Project Profile

Asia-Africa-Europe-1 (AAE-1) Cable System

January 2016




AUSTRALIA I ASIA PACIFIC I SOUTH ASIA AND MIDDLE EAST I AFRICA I NORTH AND SOUTH AMERICA

Project/Deliverable No.	7076341 | D01/01 – Revision No. 3.0
Project Name:	Asia-Africa-Europe-1 (AAE-1) Cable System
Report Name:	Project Profile
Report Date:	January 2016
Report for:	PCCW Global (HK) Limited

PREPARATION, REVIEW AND AUTHORISATION

Revision#	Date	Prepared by	Reviewed by	Approved by
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1.1 (Draft)	November 2015	Samantha KONG	Vivian CHAN	Alexi BHANJA
2.0 (Revised Draft)	December 2015	Samantha KONG	Vivian CHAN	Alexi BHANJA
3.0 (Final)	January 2016	Samantha KONG	Vivian CHAN	Alexi BHANJA

ISSUE REGISTER

Distribution List	Date Issued	Number of Copies
PCCW Global (HK) Limited	January 2016	1 soft copy
Environmental Protection Department	January 2016	20 hard copies (in English and Chinese) 1 soft copy
SMEC Project File:		1 electronic

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1 BASIC INFORMATION

1.1 Project Title

1.1.1 The title of the Project is "Asia-Africa-Europe-1 (AAE-1) Cable System".

1.2 Purpose and Nature of the Project

1.2.1 The AAE-1 Cable System (the Project) will be one of the first cable systems connecting Hong Kong, Singapore, Middle East, Africa and Europe, providing an alternative low latency route between the Far East and Europe. ***Figure 1-1*** shows the entire AAE-1 Cable, spanning approximately 25,000 km from Hong Kong to France. Within Hong Kong, the length of the AAE-1 Cable is approximately 27.65km. Its completion will provide additional protection and diversity to the existing heavily congested cable systems.

1.2.2 AAE-1 will deploy 100Gbps technology with wavelength add/drop branching units along the lowest latency route with design capacity of over 40 terabits. AAE-1 is one of the largest cable systems ever launched and will stimulate an exponential business growth in participating countries by providing robust, reliable and lowest latency connectivity.

1.2.3 The target completion date for AAE-1 cable construction is 2016. When completed, AAE-1 will connect Hong Kong, Vietnam, Cambodia, Malaysia, Singapore, Thailand, Myanmar, India, Pakistan, Oman, UAE, Qatar, Yemen, Djibouti, Saudi Arabia, Egypt, Greece, Italy and France.

1.2.4 Within Hong Kong, AAE-1 is of strategic importance for a number of reasons:

- The Project will provide Hong Kong with faster and more diverse international telecommunications services and to meet the growing demand for network and telecommunications.
- The Project is in line with the Hong Kong Government's initiative to attract and assist the development of Hong Kong into a hub for technology and to enhance and upgrade Hong Kong's domestic infrastructure to ensure it achieves world-class standards.
- The Project will help benefit the economy and support the increased demand for bandwidth from cloud computing, mobile devices and digital entertainment usage.
- The Project is supported by the Office of the Communications Authority (OFCA).

1.2.5 AAE-1 is to be constructed by the AAE-1 Consortium, which includes PCCW Global (HK) Ltd (PCCWG), who is responsible for the installation of the Project within Hong Kong.

1.2.6 This Project Profile assesses the potential environmental impacts associated with the installation of AAE-1 Cable within Hong Kong. Installation and operation of AAE-1 Cable will be similar to that of previous submarine cable systems that have been installed in Hong Kong, and which have previously been approved via Direct Application.

1.2.7 The main environmental impacts will be during installation of the AAE-1 Cable under the seabed and at the landing site, which is at Lap Sap Wan, Cape D'Aguilar. There will be no environmental impacts during operation of the AAE-1 Cable.

1.3 Name of Project Proponent

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1.4 Selection of Cable Route and Landing Point

1.4.1 The termination point of the entire 25,000km long AAE-1 Cable is Hong Kong, specifically, at the Cape D'Aguilar Submarine Cable Station, which is operated by AAE-1 Consortium member PCCWG. This specific location is integral and fundamental to the Project and so must be considered fixed.

