

# **ARTIFICIAL REEF DEPLOYMENT IN OUTER PORT SHELTER**

## **Project Profile**

July 2000  
Agriculture, Fisheries and Conservation Department

### **Content**

	<u>Page</u>
1. Introduction	3
2. Basic Information	4
2.1 Project Title	4
2.2 Purpose and Nature of the Project	4
2.3 Name of the Project Proponent	4
2.4 Location and Scale of the Project	4
2.5 Number and Type of Designated Project	4
2.6 Names and Telephone Numbers of Contact Persons	4
2.7 Source of Funding and Support	5
3. Planning and Implementation Programme	6
3.1 Planning and Implementation	6
3.2 Project Implementation	6
3.3 Design of Prefabricated Artificial Reef Units	6
3.4 Quarry Rock Artificial Reef	8
3.5 Artificial Reef Deployment	8
3.6 Work Site	8
4. Surrounding Environment and Baseline Information	9
4.1 Geophysical Environment	9
4.2 Wave Action	9
4.3 Water Quality	10
4.4 Hard Surface Assemblages	11
4.5 Benthic Assemblages	11
4.6 Fisheries Resources	11
4.7 Fishing Operations	12

## Content (conti.)

	<u>Page</u>
5. Potential Impacts on the Environment	13
5.1 Potential Benefits in Deploying Artificial Reefs	13
5.2 Impact on Water Circulation	13
5.3 Impact on Water Quality	13
5.4 Impact on Noise Quality	13
5.5 Visual Impact	14
5.6 Impact on Utilities	14
5.7 Impact on Marine Traffic and Navigation	14
5.8 Impact on Benthic Assemblages	14
5.9 Impact on Corals and Hard Bottom Assemblages	15
5.10 Impact on Fishing Operations	15
5.11 Impact on Mariculture Operations	15
5.12 Impact on Adjoining Country Parks	16
5.13 Impact on Adjoining SSSI	16
5.14 Impact on Recreational Activities	16
5.15 Impact on Antiquity	16
5.16 Other Impacts and Considerations	16
6. Environmental Protection Measures	17
6.1 Pollution and Litters	17
6.2 Preparation of Boat Prior to Deployment	17
6.3 Noise and Visual Impacts	18
6.4 Deployment Duration	19
7. Conclusion	20
8. Literature Cited	21

## **1. Introduction**

At the meeting on 8 December 1995, the Finance Committee approved the implementation of an artificial reef (AR) project to promote bio-diversity of the marine environment in the waters of Hong Kong and rehabilitate and enhance fisheries resources. Funding of HK\$100 million for the AR project was approved (ref. FCR(95-96)87). The project is being implemented in two phases. The first phase involves the deployment of ARs in existing marine parks. The second phase will involve the deployment of ARs outside existing marine parks.

In Phase 1, redundant vessels, tyres, quarry rock and concrete modules are deployed as ARs in Hoi Ha Wan and Yan Chau Tong Marine Parks. Twenty boats, 216 tyre modules, 131 concrete modules and eight quarry rock ARs have been deployed. Phase 1 was completed in September 1999. The initial results are very encouraging. Juveniles of many high-value reef fish, including breams, snappers and grunts have already begun to establish impressive populations around the ARs. In addition, sizeable grouper and snapper adults have also taken up residence on several ARs. Over 110 fish species have so far been recorded on the deployed ARs.

To implement Phase 2 of the AR programme, the Artificial Reef Deployment Study was commissioned to identify suitable sites for deployment outside marine parks and to recommend AR site management plans. Five AR deployment sites were recommended at the West Sokos/Shek Kwu Chau, East Po Toi, Ninepin, Outer Port Shelter, and East Tap Mun. An extensive consultation on the recommendations of the Artificial Reef Deployment Study was conducted between July and September 1999. In response to comments received during the consultation Agriculture, Fisheries and Conservation Department is proceeding with AR deployment proposals in Outer Port Shelter and East Tap Mun and will withhold the proposals for West Sokos/Shek Kwu Chau, East Po Toi and Ninepin.

This Project Profile describes the revised AR deployment proposal for the Outer Port Shelter area. The original proposal was described in the Project Profile submitted to Environmental Protection Department on 8 February 2000 (EPD EIA register ref. DIR-030/2000). Basic differences between the revised proposal and the original are:

1. The AR deployment area have been moved slightly southward into deeper waters, excluding any shoreline and further away from existing inshore waters recreational areas, fish culture zones, country parks and human settlements.
2. All ARs deployed will maintain a depth clearance of at least 9m C.D. with the exception of three complexes, where a minimum depth clearance of 15m C.D. will be maintained.
3. Size of the AR complex has been reduced from 400x400m to 300x300m.
4. All ARs deployed inside the revised deployment area will be managed as "no-take" fisheries.
5. Low profile anti-trawling devices will be randomly deployed inside the 800m-wide corridor set aside for vessels getting in and out of Rocky Harbour and Inner Port Shelter.

A section on "Impact on Antiquity" is also added in view of the concern arisen from the original proposal.

## 2. ***Basic Information***

### 2.1 *Project Title*

Artificial Reef Deployment in Outer Port Shelter

### 2.2 *Purpose and Nature of the Project*

The project proposes to construct and deploy artificial reefs with the following main objectives:

1. To create habitats for hard bottom assemblages and provide protection for adult and juvenile fish resources.
2. To enhance the marine resources of the site and contribute to a Hong Kong wide enhancement of marine resources.

### 2.3 *Name of the Project Proponent*

Artificial Reefs Division, Agriculture, Fisheries and Conservation Department, Government of the Hong Kong Special Administrative Region.

### 2.4 *Location and Scale of Project*

The proposed deployment area, approximately 1 119.6ha, in which ARs will be deployed, is located at outer Port Shelter encompassing a roughly triangular shaped area bounded by Steep Island, Chan Pai (south of Tiu Chung Chau), and southern tip of Basalt Island. The location of the proposed AR deployment area is shown in *Figure 2.4a*.

