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Site formation for Kai Tak Cruise Terminal Development - Design and Construction

Detailed Coral Translocation Plan (Final)

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LIST OF ABBREVIATIONS

AFCD	Agriculture, Fisheries and Conservation Department
ArchSD	Architectural Services Department
CEDD	Civil Engineering and Development Department
EIA	Environmental Impact Assessment
EM&A	Environmental Monitoring and Audit
EP	Environmental Permit

1 INTRODUCTION

1.1 Background

1.1.1 The purpose of this Detailed Coral Translocation Plan is to detail the pre-translocation survey findings and the approach, methodologies and field data collection methods for the coral translocation works and the subsequent post-translocation monitoring for the identified Kai Tak coral colonies. All works are to be carried out in accordance with the detailed mitigation measures documented in the approved EIA Report and Environmental Monitoring and Audit (EM&A) Manual (*EIA 138/2007*) and Environmental Permit (*EP-328/2009*).

1.2 Description of the Project

1.2.1 Civil Engineering and Development Department (CEDD) have commissioned Scott Wilson Ltd under Agreement No. *CE 56/2008(CE)* to undertake a Design and Construction Supervision for site formation works for Kai Tak Cruise Terminal Development at the former Kai Tak Airport in the south-eastern region of Kowloon Peninsula (the Project). After closure in 1998, the disused airport site has been occupied by various temporary uses, including a golf driving range and has been subjected to a number of proposals to redevelop the site with change usage.

1.2.2 The Project comprises the following key components.

(a) Site Formation Works

- demolition of the existing seawall;
- construction of Edge Structures and Transition Edge Structures;
- formation and construction of an Apron Area, including the provision of trough & pit systems for installation of Apron Facilities by others;
- formation of the Designated Areas including provision of piled quay deck structures and upgrading of existing seawalls;
- installation of fender and mooring facilities, navigation aids and apron drainage; and
- dredging of seabed and fairways.

(b) Environmental monitoring and implementation of mitigation measures in association with the above.

1.2.3 In the original Project Brief, Temporary Infrastructure will be required to facilitate the operation of the Phase I Berth in mid 2013. However, further to the discussion in the kick-off meeting on 26 February 2009, it is noted that Architectural Services Department (ArchSD) is considering to bring forward the construction programme for the Cruise Terminal Building such that the required facilities for the operation of the Phase I Berth will be provided by the newly constructed Cruise Terminal Building. As a result of this, the provision of the Temporary Infrastructure will not be required and the design of the site formation works including the edge structures and seawalls will be carried out on this basis.

1.2.4 The development layout plans are presented in *Figure 1.1*.

1.2.5 A number of environmental studies have been carried out at the site as part of the masterplanning and Environmental Impact Assessments required under the Environmental Impact Assessment Ordinance (EIAO). These include:

- The Environmental Appraisal Report for the Cruise Terminal;
- EIA report (*EIA-139/2007*) for the decommissioning of the Former Kai Tak Airport Other than the North Apron – approved on 19 December 2007;
- EIA report (*EIA-138/2007*) for Dredging Works for the Proposed Cruise Terminal at Kai Tak – approved on 19 December 2007; and,
- EIA Report (*EIA-157/2008*) for the Kai Tak Development – approved without conditions on 4 March, 2009.

1.2.6 An Environmental Permit (EP) has been obtained by CEDD for Dredging Works for the Proposed Cruise Terminal (*EP-328/2009*), which links directly to the EM&A measures set out and agreed in the approved *EIA-138/2007*. The EP is presented in *Annex A.*

1.2.7 The marine ecological impacts associated with the Project identify the potential for direct loss of habitat and associated marine life due to the dredging activities and demolition of the existing seawall required for the formation of the new cruise terminal. With respect to the mitigation of potential impacts, a specific requirement of the approved *EIA-138/2007* is the need to undertake coral translocation from the impacted area to an identified site in Tseung Kwan O. The requirements for coral translocation have also been set down in the Environmental Permit for Dredging Works *EP-328/2009*.

1.2.8 As required under Agreement No. *CE 56/2008(CE)* and Environmental Permit No. *EP-328/2009*, the coral translocation works comprises three phases of works:

i. Preparation of a detailed Coral Translocation Plan, including the results of a pre-translocation surveys for the Kai Tak (donor site) and proposed coral recipient site (Tseung Kwan O);

ii. Execution and documentation of the coral translocation exercise; and

iii. The implementation and documentation of a post-translocation coral monitoring programme over a period of 12 months.

1.3 Objectives for the Detailed Coral Translocation Plan

1.3.1 To avoid and minimise any potential loss or adverse impact to corals in the vicinity of the Project area, the identified coral colonies will be translocated to a nearby suitable recipient site at Tseung Kwan O. In order to plan, implement and document an appropriate coral translocation exercise in accordance with the EM&A (*EIA-138/2007*) and EP (*EP-328/2009*), this detailed Coral Transplantation Plan is presented and will address the following objectives:

- Details of the pre-translocation survey findings for the Kai Tak donor site and the Tseung Kwan O recipient site.
- Confirm the location and suitability of the recipient site at Tseung Kwan O.
- Detail the coral translocation methodology to be employed and timing of the translocation exercise.

- Describe the post-translocation monitoring coral methodology for the transplanted coral colonies.

1.4 Structure of the Plan

1.4.1 The remainder of this Final Detailed Coral Translocation Plan is structured as follows:

Section 1: Project background and coral translocation objectives.

Section 2: Background on Hong Kong coral translocation works, presented case studies and the target coral *Oulastrea crispata.*

Section 3: Phase 1: Pre-translocation survey findings. The adopted approach and methodologies for the pre-translocation surveys undertaken at Kai Tak (donor site) and Tseung Kwan O (recipient site) are described and the pre-translocation survey findings for the donor site of Kai Tak and the recipient site at Tseung Kwan are presented, forming the basis for the Detailed Coral Translocation Plan.

Section 4: Phase 2: The Coral translocation methodology – A detailed explanation of the coral translocation methodology is presented.

Section 5: Phase 3: Post-translocation monitoring surveys. A post-translocation coral monitoring programme is explained and the methodology to be employed detailed for the 12 month survey schedule.

Section 6: The coral translocation and post-monitoring teams – the marine scientists and dive teams who will conduct all surveys and works relating to the coral translocation works are detailed and an explanation of the roles and responsibilities provided.

2 AN INTRODUCTION TO CORAL TRANSLOCATION IN HONG KONG AND THE TARGET CORAL *OULASTREA CRISPATA*

2.1 Overview of Hong Kong Coral Translocation Studies

General

2.1.1 Hong Kong's marine environment encompasses 1,174 km of coastline and contains diverse fringing coral communities. These coral assemblages are typical of high latitude areas where the corals typically do not form substantial reef structures (calcium carbonate framework) but corals attach directly onto boulders and bedrocks. The coral communities range from simple, scattered coral colonies of few species to 100 % cover and high species richness with over 80 scleractinian hard coral species recorded from Hong Kong waters[(1)]. Hong Kong's coral communities, already close to their natural physiological tolerance, also receive intense anthropogenic impacts as a result of the dense urban populations and continuous coastal development.

2.1.2 As a result of certain coastal development works, particularly pier construction or reconstruction, a small number of coral translocation exercises have been carried out in Hong Kong. Coral translocation works have always been a mitigation measure of last resort when no alternative could be identified and direct impact to corals was predicted to occur. Several small experimental coral transplantation exercises were carried out by post-graduate students working under the supervision of Professor Brian Morton (Hong Kong University) and the key results revealed the following:

- Translocation of coral colonies from areas threatened by anthropogenic disturbance to protected areas such as marine parks, is viable; and,
- Fragments from several hard coral species attached to artificial substrate exhibited a high survival rate and indicated their suitability for large-scale transplantation.

2.1.3 More recently, as mentioned, several coral translocation exercises have been successfully carried out to prevent the loss of corals due to the construction or reconstruction of piers. A case study example of the largest-scale coral translocation works carried out in Hong Kong, to date, is provided in the following sub-section.

2.2 Reconstruction of the Pier at Pak A, Sai Kung

2.2.1 A large-scale coral translocation programme took place at Pak A, a small southerly-facing bay on the West side of High Island peninsula in 2001. Over 8,000 hard coral colonies belonging to 30 scleractinian species were relocated away from an area surrounding a pier identified for reconstruction[(2)]. Assessment of the translocated corals immediately following their relocation revealed that all transplants were in good condition. Only two coral species exhibited visible sub-lethal stress signals. The fate of the transplants was followed by monitoring a suite of ten colonies belonging to each of four hard coral species (*Goniastrea aspera*, *Cyphastrea* sp., *Porites lobata* and *Goniopora columna*) which had been tagged and were examined as part of a routine monitoring programme of Impact Assessment Surveys (IAS) carried out every two weeks after the coral transplantation and during the pier reconstruction. Evidence gathered over the long term monitoring suggested that the translocation did manage to conserve the corals of Pak A which would have otherwise have been lost to the reconstruction activities.

([1]) Chan, A.L.K., Choi, C.L.S., McCorry, D., Chan, K.K., Lee, M.W. and Ang, Put Jr. 2005. Field Guide to Hard Corals of Hong Kong. Agriculture, Fisheries and Conservation Department, Hong Kong SAR Government.
([2]) Oceanway Corporation Ltd 2001. Reconstruction of the pier at Pal A, Sai Kung.

2.3 The Scleractinian Coral Species *Oulastrea crispata*

General

2.3.1 The scleractinian coral *Oulastrea crispata* belongs to the Faviidae family of which all species are known to have high tolerance limits to the physico-chemical conditions often associated with the Hong Kong nearshore environment, e.g. fluctuations in salinity, sea surface temperature (daily and seasonal), sedimentation loading, total suspended sediment and light attenuation levels. Hence the reason as to why this coral family is the most successful in terms of species recorded and abundance in Hong Kong. *Oulastrea crispata* is noted as an uncommon species in Veron's Corals of the World[1] but does have a widespread distribution throughout Southeast Asia and Australia. In Hong Kong, *O. crispata* is a common and ubiquitous coral species, though, typically not recorded in high abundance within established coral communities. It is most often recorded in the most marginal conditions for corals, ie, areas of high sediment loading, and represented by scattered, small colonies in shallow, subtidal areas with few other coral species. In summary, *O. crispata* is a common Hong Kong coral and exhibits an opportunistic life history strategy with several reproductive strategies. It is these traits that appear to be the reason that this coral species can exist and survive so successfully in the often environmental extremes of Hong Kong's inshore waters. The following sub-section provides a summary of the reproductive biology of this coral species.

2.4 Reproductive Biology of the Hard Coral *Oulastrea crispata*

2.4.1 Two research studies to gain an understanding of the reproductive biology of *Oulastrea crispata* have been undertaken in Hong Kong. The first study focused on the sexual reproduction of *O. crispata* existing at Hoi Ha Wan Marine Park in the period of 1995 to 1996[2]. The research results revealed that *O. crispata* was a hermaphrodite (contained male and female reproductive cells) broadcaster, has an annual gametogenic cycle and extended spawning period from July to October. Furthermore, the coral species broods and releases planulae in the resting period of the gametogenic cycle (an asexual reproductive mode). Another three-year study carried out at Tung Ping Chau Marine Park in 2000 to 2003 provided a different insight into *O. crispata*'s sexual reproductive strategy[3]. The study indicated *O. crispata* was a gonochoric (single sex) broadcaster and underwent asynchronous sexual reproduction. It was estimated that annual multiple spawning behaviour occurred and was most likely to occur in late spring-early summer (May-June) and late summer and early autumn (September). No spawning events for coral colonies of *O. crispata* were observed for both studies.

2.4.2 In conclusion, it is highly likely that the coral *Oulastrea crispata* has several reproductive strategies and most likely does spawn at the same time as other faviid corals (full moon period of May and/or June). While also performing asexual reproduction during other times of the year. Thus the multiple modes and flexibility of the reproductive behaviour of this coral may well explain its ubiquitous distribution, survivorship in the most disturbed inshore waters of Hong Kong and its pioneering behaviour as observed by rapid colonisation on artificially introduced hard substrate.