1.4.2 Cape D'Aguilar is an important communications hub for Hong Kong and home to a number of cable stations and communication stations, including the Cape D'Aguilar HF Radio Transmitting Station, the Cape D'Aguilar Submarine Cable Station (where the AAE-1 Cable will terminate), the Cape D'Aguilar HF Radio Transmitting Station (High Level Station) and the Cape D'Aguilar Satellite Earth Station. These are shown on ***Figure 1-2***.

1.4.3 Another aspect of the Project that must be considered fixed is the direction of the cable alignment when it enters Hong Kong waters – all cables must enter Hong Kong waters from the east. Existing cables, such as the ASE SEG-4, EAC-C2C-SEG-1/2A/C/D, SMW3-SEG-1.11, VSNL-1A-SEG-9, etc. are generally aligned within an established "east-west cable corridor". There is also an established "north-south cable corridor", which joins the main east-west cable corridor, and is used by cables such as ASE SEG-4, EAC-C2C-SEG-1/C/D, etc.

1.4.4 Given these two fixed constraints – the cable must enter Hong Kong waters from the east and terminate at Cape D'Aguilar – the following subsection discusses the selection of the cable route and the landing point for the AAE-1 Cable at Cape D'Aguilar.

Submarine Cable Alignment Selection

1.4.5 When considering the submarine route of the AAE-1 Cable, several criteria were taken into consideration. The route must:

- Minimise the length of cable.
- Minimise disturbance to other cables and not compromise the operation of other cables.
- Minimise the number of crossings of other submarine cables to ensure cable laying operations do not compromise the integrity of other cable systems.
- Avoiding known marine archaeological resources.
- Avoid key environmental sensitive receivers, including Fish Culture Zones (FCZs), nursery grounds and habitat for marine mammals.

1.4.6 All of the above criteria can be achieved by laying the AAE-1 Cable along with other existing cables within established cable corridors, such as the east-west cable corridor and the north-south cable corridor.

1.4.7 In meeting the above criteria, the optimum alignment of the AAE-1 Cable within Hong Kong waters is shown on ***Figure 1-3***, from the eastern boundary of Hong Kong waters to the Cape D'Aguilar Peninsula.

1.4.8 This alignment minimises the crossing of other cables (only 2 no. crossings), although, as with all other cables in the east-west cable corridor, the AAE-1 Cable cannot avoid crossing the Hong Kong Electric (HKE) gas pipeline. Thus, there are a total of just 3 no. crossings.

Cape D'Aguilar Landing Site Selection

1.4.9 Telecommunications cables are reasonably flexible and can adopt a curved profile when needed, provided that the curvature is gentle. Typically, cables are landed at a beach, which allows the cable to follow a gradual incline from the seabed to the shore and also allows the cable to be buried in the sand for protection. Cables will then terminate at a Beach Manhole (BMH), which is a small buried structure that houses the connection between the submarine cable and the subterranean cable that connects with existing land-based communication infrastructure.

1.4.10 Within Cape D'Aguilar Peninsula there are various land uses shown on the Tai Tam and Shek O Outline Zoning Plan (OZP) No. S/H18/10. These include Green Belt (GB), Coastal Protection Area (CPA), and Sites of Special Scientific Interest (SSSI). Furthermore, there is also a declared Monument, two graded historic buildings and a Marine Reserve at Cape D'Aguilar. These uses are shown on ***Figure 1-4***. Of particular note, however, is the area designated Other Use (OU) "Radio Communication Station", which is specifically zoned for projects of this type.

