i>Antipathes</i> sp.
22	<i>Cyphastrea</i> sp.	9	<i>Antipathes</i> sp.
23	<i>Favia</i> sp.	11	<i>Antipathes</i> sp.
27	<i>Plesiastrea</i> sp.	12	<i>Antipathes</i> sp.
28	<i>Psammocora</i> sp.	16	<i>Antipathes</i> sp.
29	<i>Porites</i> sp.	17	<i>Antipathes</i> sp.
33	<i>Porites</i> sp.	18	<i>Antipathes</i> sp.
34	<i>Psammocora</i> sp.	20	<i>Antipathes</i> sp.
35	<i>Cyphastrea</i> sp.	24	<i>Antipathes</i> sp.
36	<i>Porites</i> sp.	25	<i>Antipathes</i> sp.
37	<i>Pavona</i> sp.	26	<i>Antipathes</i> sp.
38	<i>Psammocora</i> sp.	30	<i>Antipathes</i> sp.
39	<i>Porites</i> sp.	31	<i>Antipathes</i> sp.
40	<i>Pavona</i> sp.	32	<i>Antipathes</i> sp.

The species selected are those also recorded in the shallow (<5m) and deep (<12m) zone at Chek Chau (CCC). A full list of all tagged colony details is presented in *Appendix C3C* and *C3D* of *Annex D*.

Results of the Quadrat Survey

A total of 40 quadrat surveys were carried out along a total of 40m of transect (2 x 20m). The most abundant corals recorded were the black corals. *Table 10* contains the quadrat survey results.

Table 10. The results for the shallow water coral quadrat survey carried out at Site I2.

Parameter	Result	Remarks
Diversity	13 Species	Pre-survey reconnaissance dive
Abundance:		
- Hard corals (colonies/m ²)	0.25 ± 0.11	Hermatypic hard corals
- Hard corals (colonies/m ²)	0.00 ± 0.00	Ahermatypic hard corals
- Soft corals (colonies/m ²)	0.00 ± 0.00	Excludes gorgonians
- Gorgonians (colonies/m ²)	0.03 ± 0.04	
- Black Corals (colonies/m ²)	0.85 ± 0.29	<i>Antipathes</i> sp.
Health :		
- Blanching	<10%	
- Bleaching %	0%	
- Dead / live ratio %	<15%	
- Siltation coverage %	<10%	Colour Pantone CV731 (brown)
Substratum type	Boulders	
Silt :		Colour Pantone CV411 (grey)
- Thickness	<1mm	On all unoccupied hard substratum
- Type	Fine	Fine, talc like silt.

Note: Gorgonians are presented as a separate soft coral subgroup in this table to provide more information about their abundance in this area. It should be noted that the term "soft corals" used in the main text includes gorgonians and other soft corals.

General Field Observations

This area was very similar to I1, further inside the Tolo Channel. The makeup of the area was very similar with large boulders making up the bulk of the shallow water seabed (<5m). The shallow water area (<2m) contained many anemones and encrusting sponges. The black corals started at ~4.5mCD. Most un-occupied hard substratum was covered in a fine layer of grey talc like silt <1mm thick.

3.3.3.2 Deep Water Coral Community (>5m)

The *EM&A Manual* requires that 20 hard corals and 20 soft/black corals be tagged in the deep water area (>5m). There was, however, no live hard, soft or black coral observed or recorded below 5m (similar to I1). All hard, soft and black coral below 5mCD had suffered 100% mortality (Plates 12, 13, 14 and 15 of *Appendix E* of *Annex D*). It is possible that the recent 2004 hypoxia event is responsible for the mass coral mortality.

3.3.4 Tolo Channel Impact Site 3 (I3) – Fong Wang Fat

This area was surveyed on the 1st, 2nd March and April 15th 2005. During the March survey, the sea was mild; air temperature was 13°C with the sea temperature 10°C at 5m depth. During the April survey, the air temperature was 21°C and the sea temperature was 19°C at 5m depth. The surveyed area consisted of one shallow water (<5m) coral community. Twenty-four different species of hard corals and black coral *Antipathes* sp. were observed during a reconnaissance dive carried out immediately before the survey. Thirteen coral species were recorded during the video transects survey. The main coral area was located in 1.8~5m of water along the edge of the rocky shoreline. The seabed changed to mud and sand immediately after the rocky area. No live corals were recorded in this mud and sand area for more than 200m directly out from the shore. There were numerous colonies of *Antipathes* sp. with 100% mortality observed in this deeper area; however the number of colonies was less than Site I1 and Site I2.

3.3.4.1 Shallow Water Coral Community (<5m)

The hard coral community comprised of a typical incipient reef structure with most (>60%) colonies being very small (generally < 20cm²). The area appeared quite exposed to currents flowing through Tolo Channel, however the mouth of the channel was considerably wider at this point.

Quantitative Underwater Video Transects

The data were collected in the shallow area (<5m). Colonies of the black coral *Antipathes* sp. were recorded in this area. The surveyed area had a calculated hard coral cover of 11.71 ± 3.11% (mean ± SE) with the measured proportion of live hard coral at only 3.87 ± 0.94% and dead coral at 7.83 ± 2.92%. The measured cover of soft / black coral was 30.84 ± 3.20%. This result was similar to the Site I1 (31.56 ± 4.35%) and Site I2 (34.74 ± 3.24). The percentage of un-occupied hard substratum was calculated to be 40.43 ± 2.54%. The amount of area covered by sand was measured as 12.66 ± 1.14%. The hard coral community was dominated by three genera *Oulastrea* spp., *Psammocora* sp. and *Goniopora* sp. in terms of percentage cover and the number of colonies. Almost all (>85%) of the hard coral colonies recorded were small (generally < 20cm²). The substrate and univariate parameters are listed in *Tables 11a* and *11b*, respectively. Hard coral taxa density breakdown is given in *Table 11c*.