([1]) Vernon, J.E.N. 2000. Corals of World Volumes 1-3
([2])Lam, K.K.Y. 2000. Sexual reproduction of a low-temperature tolerant coral *Oulastrea crispata* (Scleractinia, Faviidae) in Hong Kong, China. *Marine Ecology Progress Series* 205: 101-111
([3])Lin, T.P. 2003. Reproduction patterns of scleractinian corals from Tung Ping Chau Hong Kong, and the effect of physical factors on these patterns. M.Phil thesis submitted to the Chinese University of Hong Kong.

3 PHASE 1: PRE-TRANSLOCATION CORAL SURVEYS

3.1 General

3.1.1 This section of the Detailed Coral Translocation Plan details the approach, methodologies, data collection and survey findings for the pre-translocation surveys carried out at Kai Tak (coral donor site) and Tseung Kwan O (coral recipient site).

3.1.2 The coral translocation surveys had the following specific objectives:

- Identify and quantify the number of rocks/boulders with coral colonies that can be moved from Kai Tak;
- Verify the location of a suitable coral recipient site in Tseung Kwan O, as indicated in the EM&A (*EIA-138/2007*);
- Develop a suite of coral translocation methodologies and procedures with the most suitable translocation timing identified; and,
- Implement and document the post-translocation coral monitoring programme for the assessment of translocated hard coral colonies in the recipient site as well as survey records of the donor site after removal of corals.

3.2 Pre-translocation Coral Survey at Kai Tak

3.2.1 A baseline survey to re-locate and validate the number and nature of the coral colonies to be moved was a pre-requisite for the coral translocation works. In accordance with the EM&A (*EIA-138/2007*) the Kai Tak survey area encompassed the defined 'direct coral impact' area where scleractinian corals of one species (*Oulastrea crispata*) were previously recorded (see *Figure 2.1*) and within an area to be impacted by the temporary removal of a section of seawall and the dredging works. It is noted that the survey area identified in *Figure 2.2* is specific to the dredging works for the Cruise Terminal Development, only.

3.2.2 The survey area shown in *Figure 2.2* represents a narrow swathe of boulders and rocks at the bottom of the seawall area in depths of 3-7 metres (below Chart Datum). Previous dive surveys of the seabed at this location reported approximately 50 boulders/rocks with scattered corals (*Oulastrea crispata*) and these boulders/rocks were reported to be of 50 cm (longest dimension) in size. The pre-translocation survey at Kai Tak focused on relocating the same boulders and rocks with the coral *Oulastrea crispata*. The location of each boulder/rock was marked and recorded. In addition, details of the depth and size of the rocks were recorded. The pre-translocation coral survey specifically focused on the number of corals recorded on small rocks and boulders that were manually movable by a diver underwater (<50 cm longest dimension) located on the seabed at the bottom of the seawall, as detailed in the EM&A (*EIA-138/2007*).

3.2.3 The specific data collection requirements were as follows:

1. The location, size, orientation and depth of each boulder[1] /rock with coral colonies were recorded and the boulder/rock marked with a numbered sub-sea marker/tag. Video and photographic records were made of each boulder/rock colonised by *Oulastrea crispata*.

([1]) A boulder is defined as a rock no less than 256 mm in diameter. http://en.wikipedia.org/wiki/Boulder accessed on 31st March, 2009

2. Each coral colony on the identified boulders and rocks were assessed for:

   - Species identification – verification of species.
   - Size, depth and orientation on the boulder/rock surface.
   - Photographic record, that best represents the entire colony.
   - The health status of each coral colony recorded as follows (as detailed in the EM&A (*EIA-138/2007*):
     - Existing surface area exhibiting partial mortality (percentage cover).
     - Existing surface area exhibiting coral bleaching of which two categories will be recorded: a. Blanched (i.e. pale) and b. bleached (i.e. whitened).
   - Each coral colony was also assessed for sediment cover including the percentage cover of the colony affected and the colouration, texture and approximate thickness of sediment on the coral colony and adjacent substrate. Any contiguous patches of sediment cover >10 % were recorded and to aid estimates of coral cover a quadrat (50x50 cm) fitted with a 10 cm spaced metal grid was used.

3. Data were summarized as follows:

   - The total number of boulders/rocks with corals that are movable, ie. <50 cm in longest diameter) or deemed movable.
   - The total number of coral colonies to be moved with an inventory of the coral taxa recorded.

3.3 Pre-translocation Coral Survey at the Proposed Recipient Site at Tseung Kwan O

3.3.1 Dive surveys were carried out to verify the exact location of the proposed recipient coral site in Tseung Kwan O (see *Figure 2.3)* with full consideration that the site has been previously agreed (*EP-328/2009*). The recipient site was considered to meet a number of criteria specific to the success of the coral translocation exercise including suitable environmental conditions, bathymetry and an absence of potential coral stressors. The main objective of the survey was to verify that the site could accommodate the number of corals to be re-located and that there were no identified constraints to their future growth and proliferation.

3.3.2 The dive surveys were carried out as a two step process: ***Step 1***: A focused survey of the proposed recipient site. The required dimensions of the recipient site were identified based on the results of the donor site (number and size of boulder/rocks identified for translocation). ***Step 2****:* Further dive surveys were undertaken in proximity to the proposed recipient site, to enable some fine tuning or slight adjustment to the recipient site, as deemed necessary. The location of the dive surveys are presented in *Figure 2.4*.

3.3.3 The dive survey was carried out using the Rapid Ecological Assessment (REA) method[(1)], a semi-quantitative survey approach to assess the main abiotic and biotic characteristics of the marine habitat and compile a comprehensive taxonomic inventory of the species within each habitat recorded.

([1]) DeVantier, L.M., G. De'ath, T.J. Done and E. Turak 1998. Ecological Assessment of a complex natural system: A case study from the Great Barrier Reef. *Ecological Applications* 8: 480-496

3.3.4 The dive team comprised qualified marine scientists who swam along the transects and recorded the seabed attributes. The survey data were assessed 'real-time' and post-survey to record two tiers of semi-quantitative data on the subtidal habitats. Each REA transect was assessed for benthic cover (Tier I) and taxon abundance (Tier II), which are described below and a suite of representative photographs were recorded along each transect. In addition, information pertaining to the recipient site criteria such as bathymetry and adequate space to accommodate the boulders/rocks to be moved from Kai Tak were recorded.

3.3.5 Tier I: Categorisation of Benthic Cover

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

3.3.6 Tier II: Taxonomic Inventories to Define Types of Benthic Communities

An inventory of benthic taxa was compiled for each REA transect. Taxa were defined to the following levels:

1. Scleractinian corals to species.

2. Soft corals, anemones and conspicuous macro-algae identified to species, wherever possible.

3. Other benthos (including sponges, zoanthids, ascidians and bryozoans) identified to genus level wherever possible, but more typically to phylum plus growth form.

3.3.7 At the end of each transect, each taxon in the inventory were ranked in terms of abundance in the community (see *Table 2*). These broad categories ranked taxa in terms of relative abundance of individuals, rather than the contribution to benthic cover along each transect. The ranks are subjective assessments of abundance, rather than quantitative counts of each taxon.

3.3.8 It is noted that the Pre-translocation Survey Methodology Statement also referred to further considerations concerning the possible fine tuning of the exact recipient site location. It was noted that the exact recipient site location would be maintained as near to that documented both in the EM&A (*EIA-138/*2007) and *EP-328/2009*. If a slight adjustment was made it would be to the south rather than to the north of the proposed site as several features and potential developments were identified. These are shown in *Figure 2.5* and were identified as the following:

- The location of hard and soft coral records from dive surveys;

- Potential area for marine moorings (Marine Department);

- Though not noted on the map there are plans for a jetty associated with a waste facility along the same strip of coastline; and,

- An additional proposed coral recipient site at Tseung Kwan O for the corals identified in the area associated with the opening of the runway gap (see *Figure 2.6*).

3.4 Pre-translocation Coral Survey Findings

3.4.1 Kai Tak Runway (donor site)

3.4.1.1 The Kai Tak pre-translocation surveys were conducted on 3 and 4 April 2009 with a total of 1,150 metres along the bottom of the Kai Tak seawall (the identified project area) surveyed for corals. A total of 70 movable rocks with the hard coral species *Oulastrea crispata* were recorded and marked (see *Table 3* and *Figure 2.7*). These rocks with corals were distributed at a mean depth of 2.9 m and all recorded within a depth range of between 2 and 4.7 m. The average longest diameter of the identified movable rocks was 31.8 cm and mean height 11.9 cm (see *Table 4*). Of the 70 rocks marked a total of 120 corals (colonies of *Oulastrea crispata*) were recorded. The size of the coral colonies ranged from 1 to 15 cm in diameter, with a mean diameter of 3.7 cm. Each coral was assessed for partial mortality, bleaching and sediment cover (see *Table 5*). The majority of the coral colonies were shown to be in good health status. A total of 26 out of 120 coral colonies were recorded with sediment cover and this ranged from 5 to 20 % of the total coral colony area. Photographic records of all movable rocks and associated corals were made and a representative suite of photographs taken during the survey are presented in *Figure 2.8*.

3.4.1.2 As sediment covering on the rocks with corals was substantial and prohibited the use of epoxy resin to adhere individual coral tags at the time of the Pre-translocation survey all boulder/rocks were instead marked with a 3 kg metal, numbered tag (subsea marker). These metal subsea markers were carefully positioned in such as way to re-locate the rock and not to be removed by currents etc.. These markers were successfully re-located by the survey divers on the second day of the Kai Tak survey and the permanent tagging of the rocks and individual coral colonies will be addressed at the time of the coral move (see *Section 4*).

3.4.2 Tseung Kwan O (recipient site)

Rapid Ecological Assessment

3.4.2.1 A *series* of REA surveys were conducted using SCUBA to investigate the subtidal seabed conditions and sessile benthos of the proposed coral recipient site (hereafter referred to as the site) and along the natural shoreline in the vicinity of the recipient site (as indicated in *Figure 2.9*). The site was marked out underwater and surface marker buoys used as above water reference markers. A total of four transects which traversed the identified recipient site and two additional REA transects were carried out parallel to the shore to the north and south of the proposed recipient site, refer to *Figure 2.9*.

Survey Findings for the Proposed Coral Recipient Site

3.4.2.2 All REA surveys were conducted in April 2009. Survey conditions were fine with overcast weather. Sea conditions were also fine with moderate current and low wave action. The underwater dive condition was typical for the nearshore waters of this region of Hong Kong with low (<1 m) underwater visibility for all survey transects. Due to the topographic profile of the site and change in habitat below 10 m depth all REA transects were restricted to depths above 10.5 m. This maximum depth determined the length of the REA transects and full details of the REA transects are presented in *Table 6*.

3.5 Abiotic/Physical Description of the Proposed Coral Recipient Site

3.5.1 A total of four REA transects surveyed across the proposed coral recipient site. The slope of the seabed was gentle in the shallow water sections nearer the shoreline and gradually became steeper within the site. Along a 20 m section of T1 outside the site, water depth ranged from -1.5 to -4 m CD while the remaining 20 m section inside the site showed a rapid increase in water depth ranging from -4 to -10.5 m CD (see *Figure 2.9*). Once the 10 m depth mark was reached the REA transect was terminated.

3.5.2 The abiotic characteristics of the site seabed showed an area mainly composed of small and large boulders and some areas of bedrock (see *Table 7*). A higher percentage cover of large boulders were recorded within the site and there was a noticeable higher covering of sediment on these boulders as compared to the small boulders associated with noticeably lower sediment cover in the shallower depths (-1.5 to -4 m CD) outside the site and nearer to the shoreline. Small patches of sand and rubble (small rocks <10 cm) were recorded along REA transect sections of all transects (T1 to T4), inside and outside the site. The proposed recipient site was confirmed to have similar hydrographical conditions (hard substrate seabed type, water depths (nearer the shoreline) and low to moderate wave action) as the coral donor site at Kai Tak.