The proposed deployment area will be comprised of twelve AR complexes. Locations of these complexes are detailed in *Figure 2.4b*. Each square-shaped complex, measuring 300m x 300m, will contain five AR groups, four located at the corners and one at the centre. Each corner group will be formed from high profile prefabricated AR units that collectively occupy an area of 250m<sup>2</sup> on the seabed. The centre group will be comprised of quarry rock piles occupying a seabed area of 707m<sup>2</sup>.

In addition, about 20 low profile AR units, each with a footprint area of about 4m<sup>2</sup>, will be randomly deployed inside the 800m-wide corridor (*Figure 2.4b*) set aside for vessels getting in and out of Rocky Harbour and Inner Port Shelter. These units will function as anti-trawling devices to deter trawling activities along the corridor.

Total footprint area of the ARs to be deployed under this project is therefore approximately 20 600m<sup>2</sup>.

### 2.5 *Number and Type of Designated Projects*

The proposed project will involve reclamation works of more than 1ha in size and the boundaries of some proposed AR complexes are less than 500m from boundaries of the Bluff Island and Basalt Island Site of Special Scientific Interest (SSSI) and is thus

classified as a Designated Project under Schedule 2 Part I C.2 (a)(i) of the Environmental Impact Assessment Ordinance.

2.6 *Names and Telephone Numbers of Contact Persons*

Senior Fisheries Officer, AFCD

2.7 *Sources of Funding and Support*

The project is funded solely by the Agriculture, Fisheries and Conservation Department, Government of the Hong Kong Special Administrative Region.

### 3. *Planning and Implementation Programme*

#### 3.1 *Planning and Implementation*

The whole project is planned and implemented by Agriculture, Fisheries and Conservation Department. Acquisition of construction material, fabrication and deployment of AR will be carried out by a contractor to be appointed by AFCD.

#### 3.2 *Project Implementation*

The project is scheduled for gazettal under Section 5 of the Foreshore and Seabed (Reclamations) Ordinance in September 2000, authorization under Section 8 of the Ordinance is expected in January 2001. Contract for the works will commence in April 2001 and complete in 18 to 24 months time. The project implementation schedule is given in *Table 3.2*.

#### 3.3 *Design of the Prefabricated Artificial Reef Units*

Final design of the prefabricated artificial reef units to be located at the corners of the AR complexes is not yet fixed but will have the following functional requirements:

1. The artificial reef unit shall be optimally designed to enhance marine resources present in the deployment area. AR deployed will provide an appropriate combination of large void space, high surface area to volume ratio and high numbers of refugia;
2. The prefabricated artificial reef unit shall be united with no loose parts;
3. The artificial reef unit, or part of it, shall be as high as possible while satisfying the minimum depth clearance specified for its particular deployment location;
4. The artificial reef unit shall be massive; sufficient to withstand storms, current surges or trawl net towed by 1,000Kw trawlers without lateral displacement;
5. The artificial reef unit shall be made of materials that are non-polluting and durable, and constructed to ensure they remain intact for at least 20 years submerged in a marine environment;
6. The artificial reef unit shall be designed for minimal bearing pressure on the seabed to minimize sinking in soft mud; and
7. The surface of the artificial reef unit shall have a rough texture to enhance marine growth.
8. The artificial reef unit used specifically for anti-trawling purpose shall be designed with protruding sharp edges for tearing into any incoming nets and shall be not more than 3m in overall height.

**Table 3.2: Project Implementation Schedule**

	99		2000												2001												2002											
	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O		
AR deployment gazette preparation under FSO	*	*	*	*	*	*	*	*	*	*	*																											
Permission to apply directly for an Env. Permit									*	*	*																											
Public consultation and objections resolution			*	*	*	*	*	*	*	*	*	*	*	*																								
Gazette AR deployment area under FSO											*	*	*																									
CE-in-Council ruling on objections														*																								
Authorization of AR deployment under FSO															*																							
AR deployment contract preparation						*	*	*	*	*	*	*	*	*	*																							
Application for an Environmental Permit															*	*																						
Tender procedures															*	*	*																					
Contract commencement & deployment of AR																	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	

### 3.4 Quarry Rock Artificial Reef

Natural quarry rocks will be used in the formation of the central artificial reefs (in each AR complex). 90% of the rock used will be over 70kg (i.e., equivalent to approximately 30 cm x 30 cm x 30 cm in size) with maximum size not exceeding 325kg. No small rocks or fine materials will be used in the building of the sea-mounts.

### 3.5 Artificial Reef Deployment

The AR units will be fabricated offsite and transported to the deployment sites by barges. A derrick will be used to lower the AR units onto the seabed in a control manner and then released. Quarry rocks will be acquired offsite and deployed using a mechanical grab. The grab load will be released on or close to (1m) the sea bottom. Differential Global Positioning System (dGPS) will be used to ensure accurate deployment of the ARs to within 5m from positions specified in the contract.

All ARs will be deployed at least 200m away from the shoreline (high water mark) and will be deployed in a depth ranging from 20 to 25m below chart datum (*Table 3.5*). Minimum water clearance, from top of the deployed AR to sea surface, will be at least 9m C.D. with the exception of the anti-trawling devices and the ARs at Complexes 5, 6 and 9, where a greater minimum depth clearance of 15m C.D. will be maintained.

**Table 3.5 Water depths at the proposed deployment locations and maximum height of AR to be deployed**

AR Complex*	Depth range before AR deployment (m)	Maximum height of AR to be deployed (m)
PS1	20-22	11-13
PS2	22-24	13-15
PS3	22-24	13-15
PS4	23-25	14-16
PS5	22-25	7-10
PS6	22-24	7-9
PS7	20-22	11-13
PS8	21-23	12-14
PS9	22-25	7-10
PS10	22-25	13-16
PS11	22-24	13-15
PS12	20-25	11-16

Note: \* Please refer to *Figure 2.4b* for location of the AR complex

### 3.6 Work Site

No work site will be provided for the storage of raw materials and fabrication of the AR units under this project. The appointed contractor will have to have its own work site and if located in Hong Kong will be subjected to the requirements of the ordinances and regulations of the Hong Kong SAR.