Table 11a. A summary of substrate type parameter estimates for Site I3

Substrate	% Baseline
Hard Coral (inc. dead)	11.71 ± 3.11
Dead Coral (inc. damage)	7.83 ± 2.92
Live Coral	3.87 ± 0.94
Soft/black Coral	30.84 ± 3.20
Rubble	7.62 ± 0.99
Invert. Life forms	4.36 ± 0.68
Bare rock/boulders	27.34 ± 1.89
Sand	12.66 ± 1.14

Data are mean ± SE. n=10

Table 11b. A summary of univariate type parameter estimates for Site I3

Univariate community parameters	% Baseline
Total species/taxa	13
Species richness	3.700 ± 0.776
Diversity	1.087 ± 0.200
Evenness	3.289 ± 0.842
No. of colonies per transect	6.300 ± 1.529

Data are mean ± SE. n=10

Table 11c. Taxa density of the Site I3, Baseline

Coral Taxa	% 2005
<i>Montipora</i> spp.	6.3
<i>Acropora</i> spp.	4.8
<i>Psammocora</i> sp.	11.1
<i>Pavona</i> sp.	4.8
<i>Porites</i> spp.	6.3
<i>Goniopora</i> spp.	17.5
<i>Favia</i> spp.	4.8
<i>Plesiastrea</i> sp.	6.3
<i>Oulastrea</i> sp.	14.3
<i>Leptastrea</i> spp.	3.2
<i>Cyphastrea</i> sp.	9.5
<i>Lithophyllon</i> sp.	3.2
<i>Stylocoeniella</i> sp.	7.9
Total (%) live hard coral cover :	3.87 ± 0.94

Shallow Water Coral Tagging Results

This area recorded a community that was a mixture of hard, soft and black corals and a total of 40 suitable corals were selected for the shallow water monitoring. Twenty hard and 20 black coral colonies were selected as required by the *EM&A Manual*. They were selected in the area as being suitably large colonies that would show sedimentation stress. The list of the selected corals is presented in *Table 12*.

Table 12. Recommended shallow area coral colonies selected for monitoring at Site I3.

Coral Number	Species	Coral Number	Species
2	<i>Cyphastrea</i> sp.	1	<i>Antipathes</i> sp.
7	<i>Leptastrea</i> sp.	3	<i>Antipathes</i> sp.
9	<i>Cyphastrea</i> sp.	4	<i>Antipathes</i> sp.
12	<i>Cyphastrea</i> sp.	5	<i>Antipathes</i> sp.
13	<i>Cyphastrea</i> sp.	6	<i>Antipathes</i> sp.
14	<i>Cyphastrea</i> sp.	8	<i>Antipathes</i> sp.
17	<i>Porites</i> sp.	10	<i>Antipathes</i> sp.
18	<i>Cyphastrea</i> sp.	11	<i>Antipathes</i> sp.
20	<i>Cyphastrea</i> sp.	15	<i>Antipathes</i> sp.
21	<i>Porites</i> sp.	16	<i>Antipathes</i> sp.
23	<i>Porites</i> sp.	19	<i>Antipathes</i> sp.
24	<i>Cyphastrea</i> sp.	22	<i>Antipathes</i> sp.
26	<i>Cyphastrea</i> sp.	25	<i>Antipathes</i> sp.
27	<i>Cyphastrea</i> sp.	30	<i>Antipathes</i> sp.
28	<i>Leptastrea</i> sp.	31	<i>Antipathes</i> sp.
29	<i>Cyphastrea</i> sp.	33	<i>Antipathes</i> sp.
32	<i>Cyphastrea</i> sp.	34	<i>Antipathes</i> sp.
35	<i>Pavona</i> sp.	37	<i>Antipathes</i> sp.
36	<i>Cyphastrea</i> sp.	40	<i>Antipathes</i> sp.
38	<i>Cyphastrea</i> sp.	41	<i>Antipathes</i> sp.

The species selected are those also recorded in the shallow (<5m) and deep (<12m) zone at Chek Chau. A full list of all tagged colony details is provided in *Appendix C4C* and *C4D* of *Annex D*.

Results of the Quadrat Survey

A total of 40 quadrat surveys were carried out along a total of 40m of transect (2 x 20m). The most abundant corals recorded were the black corals. *Table 13* contains the quadrat survey results.

Table 13. The results for the shallow water coral quadrat survey carried out at Site I3.

Parameter	Results	Remarks
Diversity	24 Species	Pre-survey reconnaissance dive
Abundance:		
- Hard corals (colonies/m ²)	0.23 ± 0.14	Hermatypic hard corals
- Hard corals (colonies/m ²)	0.00 ± 0.00	Ahermatypic hard corals
- Soft corals (colonies/m ²)	0.00 ± 0.00	Excludes gorgonians
- Gorgonians (colonies/m ²)	0.18 ± 0.10	
- Black Corals (colonies/m ²)	0.80 ± 0.24	<i>Antipathes</i> sp.
Health :		
- Blanching	0%	
- Bleaching %	0%	
- Dead / live ratio %	<20%	
- Siltation coverage %	<40%	Colours Pantone CV409 (grey), CV1215 (creamy), CV411 (grey)
Substratum type	Boulders	
Silt :		Colour Pantone CV411 (grey)
- Thickness	<2mm	On all unoccupied hard substratum
- Type	Fine	Fine, talc like silt.

Note: Gorgonians are presented as a separate soft coral subgroup in this table to provide more information about their abundance in this area. It should be noted that the term "soft corals" used in the main text includes gorgonians and other soft corals.

General Field Observations

This area was very similar to I1 and I2, further inside the Tolo Channel. The makeup of the area was very similar with large boulders making up the bulk of the shallow water seabed (<5m). The shallow water area (<2mCD) contained many anemones and encrusting sponges. The black corals started at ~4.5mCD. Most un-occupied hard substratum was covered in a fine layer of grey talc like silt <2mm thick. The colour of the sediment recorded on the hard colonies ranged from grey, dark-grey and cream and it is possible that coral mucus was responsible for the difference in deposited sediment colour (particularly with the *Cyphastrea* spp. Colonies).

3.3.4.2 Deep Water Coral Community (>5m)

The *EM&A Manual* requires that 20 hard corals and 20 soft/black corals be tagged in the deep water area (>5m). There was, however, no live hard, soft or black coral observed or recorded below 5m (similar to I1 and I2). All hard and black coral below 5mCD had suffered 100% mortality (Plates 17, 18 and 19 of *Appendix E* of *Annex D*). It is possible that the recent 2004 hypoxia event is responsible for the mass coral mortality.

3.3.5 Tolo Channel Impact Site 4 (I4) – Gruff Head

This area was surveyed on the 1st, 2nd, 4th March and 15th April 2005. During March the sea was mild, air temperature was 10~13°C with the sea temperature 10~12°C at 5m depth. During April the weather was mild, air temperature was 20°C and the sea temperature was 19°C at 5m depth. The surveyed area consisted of one shallow water (<5m) coral community. Twenty-six different species of hard corals and one species of black coral *Antipathes* sp. were observed during a reconnaissance dive carried out immediately before the survey. Fourteen species of coral were recorded during the video transects. The main coral area was located in 1.8~5m of water along the edge of the rocky shoreline. The seabed changed to mud and sand immediately after the rocky area. No live corals were recorded in this mud and sand area for more than 280m directly out from the shore. There were numerous colonies of *Antipathes* sp. with 100% mortality observed in this area; however the number was less than Site I1, Site I2 and Site I3.