3.6 Biotic Description of the Benthic Communities

3.6.1 Hard and soft coral cover was estimated at less than 10 % and 30 %, respectively (see *Table* 8). A total of seven hermatypic hard coral species (*Turbinaria peltata*, *Favia rotumna*, *Favites pentagona*, *Oulastrea crispata*, *Leptastrea purpurea*, *Goniopora stutchburyi* and *Goniopora* sp.) and two ahermatypic hard coral species (*Tubastrea/Dendrophyllis* sp.) and an unidentified cup coral species were recorded. A total of ten octocoral species (*Anthogorgia* sp., *Cladiella* sp., *Dendronephthya* spp., *Echinogorgia* sp, *Echinomuricea* sp., *Euplexaura* sp., *Menella* spp. and *Paraplexaura* sp.) were recorded along the REA transects (see *Table 9*). Hard corals were generally distributed within the shallower water depths outside the site and nearer to the shoreline (i.e. -1.5 to -4 m CD). Relative higher abundance and diversity of hard corals were recorded at nearshore sections of T3 and T4. The hard coral species recorded were all common and exhibit a widespread distribution throughout Hong Kong's nearshore waters. A total of less than 25 colonies of *Oulastrea crispata* were recorded on the REA transect sections along T1, T2 and T3, outside the site (refer to *Figure 2.10* for representative photographs of the benthic community and *Figure 2.11* for the location of the *O. crispata*). All colonies were smaller than 5 cm in diameter and they were all located within the shallow water sections (nearshore area) of the three REA transects.

3.6.2 The abundance and diversity of octocorals (soft corals and gorgonians) recorded along T1 to T4 were higher than that for hard corals. *Dendronephthya* sp., *Echinomuricea* sp. and *Menella* sp. were the most common octocoral genera recorded and were recorded along all REA transects. All octocoral genera recorded are common and exhibit a widespread distribution throughout Hong Kong's nearshore waters. Several colonies of the black coral genera: the bush-like/branching *Antipathes* and whip-like *Cirripathes* were recorded within the deeper area of the site at deep depths (> -8mCD).

3.6.3 Associated invertebrates including barnacles *Balanus* sp., the encrusting bryozoan *Schizoporella errata*, bivalves *Saccostrea* sp., sea urchins *Diadema setosum*, *Salmacis sphaeroides*, unidentified gorgonian anemone, sponges and gastropods were common along the transects. Filter-feeding invertebrates such as crinoids (feather stars) were also observed.

3.6.4 To conclude a higher percentage cover of soft corals and coralline algae (between 15 – 20 %) were recorded along T1 to T4. The percentage cover of hard coral ranged from 3 – 5 % along the four transects, however, no hard coral was recorded within the site. Hard coral occurrence (including *Oulastrea crispata*) was observed in the shallower subtidal areas nearest to the shoreline outside the site (see *Figure 2.11*).

Survey findings for the Natural Shoreline in the Vicinity of the Proposed Coral Recipient Site

3.7 Abiotic Attributes of the site

3.7.1 A total of two REA transects (T5 and T6) carried out along the natural shoreline in the vicinity of the proposed coral recipient site. The slope of the seabed was gentle with a range in depths of -1 to -4 m CD. This shallow, nearshore subtidal zone was a mix of sand, rubble and hard substrate (bedrock and boulders) and scattered small to medium sized hard coral colonies (see *Table 7*).

3.8 Biotic Description of the Benthic Communities

3.8.1 Hard and soft coral cover was estimated to be less than 10 % (see *Table* 8). A total of five hermatypic hard coral species (*Turbinaria peltata*, *Favites pentagona*, *Oulastrea crispata, Goniopora stutchburyi* and *Psammocora superficialis*) and eight octocoral species (*Cladiella* sp., *Dendronephthya* spp., *Echinomuricea* sp., *Euplexaura* sp., *Menella* spp., *Paraplexaura* sp.) were recorded along the REA transects (see *Table 10*). Scattered hard coral colonies were recorded along the coastline, where *O. crispata* and *G. stutchburyi* were the most common species observed. Lower diversity and abundance of octocorals were recorded in this shallower subtidal zone (as compared to the proposed recipient site) with the azooxanthellate species present in Tseung Kwan O exhibiting a preference for deeper, silt covered substrate not adjacent to the shoreline. These filter-feeding organisms which do not require light optimise their habitat to maximise areas of water flow for nutrient uptake. Branching gorgonians *Euplexaura* sp. and *Paraplexaura* sp. were the most common octocoral species observed. All the hard coral and octocoral species recorded are of widespread distribution and regarded as common within Hong Kong waters.

3.8.2 Marine invertebrates including barnacles *Balanus* sp., the bryozoan *Schizoporella errata*, bivalves *Saccostrea* sp., sea urchins *Diadema setosum, Anthocidaris crassispina, Salmacis sphaeroides*, unidentified gorgonian anemone and gastropods were common along these two REA transects.

3.8.3 When compared to benthic composition of T1 to T4 (i.e. transects traversing the site) two main observations were made: 1. This area of shallow, subtidal shoreline was comprised a relatively higher abundance of hard corals and lower diversity of octocoral and 2. the percentage cover of hard coral was estimated to be greater than 5 % along the two transects. Furthermore, it was noted that a higher relative abundance of octocorals was recorded for T6 and also *Oulastrea crispata* was recorded along this REA transect.

3.8.4 Please note that summary data for the full list of hard and soft corals recorded with their Hong Kong abundance rating is presented in *Table 11* and the survey data for *Oulastrea crispata* in *Table 12*.

Proposed Location of the Coral Recipient Site

3.8.5 Based on the findings of the REA surveys conducted to assess the abiotic and biotic composition of the proposed coral recipient site it is recommended that the site location is modified slightly. The positional adjustment is shown in *Figure 2.12* and involves shifting the area slightly to the West so that it encompasses the area of shallow, subtidal shoreline where *Oulastrea crispata* naturally occur.

3.8.6 This slight adjustment in the location of the recipient coral site allows for the accommodation of the 70 rocks recorded from Kai Tak. Furthermore, it was observed that the original proposed coral recipient site was generally deeper and with the increased depth sedimentation appeared higher and there was an associated reduction of light attenuation.

Factors that are not conducive to hard coral growth and survivorship. The slightly modified recipient site location is proposed in the shallow waters ranging from -1.5 to -5 m CD to the west of the originally proposed site (matching the depth range of the corals recorded from Kai Tak). Within the new proposed site, hard corals, in particular, *Oulastrea crispata* were recorded and this shallower location exhibits a lower sedimentation regime and an associated higher light attenuation. It is thus considered that this slightly modified proposed site would represent a suitable area for the location of the Kai Tak translocated corals. The newly proposed recipient site maintains the same dimensions (20 x 20 m) and a total area of 400 m^2. The recipient site will be divided into a 1 m^2 grid plot with one Kai Tak boulder with corals placed in each square. This grid will allow for an additional method of relocating the corals for the post-translocation monitoring and the site can accommodate many more boulders/rocks, possibly with later coral translocation works.

4 PHASE 2: CORAL TRANSLOCATION WORKS

4.1 Key Criteria of Hard Coral Translocation

4.1.1 For the successful translocation of hard corals the moving exercise should be carried out by manual lifting of the identified coral colonies using supervised divers. Research documenting the transplantation of corals clearly indicates that coral that has not been exposed to the atmosphere, wind and direct sunlight have a significantly higher chance of survival (Harriott and Fisk 1989[(1)]; Kaly 1995[(2)]). A manual underwater method ensures that translocated corals are collected and moved carefully and deposited in the correct orientation in an area similar to that from which they were removed from (Munoz-Chagin 1997[(3)]). The recipient area must possess similar physical parameters to the original location in terms of depth, turbidity, wave action, tidal currents and degree of exposure to freshwater run-off (Harriott and Fisk 1989).

4.1.2 The key criteria and techniques of coral translocation are summarised (as synthesised from the citations above) as follows:

- Corals need to be relocated to areas where the environmental conditions are similar or better than the donor site.
- The recipient site should have similar bathymetry as the donor site.
- Corals need to be kept out of direct sunlight and kept submerged at all times during the moving process.
- Handling of corals needs to be kept to a minimum.
- The translocation process needs to be completed quickly in order to keep stress to a minimum.
- The timing of the relocation should coincide with cool water conditions or not during coral spawning periods.

4.2 Coral Translocation Timing

4.2.1 *Oulastrea crispata* is the directly affected hard coral species which needs to be translocated from the Project site. According to the literature findings its reproductive strategies and seasons as described in *Section 2.2.2* highlight the coral spawning period which is potentially from July to October with possible spawning behaviour also occurring during the full moon period of May/June and September. Therefore, in order to avoid the main spawning period and complete the coral translocation work prior to the commencement of dredging and construction activities in the Project area the following timing for the coral translocation works is recommended.

4.2.2 During a period at least five days after the full moon in June (7 June) whereby the recipient site will be prepared (marked out) and the corals moved over a two day period between 15 to

([1]) Harriott, V.J. and Fisk, D.A. 1987. Accelerated Regeneration of Hard Corals: A manual for coral reef users and managers. Great Barrier Reef Marine Park Authority Technical Memorandum GBRMPA-TM-16.
([2]) Kaly, U.L. 1995. Experimental test of the effects of methods of attachment and handling on the rapid transplantation of corals. CRC Reef Research Centre Technical Report No.1, Townsville, Australia.
([3]) Coral Transplantation program in the Paraiso coral reef, Cozumel Island, Mexico. Proceedings of the Eight International Coral Reef Symposium 2.

19 June 2009. Thus, allowing for any potential spawning to have occurred before translocation (ie, May/June spawning) and ensuring the corals have been moved before the reproductive period of July to October commences.

4.3 Preparation of Recipient Site

4.3.1 Prior to the translocation of the Kai Tak corals the recipient site at Tseung Kwan O will be marked out so that the boundaries of the site are highly visible underwater. Furthermore, the site will be set up as a one by one metre square grid using a rope line and stakes so that the location of each translocated boulder/rock with corals can be mapped at the time of the translocation works. This will ensure a return to the same boulder/rock with corals at each post-monitoring period.

4.4 Coral Translocation Methodologies and Procedures

Coral Removal/Lifting

4.4.1 Using the independent dive team (marine scientist) to re-locate the marked corals and the assistance of the commercial diver each boulder/rock will be removed from the bottom of the seawall and either directly loaded on to the vessel (with the rock maintained underwater) and then placed directly in prepared large tubs of aerated seawater. An alternative and/or additional technique proposed is to remove a number of boulder/rocks and place these on a suspended tray/platform maintained in the water column by a diving lift bag or other form of buoyancy. When the tray is adequately filled with boulder/rocks it will be transferred to the vessel using divers on the sea surface. The boulders/rocks will be removed and placed in the seawater tubs. A total of 70 identified boulders/rocks with corals marked during the pre-translocation survey will be moved to the new location (Tseung Kwan O) over a period of two days. Individual boulders/rocks will be transferred to the vessel by a supervised diver wearing gloves. An effort shall be made to minimise the amount of contact by the diver and the length of time the boulders/rocks are handled. Divers will avoid contact with the coral colonies at all times. All the corals on the boulder/rocks will be kept submerged at all times with a brief exposure unavoidable when transferred onto the vessel.

4.4.2 It is noted that there is a number of scenarios that may be encountered at the time of the translocation works and these are as follows: 1. Marked boulders with corals are not relocated; 2. There has been a die-off event of the coral(s) on the marked boulder and 3. Additional boulders with corals are discovered. It is considered highly unlikely that the marked boulders with corals will not be relocated as there are identifiers underwater (subsea markers) and shore references with position fixes. The live coral on movable boulders/rocks were located in a narrow depth band and can be easily re-surveyed. Thorough underwater searches by the independent Marine Scientist will be carried out to relocate the marked boulders. If a marked boulder with corals (as recorded in April 2009) no longer accommodates live coral growth the boulder will not be moved. The boulder will be photographed and details of the coral appearance documented. If additional boulders with corals that can be moved are discovered while removing the marked boulders with corals, these boulders will also be incorporated into the translocation works. Additional, coral tags and markers will be prepared for such a scenario (a minimum set of ten tags will be prepared).