#### 4. *Surrounding Environment and Baseline Information*

##### 4.1 *Geophysical Environment*

Information supplied by the Fill Management Committee of CED details the physical nature of the sediments in the proposed area. From a series of boreholes taken during 1988 information was obtained on the sediment texture and particle size distribution. The records provided by CED detailed the top 20m of sediment. The table below presents the top 6m of sediment as depths greater than this are unlikely to have any impact on the stability of the ARs (*Table 4.1*). The information indicates that as with the majority of areas in Hong Kong the sediments are soft and silt clay dominated.

There are a wide variety of substrata at the proposed Outer Port Shelter deployment area due to the numerous islands and exposed rocks. The substratum ranges from rock walls and boulders surrounding the islands to the more common sand or mud generally found at levels -7mPD (BCL 1995) which is detailed in the table below. AR deployment will avoid all areas of rocky and boulder habitats and will take place on the softer more homogeneous sediments.

*Table 4.1 Geophysical Information for Outer Port Shelter Artificial Reef Deployment Area*

Drillhole No.	Sediment Texture at		
	0-2m	2-4m	4-6m
VC1 /35	Soft, olive grey, clayey silt with fine sand bands and abundant shell fragments	Soft to firm, becoming more sandy with scattered window pore oysters	Stiff, to very soft, strongly mottled orange brown, yellow ochre and light blue grey silty clay
C2/3Z	Soft, olive grey, silty clay with small broken shell fragments	Soft to firm, olive grey, silty clay with small broken shell fragments	Green, grey, very clayey fine sand

##### 4.2 *Wave Action*

The proposed deployment area is partly sheltered by the surrounding islands with exposure reducing to the south of the area. As a result of this the proposed deployment area is open to the effects of seasonal monsoons and occasional typhoons. The currents in the proposed deployment area flow predominantly seaward. The wave climate at the proposed deployment area is detailed in *Table 4.2*.

There are no constrained areas with respect to AR deployment within the area boundary as seabed currents are not excessive and there are no scour holes.

**Table 4.2 Wave Climate at Outer Port Shelter**

Direction (Degree)	F (m)	d (m)	US (ms <sup>-1</sup> )	UA (ms <sup>-1</sup> )	H (m)	T (s)	L (m)	Seabed Velocity max (ms <sup>-1</sup> )
<b>Clearwater Bay</b>								
N	3,000	15	30	47	1.3	3.1	15	0.006
NE	1,000	16	35	56	0.9	2.4	9	0.000
E	1,000	15	41	68	1.1	2.5	10	0.000
SE	1,000	22	41	68	1.1	2.5	10	0.000
S	450,000	27	35	56	7.4	11.9	178	1.775
SW	3,000	22	35	56	1.5	3.4	18	0.001
W	1,200	22	31	48	0.9	2.4	9	0.000
NW	1,000	20	21	30	0.5	1.9	6	0.000
<b>Leung Shuen Wan</b>								
N	1,000	22	30	47	0.7	2.2	8	0.000
NE	4,000	22	35	56	1.8	3.7	21	0.004
E	5,000	30	41	68	8.9	13.2	210	2.074
SE	4,000	27	41	68	2.2	3.9	24	0.003
S	450,000	27	35	56	7.4	11.9	178	1.775
SW	3,000	23	35	56	1.5	3.4	15	0.001
W	1,500	20	31	48	0.9	2.6	10	0.000
NW	1,000	22	21	30	0.5	1.9	6	0.000

Note: F = Fetch Length, d = Water Depth, US = Surface wind speed, UA = Wind-stress factor, H = Wave height, T = Wave Period, L = Wavelength.

### 4.3 Water Quality

Four EPD water quality sampling stations, PM7, PM8, PM9 and PM10N, are in the vicinity of the proposed deployment area. Results from EPD's monitoring programme over the period from 1988 to 1998 (EPD 1989-1999) have shown the following:

1. Sea bottom temperature for the area had an average annual value of 21.8°C and a range of 12.4- 29.4°C. The surface temperature had an average annual value of 23.4°C and a range of 12.6 - 30.5°C.
2. Salinity at the sea bottom had an average annual value of 33.1 ppt and a range of 29.9 - 36.3 ppt. Salinity at the surface had an average annual value of 31.6 ppt and a range of 20.3 - 36.0 ppt.
3. Dissolved oxygen at the sea bottom had an average annual value of 82.5% saturation and a range of 9.0 - 199.0% saturation. The surface had an annual average value of 98.0% saturation and a range of 49.0 - 143.0% saturation.
4. Suspended solids had an average annual value of 2.4mg.l<sup>-1</sup> and a range of 0.5 - 17.3 mg.l<sup>-1</sup>.

#### 4.4 *Hard Surface Assemblages*

Dive surveys by Binnie Consultants Ltd, as part of the Coastal Ecology Studies for the Civil Engineering Department, were carried out to characterise the condition of coral communities around Hong Kong waters. The nearest survey locations to the proposed deployment area were southern Kau Sai Chau and northern Tiu Chung Chau (BCL 1996).

Findings from these surveys described the coral communities at the study sites as dominated by hard corals with relatively poor abundance and diversity, however it was partly explained by the lack of suitable substrate for growth. Species dominated according to depth with the highest hard coral cover occurring at -5mPD dominated by *Porites lobata*, *Psammacora superficialis* and *Cyphastrea microphthalma*. In the depth range of -5mPD to -7mPD the rock was dominated by the hard coral family Faviidae. Soft corals (*Dendronephythya* sp.) and gorgonians were also found to be present although the abundance and diversity of these was found to be much lower, except in earlier studies on the Trio Islands (BCL 1995).