1.4.11 Seven landing point options were identified surrounding the Cape D'Aguilar Peninsula, based in part on the above planning designations, as shown on ***Figure 1-5***, which also shows planning designation, locations of steep cliffs, rocky outcrops, etc.:

- **Option 1** is located within the CPA zone at the northern part of Lap Sap Wan. CPA is designated to conserve, protect and retain the natural coastlines and the sensitive coastal natural environment. Part of Option 1 covers the northern shoreline of Lap Sap Wan beach, which is a relatively flat pebble beach. The remainder of Option 1 is steep cliffs with no flat area. It is also distant from the Cape D'Aguilar Submarine Cable Station.
- **Option 2** is located at the western end of OU "Radio Communication Station" zone that covers the southern shoreline of Lap Sap Wan beach and is relatively flat, including surrounding area. The zoning is designated for uses such as cable landing. It is reasonably close to the Cape D'Aguilar Submarine Cable Station.
- **Option 3** is located at the eastern end of OU "Radio Communication Station" zone that covers the southern shoreline of Lap Sap Wan beach. There is a large rock outcrop offshore that prevents a gentle, flat approach for a cable and cliffs to the east. Landing in this area would, however, maximise separation from the CPA on each side. It is reasonably close to the Cape D'Aguilar Submarine Cable Station.
- **Option 4** is located within the CPA zone at the southern part of Lap Sap Wan. Steep cliffs offer no flat landing point. It is reasonably close to the Cape D'Aguilar Submarine Cable Station.
- **Option 5** is located within the Hok Tsui (Cape D'Aguilar) SSSI at the southern part of the Cape D'Aguilar Peninsula and Cape D'Aguilar Marine Reserve, which have been designated in recognition of the conservation of the marine and intertidal

environment. It is closest to the Cape D'Aguilar Submarine Cable Station. It comprises mainly steep cliffs but there is a small flat beach in Hok Tsui Wan that was used as a cable landing site prior to the SSSI and Marine Reserve designation:

- Hon-Tai 2 (Hong Kong – Taiwan 2) is a 735km submarine cable from Cape D'Aguilar to Fangshan, Taiwan. It was activated in 1990 and was withdrawn from service in June 2003.
- APC (Asia Pacific Cable) is a 7,516km submarine cable connecting Miura and Miyazaki (Japan), Toucheng (Taiwan), Cape D'Aguilar (Hong Kong), Cherating (Malaysia) and Katong (Singapore). It was activated in 1993 and was withdrawn from service on 1 April 2006.

- **Option 6** is located at the southern part of the Cape D'Aguilar Peninsula but still within the OU "Radio Communication Station" zone. The coastline comprises steep cliffs and there is no flat land. It is distant from the Cape D'Aguilar Submarine Cable Station.
- **Option 7** is located within the CPA zone at the southern part of at the Cape D'Aguilar Peninsula. With the exception of a beach in Tai Tam Bay at the western most side, the coastline comprises steep cliffs with no flat land. It is also furthest from the Cape D'Aguilar Submarine Cable Station.

1.4.12 The above options were evaluated against a set of criteria to determine the optimum landing point. The criteria are as follows and cover planning, environmental and engineering considerations:

- **Planning Intent.** Is the landing of a cable in line with the planning intent as stated on the OZP?
- **Environmental Impact.** Would the environmental impacts likely be considered acceptable once assessed?
- **Ease of Engineering.** Is there sufficient, unimpeded, flat ground to allow the cable to make a gentle landfall?
- **Distance to Terminal.** Is the landing point sufficiently close to the Cape D'Aguilar Submarine Cable Station to avoid extensive land-based cable laying?

1.4.13 *Table 1-1*, below, provides an evaluation of the seven landing options against the evaluation criteria. This is a qualitative evaluation and has been colour-coded for ease of understanding as follows:

Assessment	Explanation
Unacceptable	Option does not align with planning intent / significant environmental impact / adverse engineering / distant from Cape D'Aguilar Submarine Cable Station
Possible	Option has moderate environmental impact / challenging engineering / reasonably close to Cape D'Aguilar Submarine Cable Station
Acceptable	Options aligns with planning intent / minimal environmental impact / straight forward engineering / close to Cape D'Aguilar Submarine Cable Station

1.4.14 Any option with an "unacceptable" assessment should be discounted. Options with "acceptable" assessments are more preferable than options with "possible" assessments.