Coral Maintenance on the Vessel

4.4.3 A minimum of 17 large plastic tubs (21x17x14 cm in dimension and 95 litres in volume) will be used to hold the boulders with corals during the transfer process. Each tub will be filled with seawater prior to the transfer of the boulders with corals and fitted with a battery

operated aerator. Each tub will hold two boulders with corals and placement in the tub will ensure that the coral colonies are fully emerged in seawater. The translocation works will be carried out over two days as it is planned to move 50 % (35 boulders) a day. Tubs will be filled to within 2 cm of the height of the tubs (depth of 12 cm) and it will be crucial to ensure that all coral colonies on the boulders are submerged at all times during the coral translocation transfer. Ambient water quality parameters of sea surface temperature and dissolved oxygen will be measured at Kai Tak on each day of transfer and the seawater tubs checked every ten minutes to ensure no fluctuation above 10 % ambient occurs to the seawater in which the corals are submerged. This activity will be conducted as the corals are being transferred onto the vessel and through the transportation of the corals to the recipient site. Furthermore, the seawater in the tubs will be regularly exchanged when still at the donor site and on the journey to Tseung Kwan O. It is anticipated that the process of removing 35 of the boulders with corals from Kai Tak will take no more than two hours to complete.

Coral Tagging

4.4.4 Each boulder/rock and each coral colony on the movable boulder/rock will be tagged for subsequent monitoring. The tagging process will be carried out on the vessel as this will allow for the boulder/rock to be carefully handled and excess sediment to be removed from the rock surface where the tags will be applied. A sturdy, metal tag with an identifier number engraved and painted (with anti-fouling paint) will be fixed to each boulder/rock. This tag shall also have a small fishing float attached to aid relocation in poor visibility at the recipient site. In addition, each coral colony on the boulder/rock will also be tagged with a small, numbered metal tag placed in the vicinity of the coral but not so near as to interfere with potential growth. All tags will be prepared prior to the translocation works and an additional set of tags (minimum of ten sets) made for potential extra boulders/rocks with corals being located and also moved on the translocation days. All tags to be applied on the boulder/rocks with corals will be permanently attached using an epoxy that takes approximately 10-15 minutes to set. At all times during the tagging process the coral colonies on the boulder/rocks will remain submerged in the seawater tubs. It is anticipated that the process of removing 35 boulders/rocks from Kai Tak, tagging and ensuring all boulders/rocks with corals and the tubs they are held in are secure for transfer will take up to two hours.

Transportation to the Recipient Site

4.4.5 The coral translocation will be conducted with the use of vessel with a large working back deck and shading provided by a fixed hard shell roof or tarpaulin cover). Corals will not be exposed to direct sunlight during the translocation works. Once all the marked boulder/rocks (70 in total) plus any additional boulder/rocks picked up at the time of the translocation are on the vessel and the seawater quality and aeration have been checked the vessel will progress at a slow and steady speed (<5 knots) to the recipient site at Tseung Kwan O. The travel distance between Kai Tak and the coral recipient site at Tseung Kwan O is 5 km and it is estimated that the travel time will be about 35 minutes. Constant supervision of the boulder/rocks and the correct orientation of boulder/rock in the seawater holding tubs will be carried out to ensure coral colonies are not damaged *en route*.

Coral Placement

4.4.6 Once the boat reaches the recipient site the boulder/rocks will be individually moved to an identified area within the grid setup at the recipient site. Divers (marine scientists plus one commercial diver) will move the boulders/rocks either one by one from the vessel or a number of them placed on the suspended and submerged tray/platform. Each boulder/rock

will then be positioned within the recipient site by an ERM marine scientist. Each rock will be placed on the seabed carefully in order to minimize disturbance to the seabed and/or sediment. The location of each numbered rock within the recipient site will be recorded with reference to the underwater grid at the time of the translocation.

Coral Removal Verification

4.4.7 A survey of the vacated donor coral site (Kai Tak) will be carried out on each of the two days after all marked boulders/rocks have been removed as past of the translocation exercise. Marine Scientist Keith Kei will conduct a dive survey and check that no movable boulders/rocks with corals remain at the Kai Tak project site. Photographs and video footage will be taken.

4.5 Assessment of Translocated Coral Colonies

4.5.1 Each translocated coral colony will be re-assessed immediately after the translocation for the standard coral health parameters measured at the time of the pre-translocation survey (see below). The condition of the coral colonies, including partial mortality, bleaching or lesions will be noted and the depth and location of the rock within the recipient site (as referenced by the underwater grid). Each tagged coral colony will be photographed and *in situ* records of general condition and health status will be taken to form the first post-translocation dataset. These data will be used to compare to the pre-translocation dataset to assess any immediate impacts resulting from the translocation and also as the first of the temporal monitoring datasets to be collected during the 12 month post-translocation monitoring programme.

4.5.2 The health status of each coral colony will be recorded as follows (as detailed in the EM&A (*EIA-138/2007*):

- Existing surface area exhibiting partial mortality (percentage cover).
- Existing surface area exhibiting coral bleaching of which two categories will be recorded: a. Blanched (i.e. pale) and b. bleached (i.e. whitened) – percentage cover.
- Each coral colony will also be assessed for sediment cover including the percentage cover of the colony affected and the colouration, texture and approximate thickness of sediment on the coral colony and adjacent substrate. Any contiguous patches of sediment cover >10 % shall be recorded and to aid estimates of coral cover a quadrat (50x50 cm) fitted with a 10 cm spaced metal grid used.

4.5.3 The growth and change in cover of the individual *Oulastrea* colonies will also be followed. This will be carried out using a measurable photographic survey approach whereby a fixed distance photographic record will be made of each coral colony on the translocated boulders/rocks. Individual coral colony size will be tracked through time using a photo sequence over the 12 months of monitoring. A wide angle compact camera in a dedicated housing (Sea&Sea) with a reference bar to standardise the camera distance from the coral will be used. All photographs will be recorded with the inclusion of scale bar (cm) and the images digitally analysed to record changes in coral cover and growth of individual colonies.

5 PHASE 3: POST-TRANSLOCATION CORAL MONITORING PROGRAMME

5.1 Monitoring will focus on tracking the health condition of the translocated corals at the recipient site. The environmental monitoring upon completion of the coral translocation works consists of the following:

- Surveys at the recipient coral site (Tseung Kwan O) to document the condition of the sites and health status corals with photographic/ video records. In accordance with EM&A, coral monitoring should be carried out quarterly for a period of one year.

5.2 During the monitoring, each rock with corals moved from Kai Tak will be re-located with the recipient site and each coral colony on each rock examined, measured and photographed. The health status of each coral colony will be recorded as follows [as detailed in the EM&A (*EIA-138/2007*)]:

- Existing surface area exhibiting partial mortality.
- Existing surface area exhibiting coral bleaching of which two categories will be recorded: a. Blanched (i.e. pale) and b. bleached (i.e. whitened).
- Each coral colony was also assessed for sediment cover including the percentage cover of the colony affected and the colouration, texture and approximate thickness of sediment on the coral colony and adjacent substrate. Any contiguous patches of sediment cover >10 % were recorded and to aid estimates of coral cover a quadrat (50x50 cm) fitted with a 10 cm spaced metal grid was used.
- Standardised photographic record made of each coral colony during each monitoring survey.

5.3 Condition of the surrounding environment as well as weather, visibility, sea and tidal conditions will also be recorded. All tags will be removed/ retrieved when the monitoring programme has been completed.

5.4 If, during the post-translocation monitoring observations of any die-off of the translocated corals are made the ET will inform AFCD and in liaison with AFCD investigate any measures needed.

5.5 The coral monitoring programme will be conducted every three months for a period of one year, with the survey schedule as follows:

Table 5.1 Post-translocation Coral Monitoring at the Recipient Coral Site at Tseung Kwan O

Survey Activity	Scheduled Implement Time
Pre-translocation Baseline survey - Kai Tak	3 - 4 April 2009
Pre-translocation Baseline survey - Tseung Kwan O	6 April 2009
Preparation of Recipient Site	16 June 2009
Coral Translocation	17-18 June 2009*
Post-translocation Monitoring Survey (time zero)	19 June 2009
First Post-translocation Monitoring Survey	September 2009
Second Post-translocation Monitoring Survey	December 2009
Third Post-translocation Monitoring Survey	March 2010
Fourth Post-translocation Monitoring Survey	June 2010

* Please note that the translocation team will be on standby from 16 June and if adverse weather prevents the translocations works proceeding on 17 and 18 June the corals will be moved as the next available window of suitable weather (with the corals before the beginning of July).

5.6 A post-translocation monitoring report will be submitted to CEDD and AFCD within two weeks after the completion of coral translocation and at the time of each quarterly post-translocation monitoring survey. The results of the post-translocation monitoring surveys will be reviewed with reference to the baseline survey results and findings of the condition of the surrounding environment.

6 CORAL TRANSLOCATION AND POST-TRANSLOCATION MONITORING TEAMS

6.1 Coral Translocation Team

6.1.1 The translocation works will be led by ERM marine scientists with an established knowledge of the coral communities of Hong Kong and many years survey experience including coral translocation works in Hong Kong and overseas. The identified ERM marine scientists are: Dr Denise McCorry and Ms Samantha Lee (experts in the hard and soft coral taxonomy and ecology of Hong Kong, respectively).

6.1.2 The translocation works to be carried out at Kai Tak and Tseung Kwan O will be supervised and carried out by the ERM marine scientists with assistance from a dive team of the following sub-consultants.

6.1.3 Marine scientist Mr Keith Kei: Keith who conducted the dive surveys that identified the corals at the Kai Tak site in 2007 and he was also involved with the relocation of the corals in the Pre-translocation survey at Kai Tak, April 2009. Keith (with a dive buddy) will be responsible for re-locating the corals during translocation, verifying their condition on that day and then conducting a dive survey to verify that all movable corals (as marked or observed during the coral translocation works) have been removed from the bottom of the Kai Tak seawall area within the project site.

6.1.4 Support team of commercial divers, BEKK Solutions Ltd: The commercial dive team, who have considerable experience and knowledge of the Kai Tak survey area, will consist of two teams one shore-based (at Kai Tak) and one on the vessel to be used to transport the corals to the recipient site at Tseung Kwan O. The shore-based team will consist of one CCTV technician, one dive supervisor and two divers (of which one will be working underwater at any one time), tender (managing the surface supply hose) and truck driver (surface supply mobile unit) operating from the runway (shore side). The vessel based team will consist of at least two people to maintain the aerated water in large containers for storing the corals while transfer from Kai Tak to Tseung Kwan O is made.

6.1.5 The ERM marine scientists will be assisted by the BEKK Solution Ltd dive team to transfer the rocks with corals to a final location and be responsible for the final position and orientation of each of the 70 rocks moved from Kai Tak into the grid set up at the established coral recipient site.

6.1.6 Full curriculum vitaes for the project marine scientists and a company profile for BEKK Solutions Ltd are provided in *Annex B.*

6.2 Post-Translocation Monitoring Team

6.2.1 The identified ERM marine scientists are: Dr Denise McCorry and Ms Samantha Lee (experts in the hard and soft coral taxonomy and ecology of Hong Kong, respectively) and Mr Jovy Tam, an experienced marine scientist with much diving experience and a robust knowledge of the Hong Kong subtidal ecology. These three qualified divers will conduct all post-translocation monitoring surveys.

7 CORAL TRANSLOCATION AND POST-TRANSLOCATION MONITORING REPORTING REQUIREMENTS

7.1 According to the EP (EP -328/2009), the Detailed Coral Translocation Plan should detail the reporting requirements for the coral translocation and post-translocation monitoring. The following details the reporting requirements:

- Final Detailed Coral Translocation Plan, submitted one month prior to the translocation works;
- Post-Translocation Monitoring Report submitted to AFCD within two weeks after the completion of the coral translocation; and,
- Quarterly Post-Translocation Monitoring Reports for a period of 12 months.