#### 4.5 *Benthic Assemblages*

The most comprehensive study of the benthic communities in and around the waters of Outer Port Shelter was undertaken as part of the Benthic Study of Hong Kong waters by Shin and Thompson (1982). This study concluded that the benthic assemblages of the eastern waters, an area inclusive of the Outer Port Shelter site, supported communities that were polychaete dominated (72.5%), with the most dominant species being *Aglaophamus lyrochaeta*. Crustaceans were next in order of abundance (9.5%), followed by other groups (6.9%), echinoderms (5.9%) and molluscs (5.2%). Species diversity was the highest in Hong Kong with a mean number of species of 19.2m<sup>-2</sup>. Mean number of individuals was 88.2m<sup>-2</sup> which is lower than the average for Hong Kong (101.4m<sup>-2</sup>) and the mean biomass for the area was 22.5g.m<sup>-2</sup>, which is low compared to the overall mean biomass for Hong Kong at 35.2g.m<sup>-2</sup>.

A more recent study (ERM 1998a) at Basalt Island, east of the AR deployment area, is generally similar to that previously reported for Hong Kong territorial waters (Shin and Thompson 1982), with low abundance recorded and a numerical dominance of polychaetes. At approximately 6g.m<sup>-2</sup>, the average biomass of the benthic community at Basalt Island is considerably lower than that of the earlier report.

#### 4.6 *Fisheries Resources*

As part of the recommendations made by the Fisheries Resources and Fishing Operations in Hong Kong Waters Study (ERM 1998b) three areas have been identified as candidate areas for protection. Outer Port Shelter falls within one of these areas identified as important spawning and nursery area for commercial fish species. Trawls conducted in the eastern waters of Hong Kong (station T7 - Basalt) recorded average catches compared to other areas in Hong Kong that were sampled. The catches were composed mostly of medium value (>\$15kg<sup>-1</sup>) crustaceans (Table 4.6).

Eastern waters were found to be important areas for commercial fish spawning, with the peak spawning periods identified as occurring from May through August (ERM 1998b). Trawls undertaken in the Outer Port Shelter area indicate that monthly mean catch size (4.2kg) was ranked 10 of the 18 stations sampled in Hong Kong. The highest catch

weight was recorded during June to September (ERM 1998b). Juvenile resources were abundant in the area during August and were composed mainly of prawns.

**Table 4.6 Fisheries Resources from the Vicinity of the Proposed AR Deployment Area at Outer Port Shelter (ERM 1998b)**

<b>Species</b>	<b>% of Catch</b>	<b>Mean Weight (g)</b>
<i>Metapenaeopsis palmensis</i>	14.3	4.1
<i>Oratosquilla oratoria</i>	7.8	11.8
<i>Oratosquilla.anomala</i>	5.7	10.4
<i>Portunus sanguinolentus</i>	5.1	66.0
<i>Apogon fasciatus</i>	4.8	5.3
<i>Loligo edulis</i>	4.5	7.7
<i>Argyrosomus macrocephalus</i>	4.4	25.9
<i>Charybdis cruciata</i>	4.3	107.1
<i>Harpisquilla harpax</i>	2.9	20.1
<i>Saurida tumbil</i>	2.7	66.5

#### 4.7 Fishing Operations

There are many home ports near the Outer Port Shelter area all of which contain small fishing fleets of mainly P4 vessels. Data from the extensive interview programme conducted for the AFCD Fisheries Study (ERM 1998b) indicates that the areas in the immediate vicinity of Outer Port Shelter are fished by all types of vessels. These vessels operate mainly gill net, long line, purse seine and hand line gear. From helicopter surveys conducted between June 1996 to May 1997 it has been observed that the most common types of vessels fishing in the Outer Port Shelter area include trawlers which exploit demersal resources plus heavy concentrations of P4/7 vessels.

The operations responsible for the majority of the catch are purse seine and P4 operators. Catch weights reported by the fishermen during the interviews rank low in comparison with the rest of Hong Kong. Out of the 179 areas in Hong Kong waters where fishermen reported catches Nam Fung Wan ranked 14<sup>th</sup>, Leung Shuen Wan 15<sup>th</sup>, Shelter Island 27<sup>th</sup>, Clearwater Bay 58<sup>th</sup>, Po Toi O 91<sup>th</sup>, Tiu Chung Chau 128<sup>th</sup>, Lung Ha Wan 144<sup>th</sup> and Basalt and Bluff Islands 145<sup>th</sup>. All of these areas reported very high catches of fry, mainly of high value seabreams (eg *Pagrus major* and *Rhabdosargus sarba*).

## 5. *Potential Impacts on the Environment*

### 5.1 *Potential Benefits in Deploying Artificial Reefs*

The potential benefits of AR deployment in Outer Port Shelter include the following:

1. To create habitats for hard bottom assemblages and provide protection for adult and juvenile fish resources.
2. The enhancement of marine resources in the Outer Port Shelter area and a contribution to the enhancement of Hong Kong's marine resources.

### 5.2 *Impact on Water Circulation*

The low-density of ARs precludes any impact on the overall wave climate, tidal current and sediment regimes. The volume of reefs placed in each group will make no discernible difference to the flow of water through the area. Locally the ARs may encourage scour and may cause waves to break further offshore than normal. This will only affect the immediate area of the AR.

### 5.3 *Impact on Water Quality*

The placement of ARs, using the methods described in *Section 3.5*, is unlikely to cause any significant impact on water quality during deployment. Disturbance of seabed, causing a slight increase in turbidity and suspended solids, will occur during placement of ARs. This, however, will be very localized and restricted to the immediate vicinity of the ARs and very transient in duration. The overall water quality impact is therefore insignificant.