3.3.5.1 Shallow Water Community (<5m)

The hard coral community comprised of a typical incipient reef structure with most (>90%) colonies being very small (generally < 20cm²). The area appeared quite exposed to currents flowing through Tolo Channel.

Quantitative Underwater Video Transects

The data were collected in the shallow area (<5m). Colonies of the black coral *Antipathes* sp. were recorded in this area. The surveyed area had a calculated hard coral cover of 4.74 ± 0.92% (mean ± SE) with the measured proportion of live hard coral at only 4.25 ± 0.88% and dead coral at 0.50 ± 0.27%. The measured cover of soft / black coral was 29.05 ± 9.67%. This result was similar to the Site I1 (31.56 ± 4.35%), Site I2 (34.74 ± 3.24%) and Site I3 (30.84 ± 3.20%). The percentage of un-occupied hard substratum was calculated to be 47.83 ± 6.24%. The amount of area covered by sand was measured as 10.55 ± 2.41%. The hard coral community was dominated by four genera *Cyphastrea* spp., *Turbinaria* sp., *Oulastrea* sp. and *Plesiastrea* sp. in terms of percentage cover and the number of colonies. Almost all (>85%) of the hard coral colonies recorded were small (generally < 20cm²). The substrate and univariate parameters are listed in *Tables 14a* and *14b*, respectively. Hard coral taxa density breakdown is given in *Table 14c*.

Table 14a. A summary of substrate type parameter estimates for Site I4

Substrate	% Baseline
Hard Coral (inc. dead)	4.74 ± 0.92
Dead Coral (inc. damage)	0.50 ± 0.27
Live Coral	4.25 ± 0.88
Soft/black Coral	29.05 ± 9.67
Rubble	5.90 ± 1.58
Invert. Life forms	7.83 ± 1.78
Bare rock/boulders	41.59 ± 5.69
Sand	10.55 ± 2.41

Data are mean ± SE. n=10

Table 14b. A summary of univariate type parameter estimates for Site I4

Univariate community parameters	% Baseline
Total species/taxa	14
Species richness	4.200 ± 0.728
Diversity	1.154 ± 0.219
Evenness	3.780 ± 0.817
No. of colonies per transect	6.400 ± 1.319

Data are mean ± SE. n=10

Table 14c. Taxa density of the Site I4, Baseline

Coral Taxa	% 2005
<i>Montipora</i> spp.	6.3
<i>Acropora</i> spp.	3.1
<i>Psammocora</i> sp.	7.8
<i>Pavona</i> sp.	3.1
<i>Porites</i> spp.	4.7
<i>Goniopora</i> spp.	7.8
<i>Montastrea</i> sp.	1.6
<i>Favia</i> spp.	1.6
<i>Plesiastrea</i> sp.	12.5
<i>Oulastrea</i> sp.	14.1
<i>Turbinaria</i> spp.	12.5
<i>Cyphastrea</i> sp.	20.3
<i>Lithophyllon</i> sp.	0.0
<i>Hydnophora</i> sp.	4.7
Total (%) live hard coral cover :	4.25 ± 0.88

Shallow Water Coral Tagging Results

This area recorded a community of a mixture of hard, soft and black corals. A total of 40 suitable corals were selected for the shallow water monitoring. Twenty hard corals and 20 black corals were selected for tagging as required by the *EM&A Manual*. They were selected in the area as being suitably large colonies that would show sedimentation stress. The list of the selected corals is presented in *Table 15*.

Table 15. Recommended shallow area coral colonies selected for monitoring at Site I4.

Coral Number	Species	Coral Number	Species
1	<i>Antipathes</i> sp.	21	<i>Turbinaria</i> sp.
2	<i>Antipathes</i> sp.	22	<i>Cyphastrea</i> sp.
3	<i>Antipathes</i> sp.	23	<i>Cyphastrea</i> sp.
4	<i>Antipathes</i> sp.	24	<i>Turbinaria</i> sp.
5	<i>Antipathes</i> sp.	25	<i>Porites</i> sp.
6	<i>Antipathes</i> sp.	26	<i>Pavona</i> sp.
7	<i>Antipathes</i> sp.	27	<i>Plesiastrea</i> sp.
8	<i>Antipathes</i> sp.	28	<i>Turbinaria</i> sp.
9	<i>Antipathes</i> sp.	29	<i>Turbinaria</i> sp.
10	<i>Antipathes</i> sp.	30	<i>Cyphastrea</i> sp.
11	<i>Antipathes</i> sp.	31	<i>Cyphastrea</i> sp.
12	<i>Antipathes</i> sp.	32	<i>Cyphastrea</i> sp.
13	<i>Antipathes</i> sp.	36	<i>Plesiastrea</i> sp.
14	<i>Antipathes</i> sp.	37	<i>Cyphastrea</i> sp.
15	<i>Antipathes</i> sp.	38	<i>Hydnophora</i> sp.
16	<i>Antipathes</i> sp.	39	<i>Porites</i> sp.
17	<i>Antipathes</i> sp.	40	<i>Pavona</i> sp.
18	<i>Antipathes</i> sp.	41	<i>Plesiastrea</i> sp.
19	<i>Antipathes</i> sp.	42	<i>Turbinaria</i> sp.
20	<i>Antipathes</i> sp.	43	<i>Turbinaria</i> sp.

The species selected are those also recorded in the shallow (<5m) and deep (<12m) zone at Chek Chau. A full list of all tagged colony details is provided in *Appendix C5C* and *C5D* of *Annex D*.

Results of the Quadrat Survey

A total of 40 quadrat surveys were carried out along a total of 40m of transect (2 x 20m). Black corals were the most abundant taxa recorded. *Table 16* contains the quadrat survey results.

Table 16. The results for the shallow water coral quadrat survey carried out at Site I4.

Parameter		Remarks
Diversity	26 Species	Pre-survey reconnaissance dive
Abundance:		
- Hard corals (colonies/m ²)	0.05 ± 0.05	Hermatypic hard corals
- Hard corals (colonies/m ²)	0.00 ± 0.00	Ahermatypic hard corals
- Soft corals (colonies/m ²)	0.00 ± 0.00	Excludes gorgonians
- Gorgonians (colonies/m ²)	0.00 ± 0.00	
- Black Corals (colonies/m ²)	0.98 ± 0.24	<i>Antipathes</i> sp.
Health :		
- Blanching	0%	
- Bleaching %	<10%	
- Dead / live ratio %	<10%	
- Siltation coverage %	<5%	Colour Pantone CV411 (grey)
Substratum type	Boulders	
Silt :		Colour Pantone CV 411 (grey)
- Thickness	<1mm	On deep (>4m) unoccupied hard substratum
- Type	Fine	Fine, talc like silt.