Tables

Table 1 : Categories to be used in the Coral Habitat Verification and Assessment Survey: (a) Benthic Attributes; (b) Ordinal Ranks of Percentage Cover

(a) Benthic Attributes

(a) Attributes			
Ecological		**Substratum**	
HC	Hard coral	BR	Bedrock
DC	Dead standing coral	LB	Large boulder
SC	Soft coral (including gorgonians)	SB	Small boulder
BC	Black coral	RC	Rock
TA	Turf algae	RBL	Rubble
MA	Macro-algae	SN	Sand
CA	Coralline algae	SL	Silt

(b) Ordinal Ranks of Percentage Cover

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

Table 2: Ordinal Ranks of Taxon Abundance

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

Table 3: Summary Table of the Details of Location of the Marked Rocks at Kai Tak

No.	Rock Tag Number	Distance from starting point	Latitude N			Longitude E		
			Degree	Minutes	Seconds	Degree	Minutes	Seconds
1	08	8	22	18	37.8	114	12	26.5
2	07	44	22	18	37	114	12	27.5
3	06	62	22	18	36.6	114	12	27.8
4	05	80	22	18	36.2	114	12	28.2
5	28	85	22	18	36.1	114	12	28.4
6	15	85.5	22	18	36	114	12	28.4
7	35	85.5	22	18	36.1	114	12	28.4
8	14	90	22	18	36	114	12	28.5
9	22	90	22	18	36	114	12	28.5
10	24	92	22	18	36	114	12	28.5
11	11	93	22	18	36	114	12	28.6
12	01	105	22	18	35.7	114	12	28.9
13	25	135	22	18	35.4	114	12	29.8
14	18	144	22	18	35.2	114	12	30.1
15	02	154	22	18	35	114	12	30.3
16	23	180	22	18	34.4	114	12	30.9
17	27	241	22	18	33.1	114	12	32.4
18	17	249	22	18	32.9	114	12	32.6
19	19	249	22	18	33	114	12	32.6
20	20	252	22	18	32.9	114	12	32.7
21	12	255	22	18	32.9	114	12	32.8
22	21	255	22	18	32.8	114	12	32.7
23	13	259	22	18	32.7	114	12	32.9
24	38	262	22	18	32.7	114	12	32.9
25	42	264	22	18	32.7	114	12	33
26	43	264	22	18	32.7	114	12	33
27	33	280	22	18	32.3	114	12	33.4
28	03	280	22	18	32.3	114	12	33.4
29	44	288	22	18	32.1	114	12	33.5
30	46	291	22	18	32	114	12	33.7
31	45	294	22	18	32.1	114	12	33.7
32	37	295	22	18	32	114	12	33.7
33	34	335	22	18	31.2	114	12	34.6
34	41	341	22	18	31.1	114	12	34.8
35	10	365	22	18	30.5	114	12	35.5
36	60	1105	22	18	14.1	114	12	53.4
37	52	1105	22	18	14.2	114	12	53.5
38	57	1101	22	18	14.3	114	12	53.4
39	59	1069	22	18	14.9	114	12	52.6
40	56	1025	22	18	15.9	114	12	51.6
41	39	1025	22	18	15.9	114	12	51.6
42	29	1023	22	18	15.9	114	12	51.5
43	9	1023	22	18	15.9	114	12	51.5
44	36	1000	22	18	16.5	114	12	51
45	49	989	22	18	16.8	114	12	50.7

No.	Rock Tag Number	Distance from starting point	Latitude N			Longitude E		
			Degree	Minutes	Seconds	Degree	Minutes	Seconds
46	58	966	22	18	17	114	12	49.9
47	40	964	22	18	17.2	114	12	50
48	54	923	22	18	17.7	114	12	48.8
49	51	836	22	18	19.7	114	12	46.7
50	48	836	22	18	19.7	114	12	46.7
51	66	778	22	18	21.1	114	12	45.4
52	47	702	22	18	23	114	12	43.7
53	31	611	22	18	25	114	12	41.4
54	62	592	22	18	25.5	114	12	41
55	80	572	22	18	25.9	114	12	40.5
56	50	563	22	18	26.1	114	12	40.3
57	30	551	22	18	26.3	114	12	40
58	55	550	22	18	26.4	114	12	39.9
59	61	543	22	18	26.6	114	12	39.7
60	63	537	22	18	26.7	114	12	39.6
61	64	534	22	18	26.7	114	12	39.5
62	67	481	22	18	27.9	114	12	38.2
63	65	474	22	18	28.1	114	12	38.1
64	78	446	22	18	28.7	114	12	37.3
65	73	446	22	18	28.7	114	12	37.3
66	77	446	22	18	28.7	114	12	37.3
67	76	408	22	18	29.6	114	12	36.5
68	75	400	22	18	29.8	114	12	36.3
69	74	375	22	18	30.3	114	12	35.7
70	71	375	22	18	30.3	114	12	35.7

Table 4: Summary Table of the Size and Depth Records for the Identified Boulders with Corals

No.	Rock Tag Number	Depth (m)	Rock Size	
			Maximum Diameter (cm)	Maximum Height (cm)
1	08	2.9	41	36
2	07	4.5	29	10
3	06	3.8	31	9
4	05	3.1	26	11
5	28	3	36	11
6	15	3.2	23	12
7	35	2.9	47	15
8	14	3.1	47	14
9	22	3.5	42	10
10	24	3.4	37	10
11	11	3.4	30	15
12	01	3.6	28	12
13	25	2.6	30	10
14	18	2.7	42	7
15	02	3.4	40	23
16	23	2.7	37	13
17	27	3.5	31	14

No.	Rock Tag Number	Depth (m)	Rock Size	
			Maximum Diameter (cm)	Maximum Height (cm)
18	17	3.4	33	14
19	19	2.7	41	9
20	20	3	22	8
21	12	3	29	8
22	21	3.1	23	9
23	13	3.4	34	10
24	38	3.7	31	7
25	42	2.9	46	8
26	43	2.9	30	9
27	33	2.7	39	16
28	03	2.7	28	9
29	44	2.8	48	17
30	46	2.5	43	7
31	45	2.6	37	5
32	37	2.8	26	6
33	34	2.6	19	7
34	41	2.5	38	8
35	10	3.2	44	20
36	60	4.7	25	10
37	62	4.7	35	12
38	57	3.5	41	18
39	59	2.2	20	8
40	56	2.5	30	10
41	39	2.5	29	9
42	29	2.5	36	19
43	9	2.5	21	7
44	36	2.3	16	9
45	49	2.6	39	12
46	58	2.5	25	23
47	40	2.5	27	18
48	54	2.2	42	9
49	51	2.4	24	16
50	48	2.4	40	17
51	66	2	23	8
52	47	2.3	23	6
53	31	2.2	47	15
54	62	2.6	34	6
55	80	2.4	22	14
56	50	2.5	33	12
57	30	2.6	17	4
58	55	2.6	29	23
59	61	2.3	27	14
60	63	2.4	33	21
61	64	2.1	29	13
62	67	2.4	19	7
63	65	2.5	24	13
64	78	2.7	37	10
65	73	2.7	27	14
66	77	2.8	31	9
67	76	2.8	32	7
68	75	3	30	12
69	74	3	22	14
70	71	3	26	7

Table 5: Summary Table of the *Oulastrea crispata* Coral Colony Details for Each Marked Rock at Kai Tak

Total Number of *Oulastrea* Colonies	Rock Tag Number	Maximum Diameter (cm)	Health Status	Sediment Cover
			Partial Mortality (% Affected)	% Affected
1	08	7.5	-	-
2	08	9.5	-	-
3	07	1	-	-
4	06	2.5	-	-
5	05	4	-	-
6	28	5.5	-	<1
7	15	2.5	-	15
8	35	6.5	-	40
9	14	2	-	0
10	14	1.5	-	5
11	22	7	-	-
12	22	4.5	-	-
13	24	2.5	-	-
14	11	3	-	-
15	01	4	-	-
16	25	4.5	-	-
17	18	3.5	-	-
18	18	4	-	-
19	02	3.5	-	-
20	02	1.5	-	-
21	02	3	-	-
22	23	5	-	-
23	27	4	-	-
24	27	2	-	-
25	27	1	-	-
26	17	2.5	-	-
27	19	2.5	-	-
28	20	2	-	-
29	12	3	-	-
30	21	1	-	-
31	21	2	-	-
32	13	2.5	-	-
33	13	1.5	-	-
34	38	4.5	-	-
35	38	1.5	-	-
36	42	6	-	-
37	42	2	-	-
38	43	4	-	-
39	43	1.5	-	-
40	33	5.5	-	2

Total Number of *Oulastrea* Colonies	Rock Tag Number	Maximum Diameter (cm)	Health Status	Sediment Cover
			Partial Mortality (% Affected)	% Affected
41	03	7	-	15
42	44	2.5	-	-
43	46	9.5	-	3
44	45	6	-	-
45	45	3.5	-	-
46	45	5	-	-
47	37	4	-	-
48	37	2.5	-	-
49	34	3	-	-
50	41	5	-	-
51	10	3	-	-
52	60	2.5	-	-
53	60	1	-	-
54	62	3	-	-
55	62	1.5	-	-
56	57	2.5	-	-
57	59	3	-	10
58	56	4	-	-
59	56	1	-	-
60	56	1.5	-	-
61	39	4	-	-
62	39	1.5	-	-
63	29	5.5	-	-
64	29	2.5	-	-
65	9	3	-	-
66	9	2	-	-
67	36	7.5	-	5
68	36	6	-	20
69	49	3.5	-	-
70	49	3.5	-	-
71	49	2	-	-
72	49	1	-	-
73	58	5	5	5
74	58	3	-	1
75	40	10	-	-
76	54	4	-	-
77	54	2.5	-	-
78	54	1.5	-	-
79	51	4	-	-
80	48	4	-	-
81	66	3	-	-
82	47	13	-	-
83	47	3	-	-

Total Number of *Oulastrea* Colonies	Rock Tag Number	Maximum Diameter (cm)	Health Status	Sediment Cover
			Partial Mortality (% Affected)	% Affected
84	31	6	-	10
85	62	4.5	-	10
86	62	1.5	-	-
87	62	1.5	-	-
88	62	3	-	-
89	80	3.5	-	-
90	50	6.5	-	5
91	50	6	-	20
92	30	3	-	-
93	55	12.5	-	10
94	61	5	-	3
95	61	3	-	-
96	63	2.5	-	-
97	64	5	-	5
98	64	3	-	5
99	67	7.5	-	-
100	67	5	-	-
101	65	6	-	10
102	65	2	-	30
103	78	3	-	-
104	78	2.5	-	-
105	73	6.5	-	10
106	77	1.5	-	5
107	77	4.5	-	5
108	77	2	-	-
109	77	1	-	-
110	76	3.5	-	-
111	76	4	-	-
112	76	3.5	-	-
113	76	1	-	-
114	76	1	-	-
115	75	8	-	10
116	74	3.5	-	-
117	74	2	-	-
118	71	4	-	-
119	71	3	-	-
120	71	2	-	-

Table 6: Summary of the REA Transects

Transect no.	Length (m)
T1	40
T2	50
T3	90
T4	54
T5	80
T6	78

Table 7: REA Results: Tier I data - Ecological and Physical Attributes of the Proposed Coral Recipient Site

Transect	Ecological attributes (% cover)							Physical attributes (% cover)						
	HC	DC	SC	BC	TA	MA	CA	BR	LB	SB	RC	RBL	SN	SL
T1	1	1	2	0	0	0	2	2	2	2	2	1	1	0
T2	1	1	2	1	1	0	2	1	3	1	2	1	2	0
T3	1	1	2	0	1	0	2	1	3	2	1	1	1	0
T4	1	1	2	0	1	0	2	1	2	1	2	2	2	0

Table 8: REA Results: Tier I data - Ecological and Physical Attributes of the Subtidal Shoreline