Table 1-1 Initial Evaluation of Landing Point Options for Surface Laying of Cable

Option	Assessment				Overall Evaluation of Option	Preferred Landing Point?
	Planning Intent*	Environmental Impact	Ease of Engineering*	Distance to Terminal		
1	Located within CPA zone therefore landing not in line with planning intent.	Extensive coral coverage (likely on subtidal rocks and rocky seabed) would be impacted by surface laying of the cable.	Mainly steep cliffs but the northern shoreline of Lap Sap Wan beach offers a flat landing point.	Distant from the Cape D'Aguilar Submarine Cable Station.	Within CPA and distant from Cape D'Aguilar Submarine Cable Station. Not preferred.	No
2	Located within OU "Radio Communication Station" zone therefore landing in line with planning intent.	Extensive coral coverage (likely on subtidal rocks and rocky seabed) would be impacted by surface laying of the cable.	Beach landing possible on southern shoreline of Lap Sap Wan beach, no cliffs and surrounding flat land.	Reasonably close to the Cape D'Aguilar Submarine Cable Station.	Preferred option but some concern regarding impact on coral within Lap Sap Wan during cable laying.	Yes
3	Located within OU "Radio Communication Station" zone therefore landing in line with planning intent.	Extensive coral coverage (likely on subtidal rocks and rocky seabed) would be impacted by surface laying of the cable.	Landing at Lap Sap Wan beach not possible due to offshore rock outcrop and steep cliffs to the south.	Reasonably close to the Cape D'Aguilar Submarine Cable Station.	Offshore rock outcrop means beach landing not possible. Not preferred.	No
4	Located within CPA zone therefore landing not in line with planning intent.	Extensive coral coverage (likely on subtidal rocks and rocky seabed) would be impacted by surface laying of the cable.	Steep cliffs offer no flat landing point.	Reasonably close to the Cape D'Aguilar Submarine Cable Station.	Within CPA and steep cliffs. Not preferred.	No
5	Located within SSSI zone and Marine Reserve therefore landing not in line with planning intent.	Extensive coral coverage (likely on subtidal rocks and rocky seabed) and cable would pass through SSSI and Marine Reserve.	Mainly steep cliffs but Hok Tsui Wan beach offers a flat landing point (used previously to land other submarine cables).	Closest to the Cape D'Aguilar Submarine Cable Station.	Within SSSI and Marine Reserve. Not preferred.	No
6	Located within OU "Radio Communication Station" zone therefore landing in line with planning intent.	Extensive coral coverage (likely on subtidal rocks and rocky seabed) would be impacted by surface laying of the cable.	Steep cliffs offer no flat landing point.	Distant from the Cape D'Aguilar Submarine Cable Station.	Steep cliffs and distant from Cape D'Aguilar Submarine Cable Station. Not preferred.	No
7	Located within CPA zone therefore landing not in line with planning intent.	Extensive coral coverage (likely on subtidal rocks and rocky seabed) would be impacted by surface laying of the cable.	Mainly steep cliffs but a beach in Tai Tam Bay at the western side offers a flat landing point.	Furthest from the Cape D'Aguilar Submarine Cable Station.	Within CPA, steep cliffs and most distant from Cape D'Aguilar Submarine Cable Station. Not preferred.	No

Note: * *See Figure 1-5*.

1.4.15 From *Table 1-1*, it can be seen that Option 2 – the western end of the OU "Radio Communication Station" zone that covers the southern shoreline of Lap Sap Wan beach – is the preferred landing point. However, there remains some environmental concern related to the impact on corals within Lap Sap Wan during cable laying – this is a concern for all options given the assumed extensive coral coverage on subtidal rocks and rocky seabed surrounding the entire Cape D'Aguilar Peninsula.

1.4.16 With Option 2 selected as the preferred landing site, in 2015 a BMH and buried trench were built at Lap Sap Wan beach, within the area zoned OU "Radio Communication Station". The BMH is shown in *Figure 1-4*. To build these, a temporary dirt access track down to the beach was constructed from Cape D'Aguilar Road, a restricted single track road used only for access to the existing cable stations and the Swire Institute of Marine Science (SWIMS). The small items of plant needed for construction of the BMH and buried trench could be transported via Cape D'Aguilar Road and the dirt access track.