Note: Gorgonians are presented as a separate soft coral subgroup in this table to provide more information about their abundance in this area. It should be noted that the term "soft corals" used in the main text includes gorgonians and other soft corals.

General Field Observations

This seabed in this area consisted of large boulders down to 5mCD immediately followed by sand and mud at 9mCD. There were black corals in water as shallow as 2m, however, most were between 4m and 4.5m. Most un-occupied hard substratum was covered in a fine layer of grey talc like silt <1mm thick. The colour of the sediment recorded on the hard colonies was also grey.

3.3.5.2 Deep Water Coral Community (>5m)

The *EM&A Manual* requires that 20 hard corals and 20 soft/black corals be tagged in the deep area (>5m). There was, however, no live hard, soft or black coral observed below 5m and consequently it was not possible to tag corals in this area as required in *Manual*. The area below 5mCD is a sloping sand seabed that changes to sand-mud at 9mCD (Plate 26 of *Appendix E of Annex D*). The deepest transect recorded in the pre-EM&A survey was at an average depth of 5.3m while the recent baseline surveys have shown massive die-off of the benthos.

3.3.6 Tolo Channel Impact Site 5 (I5) – Wong Chuk Kok South West

This area was surveyed on the 2nd of March and 15th April 2005. During March, the sea was mild; air temperature was 13°C with the sea temperature 12°C at 5m. During April the air temperature was 21°C and the sea temperature 19°C at 5m. The surveyed area consisted of one shallow water (<5m) coral community. Fifteen different species of hard corals, one species of soft coral (*Echinogorgia* sp.) and black coral (*Antipathes* sp.) were observed during a reconnaissance dive carried out immediately before the survey. Thirteen coral species were recorded during video transects. The main coral area was located in 1.5~5m of water along the edge of the rocky shoreline. The seabed changed to mud and sand immediately after the rocky area. No live corals were recorded in this mud and sand area for more than 150m directly out from the shore. There were numerous colonies of *Antipathes* sp. with 100% mortality observed in this area; however the number was less than Site I1, Site I2 and Site I3.

3.3.6.1 Shallow Water Coral Community (<5m)

The hard coral community comprised of a typical incipient reef structure of mostly (>95%) small colonies (generally <20cm²). The area appeared quite exposed to any currents flowing in or out of Tolo Channel.

Quantitative Underwater Video Transects

The data were collected in the shallow area (<5m). Colonies of the black coral *Antipathes* sp. were recorded in this area. The surveyed area had a calculated hard coral cover of $26.42 \pm 4.37\%$ (mean \pm SE) with the measured proportion of live hard coral at only $6.81 \pm 0.52\%$ and dead coral at $19.61 \pm 4.25\%$. The measured cover of soft / black coral was $6.97 \pm 1.92\%$. This result was much less than the other sites surveyed thus far (Site I1, I2, I3, and I4). The percentage of un-occupied hard substratum was calculated to be $46.36 \pm 2.55\%$. The amount of area covered by sand was measured as $15.59 \pm 1.47\%$. The hard coral community was dominated by five genera *Oulastrea* sp., *Plesiastrea* sp., *Goniopora* sp. and *Psammocora* sp. in terms of percentage cover and the number of colonies. Almost all (>95%) of the hard coral colonies recorded were small (generally < 20cm²). The substrate and univariate parameters are listed in *Tables 17a* and *17b*, respectively. Hard coral taxa density breakdown is given in *Table 17c*.

Table 17a. A summary of substrate type parameter estimates for Site I5

Substrate	% Baseline
Hard Coral (inc. dead)	26.42 ± 4.37
Dead Coral (inc. damage)	19.61 ± 4.25
Live Coral	6.81 ± 0.52
Soft/black Coral	6.97 ± 1.92
Rubble	9.97 ± 1.11
Invert. Life forms	4.61 ± 0.98
Bare rock/boulders	23.31 ± 2.29
Sand	15.59 ± 1.47

Data are mean ±SE. n=10

Table 17b. A summary of univariate type parameter estimates for Site I5

Univariate community parameters	% Baseline
Total species/taxa	13
Species richness	7.000 ± 0.472
Diversity	1.802 ± 0.065
Evenness	6.812 ± 0.478
No. of colonies per transect	12.700 ± 0.967

Data are mean ± SE. n=10

Table 17c. Taxa density of the Site I5, Baseline

Coral Taxa	% 2005
<i>Montipora</i> spp.	10.2
<i>Acropora</i> spp.	3.1
<i>Psammocora</i> sp.	12.6
<i>Pavona</i> sp.	9.4
<i>Porites</i> spp.	11.8
<i>Goniopora</i> spp.	13.4
<i>Goniastrea</i> sp.	2.4
<i>Favia</i> spp.	2.4
<i>Plesiastrea</i> sp.	12.6
<i>Oulastrea</i> sp.	13.4
<i>Leptastrea</i> sp.	2.4
<i>Turbinaria</i> spp.	0.8
<i>Cyphastrea</i> sp.	5.5
Total (%) live hard coral cover :	6.81 ± 0.52

Shallow Water Coral Tagging Results

A mixed community of hard, soft and black corals were recorded in this area and a total of 48 suitable corals were selected for the shallow water monitoring. Twenty-two hard coral colonies were tagged as required by the *EM&A Manual*. While the *Manual* requires only 20 hard/soft corals be tagged, 4 soft corals and 22 black corals were also tagged for monitoring. They were selected on the basis that they are susceptible to sedimentation stress. The list of the selected corals is presented in *Table 18*.

Table 18. Recommended shallow area coral colonies selected for tagging at Site 15.