Transect	Ecological attributes (% cover)							Physical attributes (% cover)						
	HC	DC	SC	BC	TA	MA	CA	BR	LB	SB	RC	RBL	SN	SL
T5	1	1	1	0	1	0	3	3	2	2	1	2	2	0
T6	1	1	1	0	1	0	2	2	2	1	1	3	2	0

Table 9: REA Results: Tier II data -Species Inventory and Abundance Rating of the Proposed Coral Recipient Site

TKO APRIL 2009 - REA Transects				**Transect no.**			
Type	**Family**	**Genus**	**Species**	**T1**	**T2**	**T3**	**T4**
Hard Coral	**Hermatypic**						
	Dendrophyllidae	*Turbinaria*	*peltata*	0	0	1	1
	Faviidae	*Favia*	*rotumana*	0	0	1	0
		Favites	*pentagona*	0	0	0	2
		Oulastrea	*crispata*	2	2	2	0
		Leptastrea	*purpurea*	0	0	0	1
	Poritidae	*Goniopora*	*stutchburyi*	1	0	2	0
		Goniopora	sp.	1	1	0	3
	Siderastreidae	*Psammocora*	*superficialis*	0	0	0	0
	Ahermatypic						
	Dendrophyllidae	*Tubastrea/Dendrophyllia*	sp.	2	2	2	2

TKO APRIL 2009 - REA Transects				**Transect no.**			
Type	**Family**	**Genus**	**Species**	**T1**	**T2**	**T3**	**T4**
		Unidentified cup coral		0	0	2	0
Octocoral	Acanthogorgiidae	*Anthogorgia*	sp.	0	0	1	0
	Alcyoniidae	*Cladiella*	sp.	0	0	0	2
	Nephtheidae	*Dendronephthya*	sp. A	2	3	2	2
		Dendronephthya	sp. B	2	3	2	2
	Plexauridae	*Echinogorgia*	sp.	0	1	1	0
		Echinomuricea	sp.	2	3	4	2
		Euplexaura	sp.	2	2	2	1
		Menella	sp. A	2	2	2	0
		Menella	sp. B	2	3	2	2
		Paraplexaura	sp.	2	2	2	0
Black Coral	Antipathidae	*Cirripathes*	sp.	0	2	0	0
		Antipathes	sp.	0	0	1	0
Others	Crustacea	*Balanus*	sp.	2	2	2	3
		Crab (unidentified)		0	2	0	0
	Bryozoan	*Schizoporella*	*errata*	2	2	2	2
	Bryozoan	Unidentified	sp.	0	2	0	0
	Bivalves	*Saccostrea*	sp.	3	2	2	3
		Scallop (unidentified)		0	0	1	0
	Urchins	*Diadema*	*setosum*	2	2	2	2
		Anthocidaris	*crassispina*	0	0	0	2
		Salmacis	*sphaeroides*	2	2	2	2
	Echinoderms	Crinoids (feather stars)		0	2	2	0
		Holothuria	*leucospilota*	0	2	0	0
	Cnidarian	Hydroids		0	0	2	0
		Gorgonian anemone		2	2	2	2
		Saucer anemone		0	0	2	2
		Zoanthids (unidentified)		0	0	0	0
		Jewel anemone (unidentified)		0	0	0	3
	Porifera	Sponges		0	2	2	2
	Mollusca	Gastropods (eg, *Turbo*)		3	3	3	3
		Hypselodoris	*festiva*	0	0	1	0
		Perna (green lip mussel)		0	0	0	0

Table 10: REA Results: Tier II data - Species Inventory and Abundance Rating of the Subtidal Shoreline

TKO APRIL 2009 - REA Transects				**Transect no.**	
Type	**Family**	**Genus**	**Species**	**T5**	**T6**
Hard Coral	**Hermatypic**				
	Dendrophyllidae	*Turbinaria*	*peltata*	1	0
	Faviidae	*Favia*	*rotumana*	0	0
		Favites	*pentagona*	2	0
		Oulastrea	*crispata*	0	3
		Leptastrea	*purpurea*	0	0
	Poritidae	*Goniopora*	*stutchburyi*	2	2
		Goniopora	sp.	0	0
	Siderastreidae	*Psammocora*	*superficialis*	2	0
	Ahermatypic				
	Dendrophyllidae	*Tubastrea/Dendrophyllia*	sp.	0	0
		Unidentified cup coral		0	0
Octocoral	Acanthogorgiidae	*Anthogorgia*	sp.	0	0
	Alcyoniidae	*Cladiella*	sp.	1	2
	Nephtheidae	*Dendronephthya*	sp. A	2	2
		Dendronephthya	sp. B	2	1
	Plexauridae	*Echinogorgia*	sp.	0	0
		Echinomuricea	sp.	1	0
		Euplexaura	sp.	0	3
		Menella	sp. A	0	2
		Menella	sp. B	1	0
		Paraplexaura	sp.	0	3
Black Coral	Antipathidae	*Cirripathes*	sp.	0	0
		Antipathes	sp.	0	0
Others	Crustacea	*Balanus*	sp.	2	2
		Crab (unidentified)		0	0
	Bryozoan	*Schizoporella*	*errata*	2	2
	Bryozoan	Unidentified	sp.	0	0
	Bivalves	*Saccostrea*	sp.	3	2
		Scallop (unidentified)		1	0
	Urchins	*Diadema*	*setosum*	2	2
		Anthocidaris	*crassispina*	2	2
		Salmacis	*sphaeroides*	2	2
	Echinoderms	Crinoids (feather stars)		0	0
		Holothurian - pink		2	0
	Cnidarian	Hydroids		0	0
		Gorgonian anemone		2	1
		Saucer anemone		0	0
		Zoanthids (unidentified)		3	0
		Jewel anemone (unidentified)		0	0
	Porifera	Sponges		3	0
	Mollusca	Gastropods (eg, *Turbo*)		3	3
		Hypselodoris	*festiva*	0	0
		Perna (green lip mussel)		2	0

Table 11: Summary List of the Hard and Soft Coral Species at Tseung Kwan O and their Hong Kong Abundance Rating

Coral Type	Genus/ Species	Hong Kong Distribution/ Abundance Rating*
Hard Coral (Hermatypic)	*Turbinaria peltata*	Common
	Favia rotumna	Abundant
	Favites pentagona	Dominant
	Oulastrea crispata	Common
	Leptastrea purpurea	Abundant
	Goniopora stutchbyryi	Common
	Psammocora superficialis	Abundant
Hard Coral (Ahermatypic)	*Tubastrea/Dendrophyllia* sp.	Uncommon
Soft Coral	*Cladiella* sp.	Uncommon
	Dendronephthya spp.	Dominant
Gorgonian	*Echinogorgia* sp.	Common
	Echinomuricea sp.	Dominant
	Euplexaura sp.	Abundant
	Menella sp.	Common
	Paraplexaura sp.	Uncommon
Black Coral	*Antipathes* sp.	Uncommon
	Cirripathes sp.	Uncommon

*Distribution/ abundance rating based on Chan et al. (2005)[1] and Lee and Ang (2007)[2].

Table 12: Summary Information for *Oulastrea crispata* Recorded for the REA Transects

Transect	T1	T2	T3	T4	T5	T6
Water Depth (m below CD)	1.5-10.5	3 -10.5	1.5-10.5	1.5-10.5	1.5-6	1.5-6
Approximate number of *O. crispata* colonies	<5	<10	<10	0	0	>20
Size range of *O. crispata* (cm)	<5	<5	<5	-	-	1-5

([1]) Chan et al. 2005. Field Guide to Hard Coral of Hong Kong. Friends of the Country Parks.
([2]) Lee & Ang. 2007. The Distribution and Community Structure of Octocorals in Eastern Waters of Hong Kong SAR. M.Phil thesis submitted to the Chinese University of Hong Kong.

Figures

Figure 1.1 Cruise Terminal Development Layout Plan

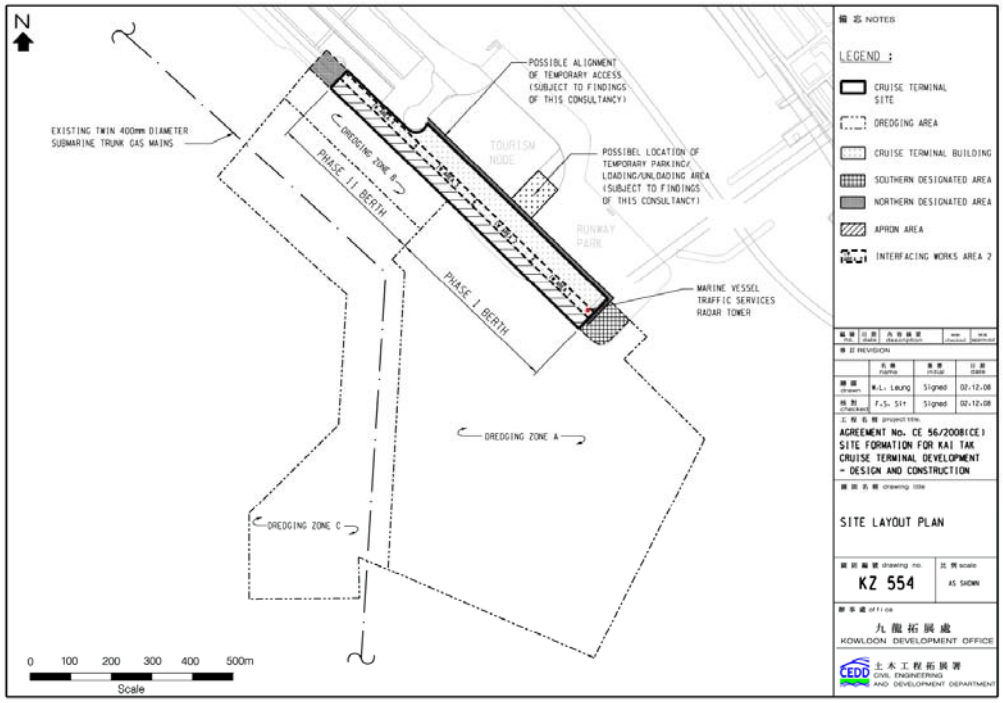


Figure 2.1 Coral Colonies of *Oulastrea crispata* Recorded on Boulders/Rocks at the Bottom of the Seawall at Kai Tak, Kowloon Bay