Design Improvement for Preferred Landing Point

1.4.17 The seabed of Lap Sap Wan is generally rocky, out to a distance of around 500m from the shore. Thereafter, the seabed is predominantly marine sediment out to the boundary of Hong Kong waters and beyond. It was originally proposed to surface lay the AAE-1 Cable and electrical earthing cable along the rocky seabed, through the corals, until reaching the marine deposits some 500m from shore. Thereafter, the cable would be laid using the usual cable burial method, which is adopted for most cable laying projects.

1.4.18 As mentioned above, even with the preferred landing point there remains some environmental concern related to the impact of cable laying on the assumed extensive coral coverage within Lap Sap Wan. Dive surveys carried out for this Project confirmed extensive coral coverage on the rocky seabed close to shore. Benthic surveys of some of the sandy seabed areas identified the presence, albeit in small numbers, of amphioxus, a fish species of conservation concern.

1.4.19 In order to address the remaining environmental concerns about the preferred landing point, the Project Proponent decided to change the cable installation method from surface laying and burial and instead adopt Horizontal Directional Drilling (HDD) to avoid impacting the corals and amphioxus within Lap Sap Wan.

1.4.20 HDD has been widely used in Hong Kong for other cable projects (both communication and power cables) and pipeline projects and throughout the world in areas where trenchless technology is preferred to minimise surface impacts.

1.4.21 The *FLAG North Asian Loop* was a cable installation project at Tong Fuk, Lantau, that included HDD to avoid surface impacts to a gazetted bathing beach. HDD was explained in the Project Profile that was submitted for Permission to Apply Directly for the Environmental Permit (EP) and permission was given. The *TKO Express Cable* is another cable installation project between Siu Sai Wan and the Tseung Kwan O Industrial Estate (TKOIE) in which HDD is proposed in the Project Profile submitted for Permission to Apply Directly for the EP, in this case HDD is being used to avoid any damage to an existing sea wall at Siu Sai Wan.

1.4.22 For this Project, HDD will involve drilling a duct using HDD some 5m to 10m below the seabed from a "break-in" point near to the BMH to a "breakout" point that is beyond the last of the corals. The AAE-1 Cable and the electrical earthing cable will be installed in this duct. Drilling a duct below the seabed will avoid any impacts at the surface to intertidal habitats and species, to coral communities and to amphioxus.

1.4.23 After the decision to adopt HDD was made, an additional coral dive survey was carried out along the first 500m of the alignment of the AAE-1 Cable, from the shore to the point at which the rocky seabed becomes soft marine deposits. The purpose of this additional survey was to determine from which point there were no more corals along the alignment (or 5m either side of the alignment). This would be the breakout point where the HDD duct could breakout from the seabed and from where the AAE-1 Cable could be surface-laid without impacts to coral.

1.4.24 The additional coral dive survey identified the last of the corals was at 275m from shore and so it was decided to locate the breakout point for the HDD duct at around 300m from shore (actually 312m), to provide a buffer distance of at least 25m from the last of the corals. Breaking out beyond 300m also minimises adverse impacts to amphioxus, which occur in greater numbers closer to the shore (see ***Section 4.4***).

1.4.25 However, there are two key prerequisites for using HDD. Firstly, there must be flat working space (either natural ground or a Temporary Working Platform) above high tide on which the HDD drilling rig and associated plant and equipment can be located. Secondly, the maximum angle that the HDD duct can be drilled is around 18^{o}. Therefore, to enable the HDD duct to achieve a 5m to 10m depth below the seabed, the break-in point must be located as close to sea level as possible.

1.4.26 Bearing this in mind, the three landing points (Options 2, 3 and 6) that are located within the OU "Radio Communication Station" zone were re-evaluated to determine whether a different option would now become the preferred option if HDD is adopted. Using HDD, an eighth option becomes available: Locating the break-in point within the second, smaller OU "Radio Communication Station" zone that surrounds the Cape D'Aguilar Submarine Cable Station. Options that do not comply with planning intent were not re-evaluated.