Materials selected for the building of ARs will not leach any harmful substance into the environment causing adverse impact. If boats are used they will be prepared to remove as far as possible any objectionable matters on board, such as oil and grease, following the guidelines described in *Section 6.2*. Impact of any residual oil and grease on water quality will be transient.

If concrete is to be used in the construction of the AR units it may be desirable to incorporate coal ash into the concrete mixture in order to increase strength of the concrete and to reduce the AR units' bearing pressure on the seabed. Results from Japan (Suzuki 1995), Taiwan (Kuo *et al* 1995), USA (Roethel and Oakley 1985), UK (Collins and Jensen 1995), Italy (Relini *et al* 1994), and a case study in Hong Kong (Leung *et al* 1997) have shown that trace metal leaching from coal ash/cement blocks is of little environmental concern because of the formation of a surface salt barrier. Assuming the ratio of PFA in the mixture is similar to that in the reported trials, it is unlikely that trace metal released will cause any impact to the water quality or damage to the flora and fauna of the Outer Port Shelter site.

### 5.4 *Impact on Noise Quality*

No noise sensitive receivers are identified within 1km from the AR deployment sites. Works at the sites will not involve construction or percussive piling. The only noise generated will be those from a single mechanical derrick or grab used by the barge during deployment of the ARs. Noise levels during working hours (from 0900hr to 1700hr on any day not being a general holiday) will not exceed the guidelines contained in the Technical

Memorandum on "Environment Impact Assessment Process". Impact on noise quality is expected to be minimal during deployment of the ARs.

#### 5.5 *Visual Impact*

No above-water structures will be erected during and after the deployment of ARs. At any given time during deployment, marine plants in the area will include one barge, one tub boat and up to two small shuttle crafts. The contractor is required to conduct deployment and related works during hours between 0900hr and 1700hr on any day not being a general holiday. Deployment will be scheduled to avoid the need to carry out works between 1700hr on Saturday and 0900hr of the following Monday or during public holidays. Unless weather or other conditions cause unavoidable change to this schedule the contractor would remove his vessels and plants from the deployment area at the weekend and public holidays and, where they might cause hazard to the navigation of other users, leave any uncompleted development adequately marked. Visual impact caused by the AR deployment is therefore kept to a minimal.

#### 5.6 *Impact on Utilities*

The proposed deployment area was selected so as to avoid any utilities. There are underwater cables to the south and north of the proposed area but these are not affected by the proposed deployment at Outer Port Shelter.

#### 5.7 *Impact on Marine Traffic and Navigation*

The proposed deployment area does not lie in any major marine traffic or navigation channels. There is a dangerous goods anchorage north of the deployment area at Rocky Harbour (*Figure 2.4b*). Apart from dangerous goods vessels, vessels using these waters are mostly local fishing vessels or those used solely for recreational purposes. Vessels getting in and out of Rocky Harbour and Inner Port Shelter will have an 800m wide access for safe passage. All ARs deployed will maintain a depth clearance of at least 9m C.D. with the exception of the anti-trawling devices and the ARs at Complexes 5, 6 and 9, where a greater minimum depth clearance of 15m C.D. will be maintained. All deployed ARs will therefore not affect passage of the small to medium craft traffic in the area. As soon as deployment is completed AR depth information will be supplied to Marine Department for updating the relevant chart to aid navigation through the area.

No restrictions on passage of vessels will be implemented as a result of AR deployment in the proposed area or the area being designated as a Fisheries Protection Area (formerly known as Marine Special Area or MSA) in the future (also see *Section 5.10*).

#### 5.8 *Impact on Benthic Assemblages*

The deployment of an AR could alter a soft bottom assemblage by producing the following alterations in the surrounding substratum:

1. The smothering of a portion of the soft bottom assemblage under the reef base;
2. Modification of the bottom current and, as a consequence, variations in the sediment size-distribution and the sedimentation rate around the reef base;

3. Change of sediment organic content through the metabolic activity of both benthic and nektonic reef assemblages; and,
4. An increase in feeding pressure on the part of the infauna due to both attracted and resident reef fish.

The benthic community in the area is not of particularly high ecological value, being typical of Hong Kong in that it is dominated by polychaetes. Although deployment of ARs may cause the above impacts it is most likely that the overall ecological value of the area (in terms of species richness and abundance) will be enhanced through AR deployment.

#### 5.9 *Impact on Corals and Existing Hard Bottom Assemblages*

Dive surveys conducted by AFCDC in December 1999 and Geophysical surveys conducted by the Institute of Geophysical & Geochemical Exploration (IGGE) in May 2000 ensured only those areas void of any corals or hard surface assemblages are chosen for placement of ARs. The survey results indicated that the bottom of the proposed AR sites is flat and covered by homogenous soft sediment and void of any visible assemblages. ARs are to be sited at least 200m away from any known corals or hard bottom assemblages. There will be no direct habitat loss of corals or hard bottom assemblages. Indirect impacts due to water quality change during deployment are also not expected since potential impact on water quality is unlikely (see *Section 5.3*). After deployment, hard bottom assemblages are expected to benefit from the additional habitat provided by the deployed ARs.

#### 5.10 *Impact on Fishing Operations*

Once ARs have been deployed, the deployment area will become unusable for the few demersal trawlers that use the area. Proposal to manage the AR deployment area as "no-take" fisheries is being considered. The operations adopted by vessels from nearby ports are mainly small-scale activities (e.g. purse seine, gill net, and hand line) which are likely to benefit from the resource enhancement brought about by the AR deployment and the exclusion of trawling activity despite the establishment of the "no-take" area.

Amendments to the Fisheries Protection Ordinance (Cap. 171) to empower the Director of Agriculture, Fisheries & Conservation to designate the proposed deployment area as Fisheries Protection Areas and to implement the necessary fisheries management measures are being pursued. It is likely that the amendment process will take two years. AR deployment at the proposed area will also take about two years to complete. AFCDC will seek to manage the AR areas through voluntary agreement with fishers prior to the implementation of the legislative amendments.