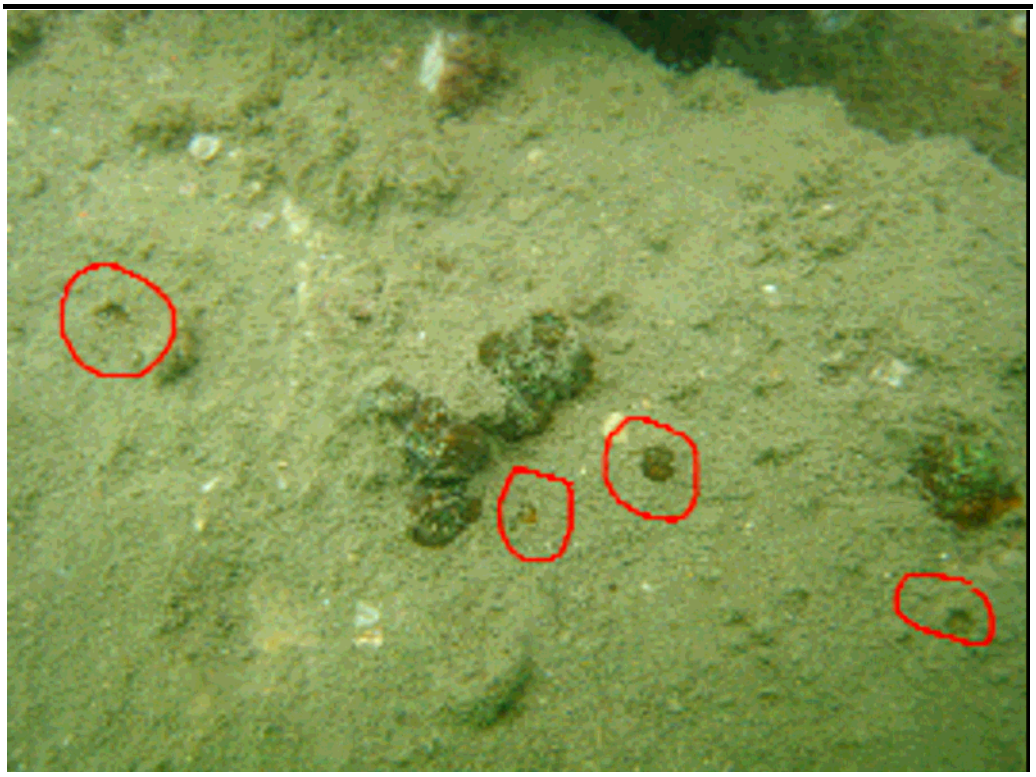


Figure 2.2 Location of the Pre-Translocation Survey at Kai Tak, Kowloon Bay

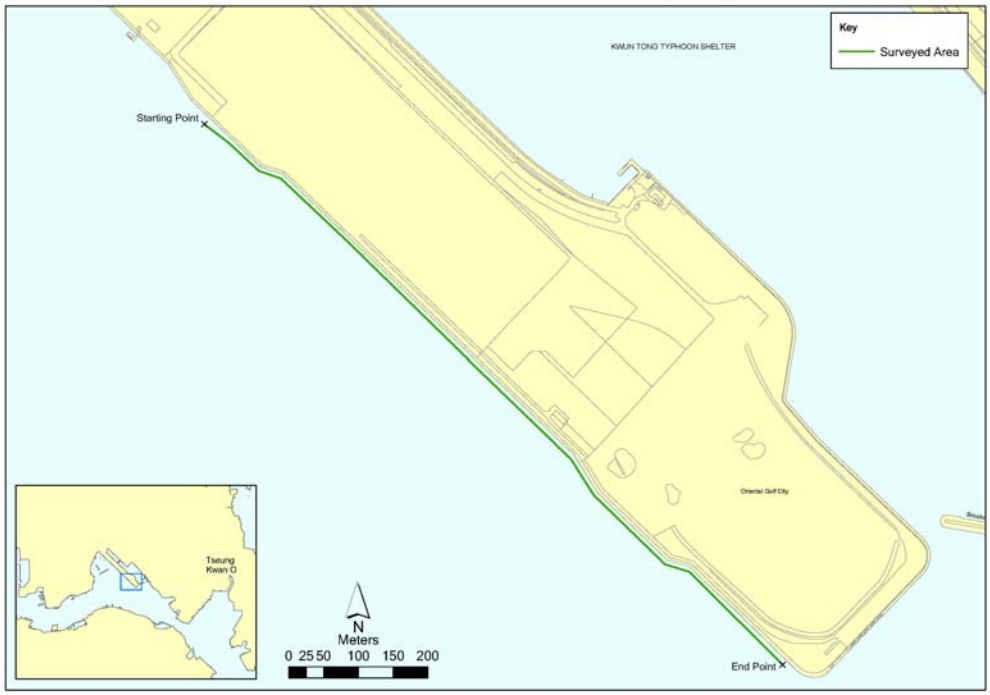


Figure 2.3 Location of the Proposed Recipient Site at Tseung Kwan O

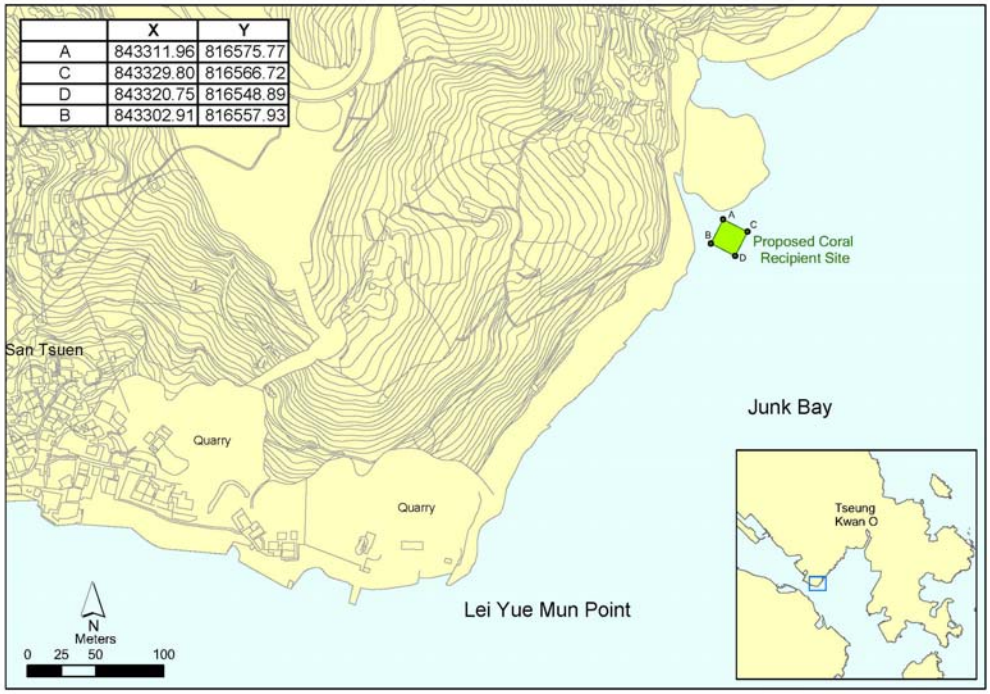


Figure 2.4 Proposed Location of the REA Transects for the Recipient Site Survey

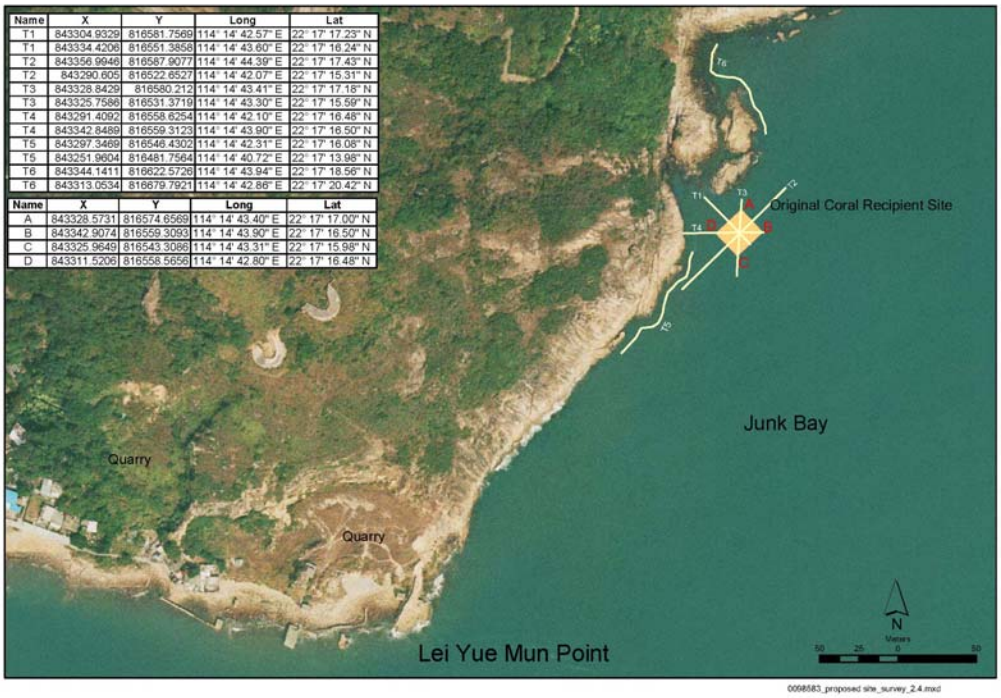


Figure 2.5 The Identified Site Constraints for the Location of the Coral Recipient Site in Tseung Kwan O

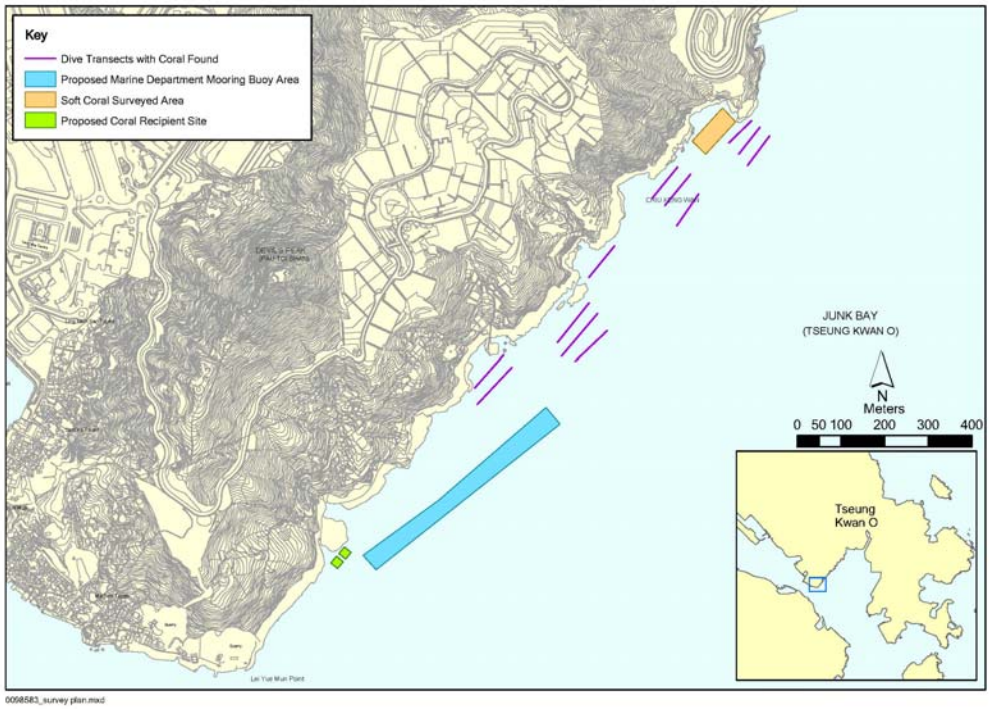


Figure 2.6 Proposed Location of the Two Coral Recipient Sites in Tseung Kwan O

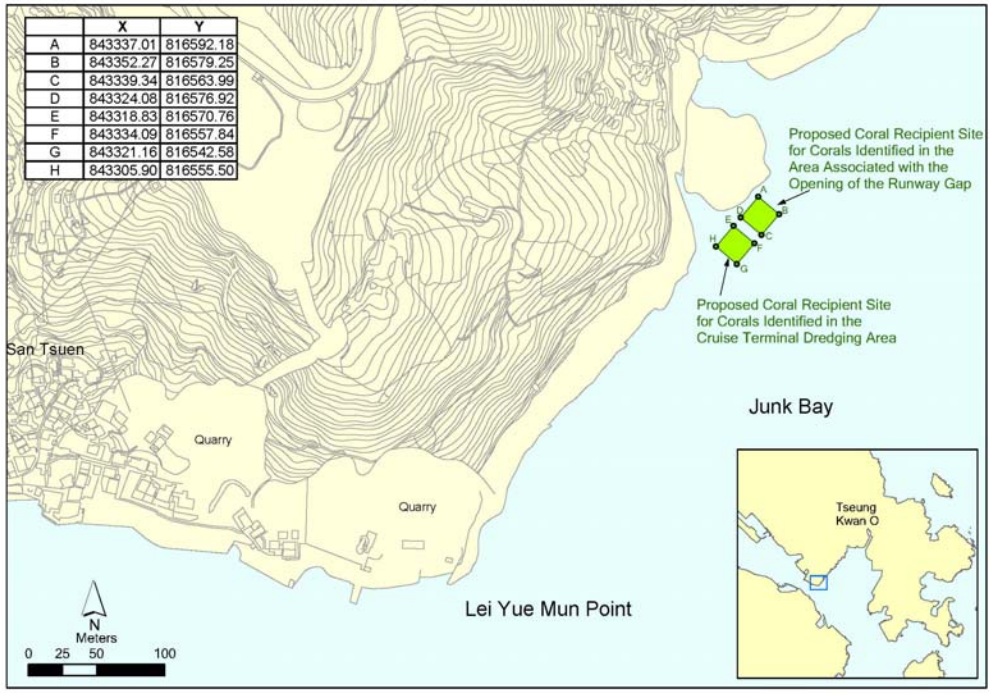


Figure 2.7 Location of the 70 Marked Rocks with Coral(s) at the Bottom of the Seawall at Kai Tak, Kowloon Bay