Coral Number	Species	Coral Number	Species
1	<i>Cyphastrea</i> sp.	11	<i>Antipathes</i> sp.
4	<i>Cyphastrea</i> sp.	18	<i>Antipathes</i> sp.
5	<i>Cyphastrea</i> sp.	19	<i>Antipathes</i> sp.
6	<i>Cyphastrea</i> sp.	23	<i>Antipathes</i> sp.
7	<i>Turbinaria</i> sp.	24	<i>Antipathes</i> sp.
8	<i>Cyphastrea</i> sp.	25	<i>Antipathes</i> sp.
9	<i>Favia</i> sp.	27	<i>Antipathes</i> sp.
13	<i>Pavona</i> sp.	32	<i>Antipathes</i> sp.
14	<i>Favia</i> sp.	34	<i>Antipathes</i> sp.
16	<i>Pavona</i> sp.	35	<i>Antipathes</i> sp.
17	<i>Turbinaria</i> sp.	37	<i>Antipathes</i> sp.
20	<i>Cyphastrea</i> sp.	41	<i>Antipathes</i> sp.
21	<i>Cyphastrea</i> sp.	43	<i>Antipathes</i> sp.
22	<i>Cyphastrea</i> sp.	44	<i>Antipathes</i> sp.
26	<i>Turbinaria</i> sp.	45	<i>Antipathes</i> sp.
28	<i>Cyphastrea</i> sp.	46	<i>Antipathes</i> sp.
30	<i>Cyphastrea</i> sp.	47	<i>Antipathes</i> sp.
31	<i>Cyphastrea</i> sp.	48	<i>Antipathes</i> sp.
33	<i>Porites</i> sp.	49	<i>Antipathes</i> sp.
36	<i>Cyphastrea</i> sp.	50	<i>Antipathes</i> sp.
38	<i>Porites</i> sp.	2	<i>Guaiaigorgia</i> sp.
39	<i>Psammocora</i> sp.	12	<i>Guaiaigorgia</i> sp.
3	<i>Antipathes</i> sp.	15	<i>Guaiaigorgia</i> sp.
10	<i>Antipathes</i> sp.	29	<i>Echinogorgia</i> sp.

The species selected are those also recorded in the shallow (<5m) and deep (<12m) zone at Chek Chau (CCC). A full list of all tagged colony details is provided in *Appendix C6C* and *C6D* of *Annex D*. This site had a considerable number of dead corals. Most of the recorded hard corals were small (generally < 20cm²) and therefore not considered suitable indicators of stress.

Results of the Quadrat Survey

A total of 40 quadrat surveys were carried out along a total of 40m of transect (2 x 20m). The most abundant corals recorded were the black corals. *Table 19* contains the quadrat survey results.

Table 19. The results for the shallow water coral quadrat survey carried out at Site 15.

Parameter		Remarks
Diversity	15 Species	Pre-survey reconnaissance dive
Abundance:		
- Hard corals (colonies/m ²)	0.20 ± 0.09	Hermatypic hard corals
- Hard corals (colonies/m ²)	0.00 ± 0.00	Ahermatypic hard corals
- Soft corals (colonies/m ²)	0.00 ± 0.00	Excludes gorgonians
- Gorgonians (colonies/m ²)	0.05 ± 0.05	
- Black Corals (colonies/m ²)	0.05 ± 0.05	<i>Antipathes</i> sp.
Health :		
- Blanching	<3%	
- Bleaching %	<0%	
- Dead / live ratio %	<10%	
- Siltation coverage %	<5%	Colour Pantone CV449 (green-brown)
Substratum type	Boulders	
Silt :		Colour Pantone CV449 (green-brown)
- Thickness	<1mm	On deep (>3m) unoccupied hard substratum
- Type	Fine	Fine, talc like silt.

Note: Gorgonians are presented as a separate soft coral subgroup in this table to provide more information about their abundance in this area. It should be noted that the term "soft corals" used in the main text includes gorgonians and other soft corals.

General Field Observations

This area was different from the impact sites investigated further inside Tolo Channel and black coral colonies were less abundant although hard corals were more abundant. There was a very thin layer of green-brown silt on all un-occupied substratum (<1mm) and on the coral colonies.

3.3.6.2 Deep Water Coral Community (>5m)

The *EM&A Manual* requires that 20 hard corals and 20 soft/black corals be tagged in the deep water area (>5m). There was, however, no live hard, soft or black coral observed or recorded below 5m (similar to sites I1 - I4). All hard and black coral below 5mCD had suffered 100% mortality (Plates 29 and 30 of *Appendix E of Annex D*). It is possible that the recent 2004 hypoxia event is responsible for the mass mortality below 5m.

3.3.7 Tolo Channel Impact Site 6 (I6) – Wong Chuk Kok

This area was surveyed on the 2nd of March 2005. During March the sea was mild; air temperature was 13°C with the sea temperature 11°C at 5m. The surveyed area consisted of one shallow water (<5m) coral community. Thirty different species of hard corals were observed during a reconnaissance dive carried out immediately before the survey. Sixteen coral species were recorded during video transects. No colonies of soft or black corals were observed in either the shallow zone (<5mCD) or deeper zone (>5mCD). The main coral area was located in 1.2~5m of water along the edge of the rocky shoreline. The seabed changed to mud and sand immediately after the rocky area. No live corals were recorded in this mud and sand area for more than 200m directly out from the shore.

3.3.7.1 Shallow Water Coral Community (<5m)

The hard coral community was typically incipient reef structure comprised of mostly (>80%) small colonies (<20cm²). The area appeared quite exposed to currents flowing through Tolo Channel.

Quantitative Underwater Video Transects

The data were collected in the shallow area (<5m). The surveyed area had a calculated hard coral cover of 68.60 ± 3.47% (mean ± SE) with the measured proportion of live hard coral at

only $67.60 \pm 3.54\%$ and dead coral at $1.00 \pm 0.39\%$. The percentage of un-occupied hard substratum was calculated to be $21.36 \pm 3.06\%$, and sand was measured as $8.05 \pm 1.40\%$. The hard coral community was dominated by three genera *Favia* spp., *Favites* spp. and *Goniopora* sp. in terms of percentage cover and the number of colonies. The substrate and univariate parameters are listed in *Tables 20a* and *20b*, respectively. Hard coral taxa density breakdown is given in *Table 20c*.

Table 20a. A summary of substrate type parameter estimates for Site I6

Substrate	% Baseline
Hard Coral (inc. dead)	68.60 ± 3.47
Dead Coral (inc. damage)	1.00 ± 0.39
Live Coral	67.60 ± 3.54
Rubble	4.26 ± 1.06
Invert. Life forms	1.20 ± 0.38
Bare rock/boulders	17.10 ± 3.02
Sand	8.05 ± 1.40

Data are mean \pm SE. $n=10$

Table 20b. A summary of univariate type parameter estimates for Site I6

Univariate community parameters	% Baseline
Total species/taxa	16
Species richness	13.400 ± 0.476
Diversity	2.200 ± 0.049
Evenness	13.254 ± 0.481
No. of colonies per transect	101.600 ± 5.327

Data are mean \pm SE. $n=10$

Table 20c. Taxa density of the Site I6, Baseline

Coral Taxa	% 2005
<i>Echinophyllia</i> sp.	4.0
<i>Acropora</i> spp.	1.9
<i>Psammocora</i> sp.	2.5
<i>Pavona</i> sp.	5.4
<i>Porites</i> spp.	2.8
<i>Goniopora</i> spp.	13.1
<i>Goniastrea</i> sp.	2.3
<i>Favia</i> spp.	22.5
<i>Favites</i> spp.	18.2
<i>Platygyra</i> spp.	7.5
<i>Oulastrea</i> sp.	3.3
<i>Stylocoeniella</i> sp.	1.8
<i>Turbinaria</i> spp.	6.1
<i>Lithophyllon</i> sp.	1.9
<i>Cyphastrea</i> sp.	3.9
<i>Hydnophora</i> sp.	2.9
Total (%) live hard coral cover :	67.60 ± 3.54