#### 5.11 *Impact on Mariculture Operations*

Three fish culture zones, Leung Shuen Wan, Kau Sai and Po Toi O, are closest to the proposed AR deployment area. The closest AR complexes (PS1 and PS12) are more than 1,000m from these FCZs. Deployment of ARs, using the methods described in *Section 3.5*, in the proposed locations will not have any impact on the mariculture activities in the area in view of the insignificant water quality impact (see *Section 5.3*).

#### 5.12 *Impact on Adjoining Country Parks*

All proposed ARs are over 500m away from the Country Parks (*Figure 2.4b*). As the closest ARs to be deployed at PS12 are over 640m from the boundary of Steep Island Country Park and submerged in marine environment of over 20m in depth, no adverse impact on the Country Park is envisaged during and after deployment of ARs.

#### 5.13 *Impact on Adjoining SSSI*

The Bluff Island and Basalt Island Site of Special Scientific Interest (SSSI) is designated because of its unique climax grassland community and spectacular basalt on the eastern coast of Basalt Island. The deployment of ARs in the waters to the south and southwest will not have any impact on the uniqueness of this terrestrial SSSI.

#### 5.14 *Impact on Recreational Activities*

The coastline and the outlying islands in the proposed AR deployment area is not covered by any statutory plan. According to the South Eastern New Territories Sub-region Land Use Plan No. SRSE-ST 85/1<sup>c</sup>, the waters around Clear Water Bay, including the sea area that covers the Clear Water Bay Golf and Country Club's marina, and Lung Ha Wan are designated as "Inshore Waters Recreation Areas" for water-based recreational activities (*Figure 2.4b*). These recreational areas are excluded from the AR deployment area. Following the deployment methods and environmental protection guidelines set out in *Section 3.5* and *Section 6*, respectively, water quality, noise and visual impacts and potential hazards on the water-based recreational activities will be either kept to a minimal or not be expected during and after implementation of the AR project.

No restrictions on passage of pleasure crafts will be implemented as a result of AR deployment in the proposed area or the area being designated as a Fisheries Protection Area in the future (also see *Section 5.10*).

#### 5.15 *Impact on Antiquity*

Pre-deployment geophysical and dive surveys will ensure that only those areas void of any bottom anomalies are chosen for placement of ARs. The preliminary survey results have indicated that the bottom of the proposed AR sites is flat and covered by homogenous soft sediment and void of any visible and buried anomalies. If anomalies were found on the sea bottom by these surveys or during deployment such findings will be reported to the Antiquity and Monument Office of the Leisure and Culture Services Department for their further investigation. In any event, no AR will be deployed on top or within 50m of any detected bottom anomaly. As such, no adverse impact on any possible underwater antiquity is expected during and after the deployment of artificial reefs in the area.

#### 5.16 *Other Impacts and Considerations*

No impact on air quality or other considerations, such as hazards, waste and landscape, can be identified in the implementation of this project.



## **6. *Environmental Protection Measures***

### **6.1 *Pollution & Litter***

The contractor to be appointed by AFCD shall carry out the work in such a manner as to minimize adverse impacts on the environment during execution of the contract. Standard pollution control clauses will be incorporated in the contract. In particular he shall arrange his method of working to minimize the effects on the environment within the works limits, adjacent areas, on the transport routes and at the loading areas.

The contractor shall take all necessary measures to ensure that:

1. Any land-based residue left shall be removed by the contractor within fourteen days whilst any sea borne refuse caused by the works will be immediately collected;
2. All waste materials, goods and substances resulting from the work undertaken by the contractor are disposed of in an environmentally friendly manner and in line with the requirements of the ordinances and regulations of the Hong Kong SAR;
3. No pollution is caused by the contractor for the purposes of carrying out the contract, either to the land or waters of Hong Kong, as defined under the ordinances and regulations of the Hong Kong SAR;
4. No visible foam, oil, grease, scum, litter or other objectionable matter shall be present on the waters within the deployment sites; and
5. Due care is taken during works to avoid unnecessary disturbance of the seabed or the creation of plumes of muddy water.

### **6.2 *Preparation of Boat Prior to Deployment***

If boats are used in the construction of the AR units, the contractor shall be required to undertake various preparatory work to them. The work undertaken shall render such boats suitable for deployment as ARs by removing all items which may otherwise cause litter, pollution and potential hazards and by converting such boats into suitable substrate and shelter for marine life. The contractor shall also be required to ensure that any boat deployed as AR shall not provide unnecessary or undue hazards to divers.

In particular the contractor shall be required to remove all items, materials and substances as follows:

1. All unsecured or partially secured items, materials, stores, substances, coverings such as canvas, floor covers and debris;
2. All covers to portholes, windows (including glass), hatches and doors (including projecting hinges) to maximize numbers of openings between hull and exterior;
3. All entrances, windows, portholes and other holes, whether through the bulkheads, floor, hull or roof, of any boat, having minimum dimensions over

50cm but less than 100cm, such that a diver attempting to pass through such holes could become wedged, will be enlarged, where possible, such that the minimum dimension of the hole is increased to at least 100cm;

4. Any oils including lubricating, fuel and hydraulic oils, from all engines and machinery, hydraulic systems, fuel systems, tanks, containers and any other sources where such engines and fuel tanks are to remain on board;
5. All residual oil, by draining and washing down any oil container, including engines and tanks, with suitable degreasing agent, subsequently flushing with water and draining;
6. Wash down all surfaces of engines and all other areas of grease to remove all excess grease;
7. All air conditioners, refrigeration, and cooling equipment;
8. All insulation material including that from the lining of fish holds and cooling pipes, asbestos covers to exhausts and any metal sheeting from the lining of fish holds;
9. All floatation or buoyancy material, e.g. from buoyancy chambers, etc.;
10. All electronic and life saving equipment and items;
11. All other potentially polluting materials and substances;
12. All such parts of masts and/or superstructures, as necessary, of any boat, which may otherwise be likely to project above a depth of - 9m CD, following deployment as AR; and
13. Any clearly hazardous materials, such as broken glass, exposed sharp nails or other sharp metal pieces shall not be left on board any boat prepared for deployment as an AR.