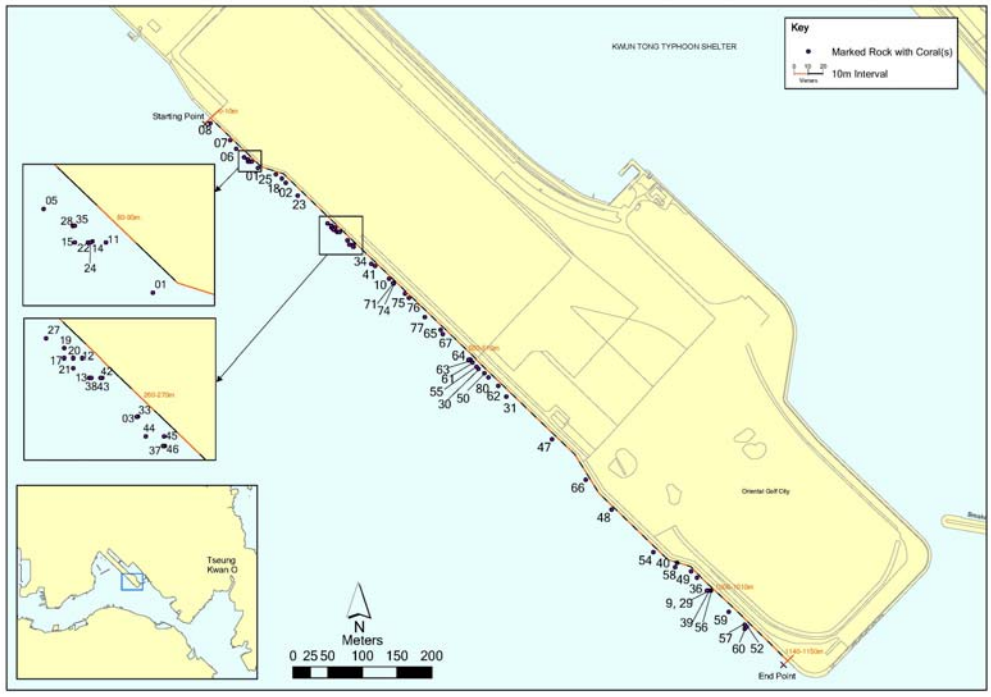


Figure 2.8 Representative Photos of the Marked Rock with Corals at the Bottom of the Seawall at Kai Tak, Kowloon Bay

Figure 2.9 Location of REA Transects at the Recipient Site, Tseung Kwan O

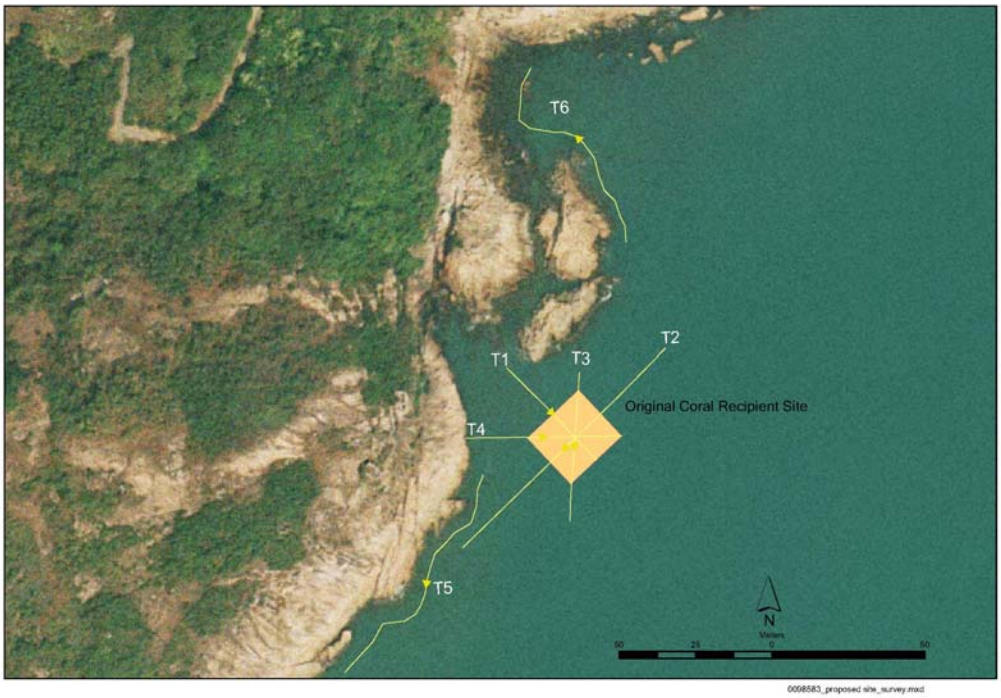
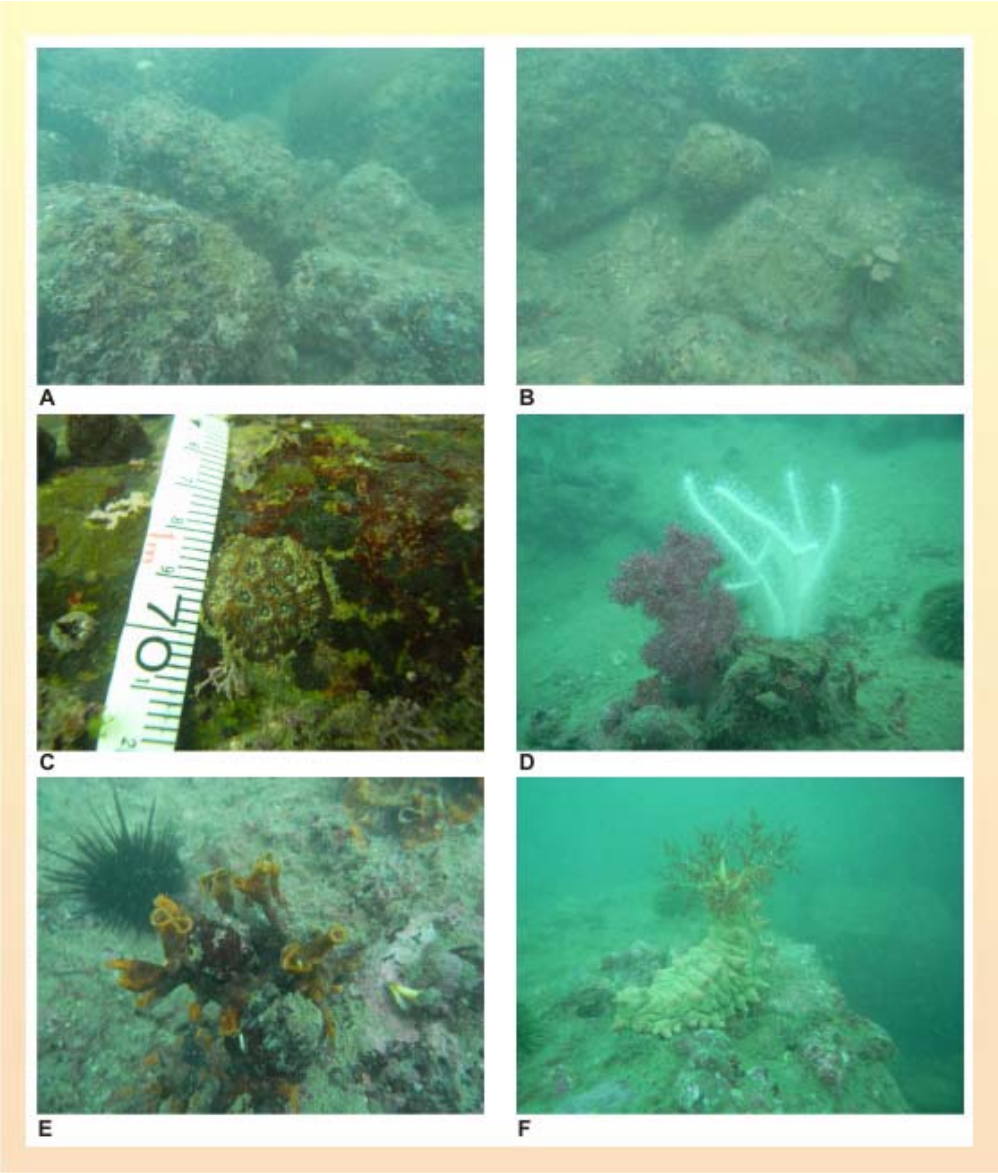


Figure 2.10 Representative Photos of Benthic Composition at the Recipient Site, Tseung Kwan O



Photograph plate descriptions:

A and B – Hard substrate seabed type of the proposed coral recipient site

C – A colony of *Oulastrea crispata*, typical colony naturally occurring within the proposed coral recipient site

D – Small octocoral colonies: *Dendronephthya* sp. (left) and *Echinomuricea* sp. (right)

E – Sessile and mobile benthic organisms: Sea urchin – *Anthocidaris crassispina*; Bryozoan – *Schizoporella errata*

F – Filter-feeding holothurian: the common pink sea cucumber – *Holothuria leucospilota*

Figure 2.11 Location of Hard Corals and *Oulastrea crispata* Recorded along the REA Transects, Tseung Kwan O

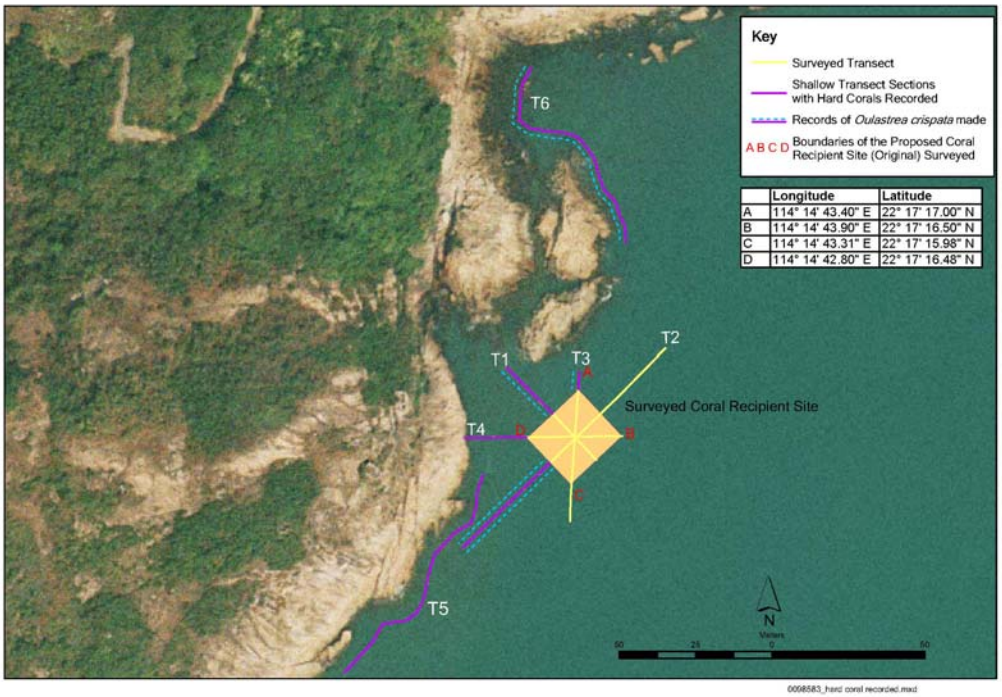


Figure 2.12 Location of the Slightly Modified Position of the Proposed Coral Recipient Site, Tseung Kwan O