Shallow water coral tagging results

A total of 20 suitable corals were selected for the shallow water monitoring. They were selected along the 40m transect as being suitably large colonies that would show sedimentation stress. This area recorded a community that consisted entirely of hard corals. The list of the selected corals is in *Table 21*. The pre-EM&A recorded <1% cover of the soft coral *Dendronephthya* sp. There was also a record of *Antipathes* sp. (<1%) in the deeper zone

of this area. The reconnaissance dive did not locate either of these corals. Four dead soft coral, possibly *Euplexaura* sp. were recorded in the deep >5m zone of this area.

- **Hard Corals**

Twenty hard coral colonies were tagged in the shallow water area (<5m) as required by the *EM&A Manual*.

- **Soft and Black Corals**

The *EM&A Manual* requires that 20 soft and black corals be tagged in the shallow water area (<5m). There were, however, no soft or black corals recorded in this area and thus none was tagged.

Table 21. Recommended shallow area coral colonies selected for monitoring at Site 16.

Coral Number	Species	Coral Number	Species
1	<i>Turbinaria</i> sp.	13	<i>Pavona</i> sp.
14	<i>Turbinaria</i> sp.	17	<i>Pavona</i> sp.
15	<i>Turbinaria</i> sp.	8	<i>Plesiastrea</i> sp.
3	<i>Hydnophora</i> sp.	12	<i>Plesiastrea</i> sp.
4	<i>Hydnophora</i> sp.	9	<i>Platygyra</i> sp.
7	<i>Hydnophora</i> sp.	10	<i>Platygyra</i> sp.
11	<i>Hydnophora</i> sp.	16	<i>Platygyra</i> sp.
2	<i>Pavona</i> sp.	18	<i>Platygyra</i> sp.
5	<i>Pavona</i> sp.	19	<i>Platygyra</i> sp.
6	<i>Pavona</i> sp.	20	<i>Platygyra</i> sp.

The species selected are those also recorded in the shallow (<5m) and deep (<12m) zone at Chek Chau (CCC). A full list of all tagged colony details is provided in *Appendix C7C* and *C7D* of *Annex D*.

Results of the Quadrat Survey

A total of 40 quadrat surveys were carried out along a total of 40m of transect (2 x 20m). The most abundant corals recorded were hard stony corals. *Table 22* contains the quadrat survey results.

Table 22. The results for the shallow water coral quadrat survey carried out at Site 16.

Parameter		Remarks
Diversity	30 Species	Pre-survey reconnaissance dive
Abundance:		
- Hard corals (colonies/m ²)	3.48 ± 0.46	Hermatypic hard corals
- Hard corals (colonies/m ²)	0.00 ± 0.00	Ahermatypic hard corals
- Soft corals (colonies/m ²)	0.00 ± 0.00	Excludes gorgonians
- Gorgonians (colonies/m ²)	0.00 ± 0.00	
- Black Corals (colonies/m ²)	0.00 ± 0.00	
Health :		
- Blanching	<0%	
- Bleaching %	<10%	
- Dead / live ratio %	<20%	
- Siltation coverage %	<10%	Colour Pantone CV449 (green-brown)
Substratum type	Boulders	
Silt :	<5%	Colour Pantone CV449 (green-brown)
- Thickness	<0.5mm	Occasionally on deep (>3m) unoccupied hard substratum
- Type	Fine	Fine, talc like silt.

Note: Gorgonians are presented as a separate soft coral subgroup in this table to provide more information about their abundance in this area. It should be noted that the term "soft corals" used in the main text includes gorgonians and other soft corals.

General Field Observations

This area was different from the impact sites investigated further inside the Tolo Channel. There were no black coral colonies recorded and considerably more hard corals were present. *Platygyra* spp. was recorded (7.5% of the coral) at this site. There was a very thin layer of green-brown silt on all un-occupied substratum (<0.5mm) and coral colonies.

3.3.7.2 Deep Water Coral Community (>5m)

The *EM&A Manual* requires that 20 hard corals and 20 soft/black corals be tagged in the deep water area (>5m). There was, however, no live hard, soft or black coral observed or recorded below 5mCD (Plate 32 of *Appendix E of Annex D*). The pre-EM&A survey recorded low densities (<1%) of both soft and black corals. For the present baseline survey, neither black or soft corals were recorded out to 200m from the shore. Only several dead soft coral colonies (possibly *Euplexaura* sp.) were observed. It is possible that the recent 2004 hypoxia event is responsible for the mass mortality.

3.3.8 Tolo Channel Impact Site 7 (I7) – Wong Chuk Kok North

This area was surveyed on the 4th of March 2005. The sea was mild; air temperature was 12°C with the sea temperature 12°C at 5m. The surveyed area consisted of one shallow water (<5m) coral community. Thirty-three different species of hard corals were observed during a reconnaissance dive carried out immediately before the survey. Fourteen coral species were recorded during video transect surveys. No colonies of soft or black corals were observed. The main coral area was located in 1.2~5m of water along the edge of the rocky shoreline. The seabed changed to mud and sand immediately after the rocky area. No live corals were recorded in this mud and sand area for more than 150m directly out from the shore.

3.3.8.1 Shallow Water Coral Community (<5m)

The hard coral community was typically incipient reef structure comprised of mostly (>75%) small colonies (<20cm²). The area appeared quite exposed to currents flowing through Tolo Channel.

Quantitative Underwater Video Transects

The data were collected in the shallow area (<5m). The surveyed area had a calculated hard coral cover of 53.80 ± 3.22% (mean ± SE) with the measured proportion of live hard coral at only 53.80 ± 3.22% and no dead coral. The percentage of un-occupied hard substratum was calculated to be 31.40 ± 3.64%. The amount of area covered by sand was measured as 11.20 ± 2.73%. The hard coral community was dominated by three genera *Favia* spp., *Favites* spp. and *Goniopora* sp. in terms of percentage cover. There were many colonies of *Platygyra* spp. recorded in this area. This community was similar to the nearby Site I6. The substrate and univariate parameters are listed in *Tables 23a* and *23b*, respectively. Hard coral taxa density breakdown is given in *Table 23c*. As with I6, Site I7 did not have any live *Antipathes* spp. or *Cirripathes* spp. present. There was only the very occasional dead black coral colony (2 recorded on a 200m transect) in deeper water below 5m.