The contractor shall be required to dispose of all items, materials and substances he has removed from the boats, in an environmentally friendly manner and in line with the requirements of ordinances and regulations of the Hong Kong SAR.

### *6.3 Noise and Visual Impacts*

The contractor is only allowed to conduct work related to the deployment of ARs with only one mechanical derrick or grab at any one time. Working hours shall be from 0900hr to 1700hr on any day not being a general holiday. Deployment will be scheduled to avoid the need to carried out works between 1700hr on Saturday and 0900hr of the following Monday or during public holidays. Unless weather or other conditions cause unavoidable change to this schedule the contractor would remove his vessels and plants from the deployment area at the weekend and public holidays and, where they might cause hazard to the navigation of other users, leave any uncompleted development adequately marked.

#### 6.4 *Deployment Duration*

The contractor shall be required to carry out and complete deployment of the artificial reefs in the shortest possible span of time so as to minimize any adverse impacts caused during deployment.

## 7. *Conclusion*

Based on the review of existing ecological, physical and marine traffic information, adverse impacts to the Outer Port Shelter area are not predicted due to the deployment of artificial reefs.

The revised AR deployment area is in deeper waters and geographically further away from human settlements, fish culture zones, Country Parks, recreational and small-scaled fishing activities than the original proposal. Adverse impacts, if any, caused by the deployment ARs on these sensitive receivers, including marine traffic and navigation, should be less than previously proposed.

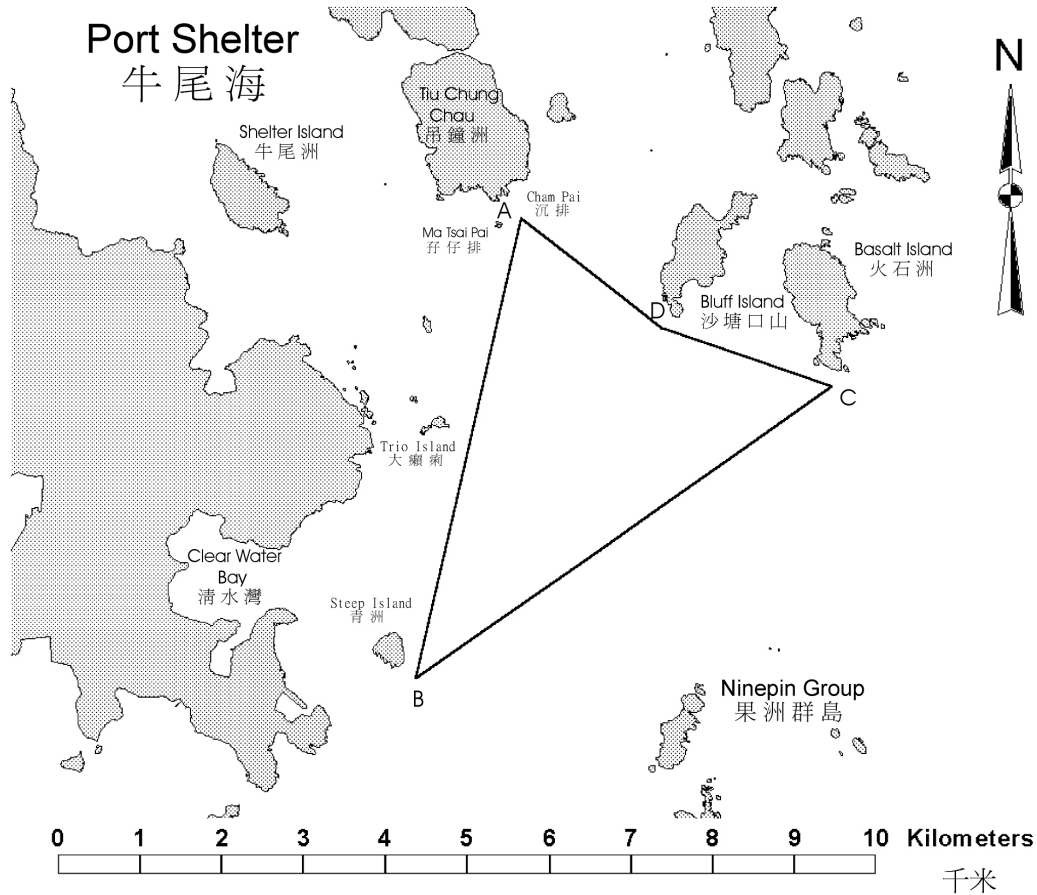
The potential benefits from the deployment of artificial reefs far outweigh the potential risks or impacts to the environment, facilities and existing activities.