Table 23a. A summary of substrate type parameter estimates for Site I7

Substrate	% Baseline
Hard Coral (inc. dead)	53.80 ± 3.22
Dead Coral (inc. damage)	0.00 ± 0.00
Live Coral	53.80 ± 3.22
Rubble	1.67 ± 0.55
Invert. Life forms	2.67 ± 0.83
Bare rock/boulders	29.73 ± 3.94
Sand	11.20 ± 2.73

Data are mean ±SE. n=10

Table 23b. A summary of univariate type parameter estimates for Site I7

Univariate community parameters	% Baseline
Total species/taxa	14
Species richness	10.600 ± 0.267
Diversity	2.061 ± 0.073
Evenness	10.435 ± 0.275
No. of colonies per transect	80.700 ± 4.829

Data are mean ±SE. n=10

Table 23c. Taxa density of the Site I7, Baseline

Coral Taxa	% 2005
<i>Echinophyllia</i> sp.	1.9
<i>Montipora</i> spp.	1.6
<i>Acropora</i> spp.	3.1
<i>Psammocora</i> sp.	2.9
<i>Pavona</i> sp.	5.2
<i>Porites</i> spp.	3.0
<i>Goniopora</i> spp.	14.1
<i>Montastrea</i> sp.	1.6
<i>Favia</i> spp.	13.5
<i>Favites</i> spp.	26.8
<i>Platygyra</i> spp.	11.2
<i>Stylocoeniella</i> sp.	5.2
<i>Turbinaria</i> spp.	5.6
<i>Hydnophora</i> sp.	4.5
Total (%) live hard coral cover :	53.80 ± 3.22

Shallow Water Coral Tagging Results

A total of 20 suitable corals were selected for the shallow water monitoring. They were selected along the 40m transect as being suitably large colonies that would show sedimentation stress. A community that consisted entirely of hard corals was recorded in this area. The list of the selected corals is presented below in *Table 24*.

- **Hard Corals**

Twenty hard coral colonies were tagged in the shallow water area (<5m) as required by the *EM&A Manual*.

- **Soft and Black Corals**

The *EM&A Manual* requires that 20 soft and black corals be tagged in the shallow water area (<5m). There were, however, no soft or black corals recorded in this area and thus none was tagged.

Table 24. Recommended shallow area coral colonies selected for tagging at Site 17.

Coral Number	Species	Coral Number	Species
1	<i>Turbinaria</i> sp.	4	<i>Cyphastrea</i> sp.
10	<i>Turbinaria</i> sp.	7	<i>Cyphastrea</i> sp.
12	<i>Turbinaria</i> sp.	11	<i>Cyphastrea</i> sp.
14	<i>Turbinaria</i> sp.	6	<i>Pavona</i> sp.
15	<i>Turbinaria</i> sp.	13	<i>Pavona</i> sp.
16	<i>Turbinaria</i> sp.	18	<i>Plesiastrea</i> sp.
2	<i>Hydnophora</i> sp.	9	<i>Leptastrea</i> sp.
5	<i>Hydnophora</i> sp.	3	<i>Platygyra</i> sp.
8	<i>Hydnophora</i> sp.	17	<i>Platygyra</i> sp.
19	<i>Hydnophora</i> sp.	20	<i>Platygyra</i> sp.

The species selected are those also recorded in the shallow (<5m) and deep (<12m) zone at Chek Chau (CCC). A full list of the tagged colony details are provided in *Appendix C8C* and *C8D* of *Annex D*.

Results of the Quadrat Survey

A total of 40 quadrat surveys were carried out along a total of 40m of transect (2 x 20m). The most abundant corals recorded were hard stony corals. *Table 25* contains the quadrat survey results.

Table 25. The results for the shallow water coral quadrat survey carried out at Site 17.

Parameter		Remarks
Diversity	33 Species	Pre-survey reconnaissance dive
Abundance:		
- Hard corals (colonies/m ²)	1.88 ± 0.40	Hermatypic hard corals
- Hard corals (colonies/m ²)	0.00 ± 0.00	Ahermatypic hard corals
- Soft corals (colonies/m ²)	0.00 ± 0.00	Excludes gorgonians
- Gorgonians (colonies/m ²)	0.00 ± 0.00	
- Black Corals (colonies/m ²)	0.00 ± 0.00	
Health :		
- Blanching	<0%	
- Bleaching %	<0%	
- Dead / live ratio %	<20%	
- Siltation coverage %	<10%	Colour Pantone CV449 (green-brown)
Substratum type	Boulders	
Silt :	<5%	Colour Pantone CV449 (green-brown)
- Thickness	<0.1mm	Occasionally on deep (>3m) unoccupied hard substratum
- Type	Fine	Fine, talc like silt.

Note: Gorgonians are presented as a separate soft coral subgroup in this table to provide more information about their abundance in this area. It should be noted that the term "soft corals" used in the main text includes gorgonians and other soft corals.

General Field Observations

This area was similar to the impact site I6 investigated further inside the Tolo Channel. There were no black coral colonies recorded although hard corals were abundant. *Platygyra* spp. represented 11.2% of the hard corals taxa present at this site. There was a very thin (<0.1mm) layer of green-brown silt on some un-occupied substratum and on the coral colonies.

3.3.8.2 Deep Water Coral Community (>5m)

The *EM&A Manual* requires that 20 hard corals and 20 soft/black corals be tagged in the deep water area (>5m). There was, however, no live hard, soft or black coral observed or recorded

below 5mCD (Plate 36, 37 and 38 of *Appendix E of Annex D*). The pre-EM&A survey recorded low densities (<1%) of black coral at 6.4m. Black corals were not recorded during the present surveys and no live coral recorded up to 150m from the shore. It is possible that the colonies recorded previously have perished during the 2004 hypoxia event.

3.4 Discussion

A summary of the coral coverage for all of the sites investigated is presented below in *Table 26*. Baseline surveys revealed a diverse series of coral communities exist in the study area. Live hard coral cover at the impact monitoring stations varied from 67.60% at Wong Chuk Kok (I6) to 2.09% at Wong Wan Tsui West. The Chek Chau Control deep zone also had low hard coral cover at 0.88 colonies m⁻². Maximum black coral cover was recorded at Wong Wan Tsui West (I1), 0.96 ± 0.23 colonies m⁻².