## 8. *Literature Cited*

- Binnie Consultants Ltd. (1995). *Marine Ecology of Hong Kong: Report on Underwater Dive Surveys - Vol. 1*. Report for Civil Engineering Department, Hong Kong Government.
- Binnie Consultants Ltd. (1996). *Coastal Ecology Studies: Kau Sai Chau Quantitative Survey*. Final report for Geotechnical Engineering Office, Civil Engineering Department, Hong Kong Government.
- Collins K J and Jensen A C (1995). Stabilised Coal Ash Reef Studies. *Chemistry and Ecology* 10: 193-203.
- Environmental Protection Department (1989-1999). *Marine Water Quality in Hong Kong*. Results for 1988 to 1998 from the Marine Monitoring Programme of the Environment Protection Department.
- ERM (1998a). *Seabed Ecological Studies*. Composite Report to the Civil Engineering Department, Hong Kong SAR Government.
- ERM (1998b). *Fisheries Resources and Fishing Operations in Hong Kong Waters*. Final Report to the Agriculture and Fisheries Department, Hong Kong SAR Government.
- Kuo S T, Hsu T C and Shoa K T (1995). Experiences of Coal Ash Artificial Reefs in Taiwan. *Chemistry and Ecology* 10: 233-247.
- Leung A W Y, Leung K F, Lam K Y and Morton B (1997). *The evaluation on an experimental artificial reef for marine habitat rehabilitation and the feasibility of using stabilised coal combustion solid residues for reef construction*. Final Report, Swire Institute of Marine Science, University of Hong Kong.
- Relini G, Dinelli G and Sampaolo A (1994). Stabilised Coal Ash Studies in Italy. *Chemistry and Ecology* 10: 217-232.
- Roethel F J and Oakley S A (1985). Effects of Seawater on the Mineralogical and Chemical Composition of Coal Waste-Blocks. In Duedall I W, Kester D R and Park P K (eds) *Wastes in the oceans* Vol. 4: Energy Waste in the Ocean, John Wiley & Sons, New York, pp 691-715.
- Shin P K S and Thompson G B (1982). Spatial Distribution of the Infaunal Benthos of Hong Kong. *Marine Ecology - Progress Series*, Vol. 10:37-47, 1982.
- Suzuki T (1995). Application of High-Volume Fly Ash Concrete to Marine Structures. *Chemistry and Ecology* 10: 249-258.

# Proposed Artificial Reef Deployment in Outer Port Shelter

## 建議在外牛尾海水域敷設人工魚礁

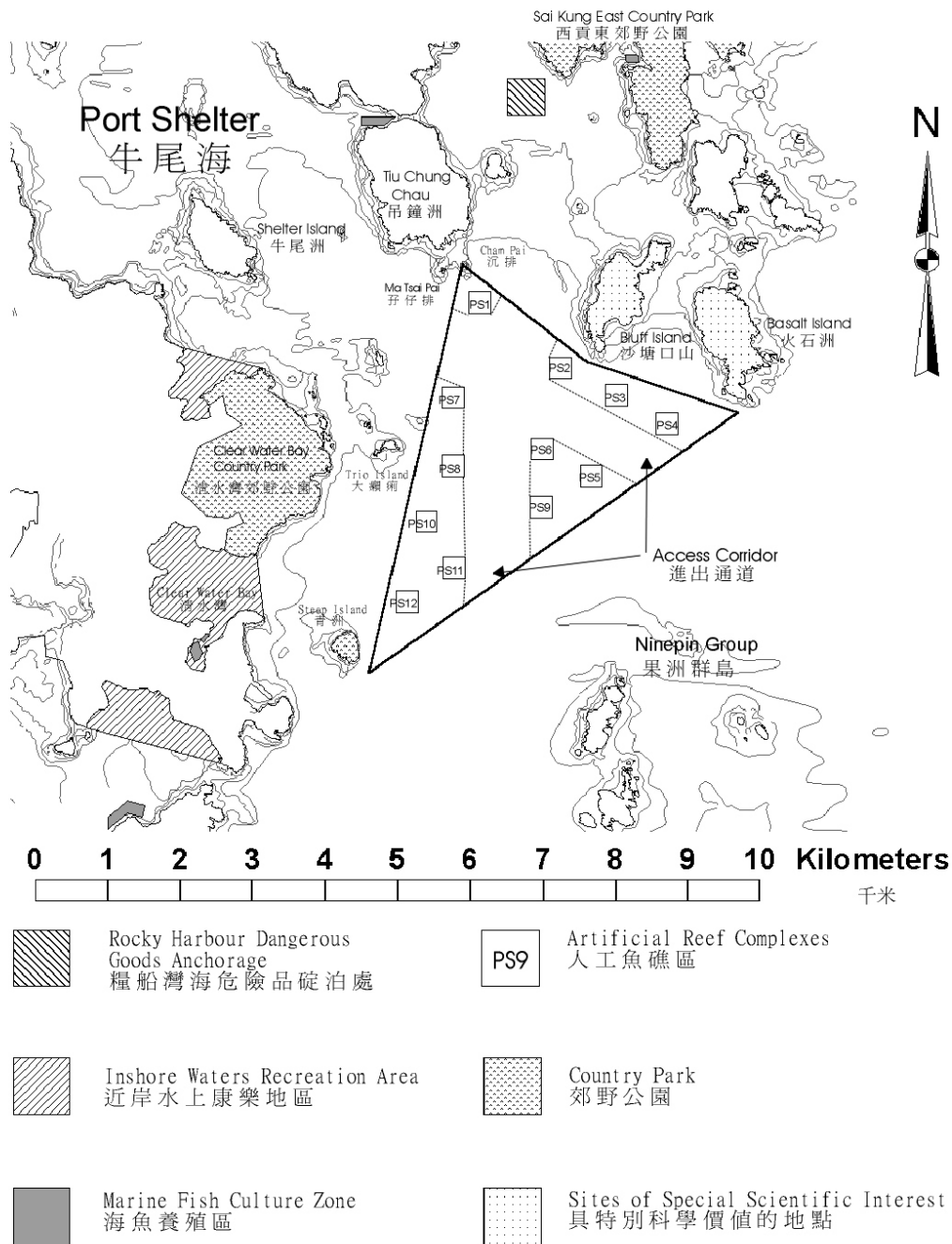


EDGED BLACK AREA  
 1119.6 HA (ABOUT) IN WHICH  
 20600 SQUARE METRES OF  
 FORESHORE AND SEA-BED  
 WILL BE AFFECTED  
 在以黑色邊線標明約

Point 點	Hong Kong 1980 Grid 香港 1980 方格圖	
	Northing 北距	Easting 東距
A	820516	852030
B	814891	850743
C	818459	855826
D	819164	853743

# Proposed Location of AR Complexes in Outer Port Shelter Deployment Area

## 建議在外牛尾海水域敷設的人工魚礁區位置



revised on 5.7.2000