Table 26. A comparison table of the coral densities /coverage results of this survey

Site	Coral Type	Coverage	Colonies Monitored
CCC Shallow (Chek Chau)	Hard coral (Live Cover %)	63.05 ± 2.79%	40 colonies
	Soft coral (No. colonies m ²)	0.0 ± 0.0	0 colonies
	Black coral (No. colonies m ²)	0.0 ± 0.0	0 colonies
CCC Deep (Chek Chau)	Hard coral (No. colonies m ²)	0.88 ± 0.39	14 colonies
	Soft coral (No. colonies m ²)	0.0 ± 0.0	0 colonies
	Black coral (No. colonies m ²)	0.78 ± 0.15	42 colonies
Impact I1 Shallow (Wong Wan Tsui West)	Hard coral (Live Cover %)	2.09 ± 0.60%	20 colonies
	Soft coral (No. colonies m ²)	0.0 ± 0.0	0 colonies
	Black coral (No. colonies m ²)	0.96 ± 0.23	20 colonies
Impact I2 Shallow (Wong Wan Tsui East)	Hard coral (Live Cover %)	2.12 ± 0.34%	20 colonies
	Soft coral (No. colonies m ²)	0.03 ± 0.04	0 colonies
	Black coral (No. colonies m ²)	0.85 ± 0.29	20 colonies
Impact I3 Shallow (Fong Wang Fat)	Hard coral (Live Cover %)	3.87 ± 0.94%	20 colonies
	Soft coral (No. colonies m ²)	0.18 ± 0.10	0 colonies
	Black coral (No. colonies m ²)	0.80 ± 0.24	20 colonies
Impact I4 Shallow (Gruff Head)	Hard coral (Live Cover %)	4.25 ± 0.88%	20 colonies
	Soft coral (No. colonies m ²)	0.0 ± 0.0	0 colonies
	Black coral (No. colonies m ²)	0.98 ± 0.24	20 colonies
Impact I5 Shallow (Wong Chuk Kok South West)	Hard coral (Live Cover %)	6.81 ± 0.52%	22 colonies
	Soft coral (No. colonies m ²)	0.05 ± 0.05	4 colonies
	Black coral (No. colonies m ²)	0.05 ± 0.05	22 colonies
Impact I6 Shallow (Wong Chuk Kok)	Hard coral (Live Cover %)	67.60 ± 3.54%	20 colonies
	Soft coral (No. colonies m ²)	0.0 ± 0.0	0 colonies
	Black coral (No. colonies m ²)	0.0 ± 0.0	0 colonies
Impact I7 Shallow (Wong Chuk Kok North)	Hard coral (Live Cover %)	53.80 ± 3.22%	20 colonies
	Soft coral (No. colonies m ²)	0.0 ± 0.0	0 colonies
	Black coral (No. colonies m ²)	0.0 ± 0.0	0 colonies

Note: The *EM&A Manual* requires 20 hard and 20 soft/black corals to be tagged in each depth. The baseline surveys conducted in 2005, however, revealed that suitable coral colonies were not always present at the abundances suggested in the *EM&A Manual*.

The high mortality of the deep water (>5m) coral communities was an interesting record that may be associated with an area-wide hypoxia event in 2004. The reconnaissance dives revealed that there did not appear to be any recruitment of deep water corals (≤5cm) although the coral spawning season is usually from June to August each year (Lam in prep).

One of the key elements of this baseline was to establish a monitoring programme to assess any construction-related impacts. A major component of the baseline was the tagging of suitable coral species for the impact monitoring and *Table 27* summarises this information. It was desirable to tag as many of corals at the Chek Chau Control (CCC) site to ensure a comprehensive coverage of as many corals as possible at the Impact sites. It should be noted

that there is some overlap between species selected at the Chek Chau Control site and the control site used for the first section of this survey at Tung Ping Chau (Tung Ping Chau Island; refer to Part A). If for any reason the integrity of either control site comes into question, then this overlap may be used to confirm the results of any area-wide comparison.

Table 27. The cross reference list of the tagged corals for the impact sites and control sites*

Species	Chek Chau (CCC)		Tolo Channel							Total
	Shallow	Deep	I1	I2	I3	I4	I5	I6	I7	
<i>Antipathes</i> spp.		42	20	20	20	20	22			144
<i>Echinogorgia</i> spp.							1			1
<i>Guaiagorgia</i> sp.							3			3
<i>Cyphastrea</i> spp.	3	6	5	6	14	6	12		3	55
<i>Favia</i> spp.	1	1		1			2			5
<i>Hydnophora</i> sp.	6					1		4	4	15
<i>Leptastrea</i> spp.	2		1		2				1	6
<i>Montipora</i> spp.	2									2
<i>Pavona</i> sp.	2	2	6	3	1	2	2	5	2	25
<i>Platygyra</i> spp.	10							6	3	19
<i>Plesiastrea</i> sp.	2	1	1	2		3		2	1	12
<i>Porites</i> spp.	6	1	2	4	3	2	2			20
<i>Psammocora</i> spp.	2		5	4			1			12
<i>Turbinaria</i> spp.	4	3				6	3	3	6	25
Total tagged at site	40	56	40	40	40	40	48	20	20	344

* No live coral was found in the deep water zones of all the Impact stations.

3.5 Conclusion

The baseline ecological survey was conducted at eight monitoring sites (1 Control and 7 Impact stations) at Chek Chau and the Tolo Channel between February and April 2005 in accordance with the *EM&A Manual*. At Chek Chau and Tolo Channel a total of 344 corals were tagged for future impact monitoring.

3.6 References

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4. CONCLUSION

The baseline water quality monitoring was conducted between February and March 2005 in accordance with the requirements stipulated in the *EM&A Manual*. A total of 12 surveys were undertaken over a 4-week period with water samples and *in situ* measurements taken at 3 water depths during mid-flood and mid-ebb tides. Statistical analysis of the data indicated that there were generally only minor differences in levels of suspended solids, turbidity and dissolved oxygen between particular Impact and Control stations. No unusual phenomena and activities which might have influenced the monitoring results were observed during the whole monitoring period. It is concluded that the water monitoring results are representative of the baseline conditions before commencement of the construction activities. The Action and Limit Levels for SS and turbidity derived from the baseline data are appropriate for use in the subsequent impact and post-project monitoring.

The baseline ecological survey at Chek Chau and the Tolo Channel was conducted at 8 selected hard, soft and black coral areas (1 Control and 7 Impact stations) between February and April 2005 in accordance with the *EM&A Manual*. A total of 344 coral colonies (hard, soft and black) were tagged for future impact monitoring. The baseline survey established the status of the coral communities prior to commencement of works. The results also indicated that the Control station is suitable as a reference area for the subsequent impact monitoring. It should, however, be noted that the coral communities previously recorded in the deeper areas of Tolo Channel had largely been extirpated (most likely as a consequence of a hypoxia event in 2004) and prevailing hydrological conditions must be considered during the Impact monitoring.