1.4.27 The results of the re-evaluation are shown in ***Table 1-2*** and are summarised as follows:

- **Option 2.** A Temporary Working Platform would need to be constructed on Lap Sap Wan beach above high tide but otherwise this is feasible.
- **Option 3.** Although the HDD duct would be drilled below the large rock outcrop offshore, the cliffs to the east mean that there is insufficient space to construct the Temporary Working Platform.
- **Option 6.** There is no flat land at sea level on which the HDD rig can be installed, which means that the rig and break-in point would need to be at the cliff top. Even set back from the cliff edge, the shallow 18^{o} drilling angle would mean that the HDD duct could not reach the seabed – it would breakout from the side of the cliff.
- **Option 8.** Locating the HDD rig at the Cape D'Aguilar Submarine Cable Station, or elsewhere within the smaller OU "Radio Communication Station" zone, would have similar problems to Option 6 – the shallow 18^{o} drilling angle would mean that the HDD duct could not reach the seabed – it would breakout from the side of the cliff.

1.4.28 From the above, Option 2 – the western end of the OU "Radio Communication Station" zone that covers the southern shoreline of Lap Sap Wan beach – remains the preferred landing point and so has been selected. As shown in ***Table 1-2***, the environmental impacts to corals can now completely avoided by adopting HDD for the first 300m or so, which means that all assessments for Option 2 are now considered to be acceptable.

1.4.29 Requirements for constructing and removing the Temporary Working Platform and for mobilising and demobilising the HDD plant and equipment are discussed in ***Section 1.6***.

Table 1-2 Revised Evaluation of Landing Point Options In Line with Planning Intent Using HDD

Option	Assessment				Overall Evaluation of Option	Preferred Landing Point?
	Planning Intent*	Environmental Impact	Ease of Engineering*	Distance to Terminal		
2	Located within the main OU "Radio Communication Station" zone therefore landing in line with planning intent.	No impacts to corals identified within Lap Sap Wan (by dive surveys) as HDD duct will be constructed beneath seabed, thereby avoiding impacts to ecological communities on seabed.	A Temporary Working Platform would need to be constructed on Lap Sap Wan beach above high tide. There is sufficient flat land in the area to do this.	Reasonably close to the Cape D'Aguilar Submarine Cable Station.	All assessments are "acceptable". Remains the preferred option.	Yes
3	Located within the main OU "Radio Communication Station" zone therefore landing in line with planning intent.	No impacts to corals identified within Lap Sap Wan (by dive surveys) as HDD duct will be constructed beneath seabed, thereby avoiding impacts to ecological communities on seabed.	HDD will avoid constraint of offshore rock outcrop but steep cliffs to the south do not allow sufficient space to construct the Temporary Working Platform on the beach.	Reasonably close to the Cape D'Aguilar Submarine Cable Station.	Insufficient space to construct Temporary Working Platform on the beach, so not possible to carry out HDD. Not preferred.	No
6	Located within the main OU "Radio Communication Station" zone therefore landing in line with planning intent.	Extensive coral coverage (likely on subtidal rocks and rocky seabed) would not be impacted as HDD duct will be constructed beneath seabed, thereby avoiding impacts to ecological communities on seabed.	No flat land at sea level, so the HDD rig and break-in point would need to be at the cliff top. Shallow 18^{O} drilling angle means that the duct would breakout from cliff and would not reach the seabed.	Distant from the Cape D'Aguilar Submarine Cable Station.	Due to elevation of break-in point at cliff top, HDD duct could not reach the seabed. Also distant from Cape D'Aguilar Submarine Cable Station. Not preferred.	No
8	Located within the smaller OU "Radio Communication Station" zone surrounding the Cape D'Aguilar Submarine Cable Station therefore landing in line with planning intent.	Extensive coral coverage (likely on subtidal rocks and rocky seabed) would not be impacted as HDD duct will be constructed beneath seabed, thereby avoiding impacts to ecological communities on seabed.	No flat land at sea level, so the HDD rig and break-in point would need to be at the cliff top. Shallow 18^{O} drilling angle means that the duct would breakout from cliff and would not reach the seabed.	Furthest from the Cape D'Aguilar Submarine Cable Station.	Due to elevation of break-in point at cliff top, HDD duct could not reach the seabed. Also, far from Cape D'Aguilar Submarine Cable Station. Not preferred.	No

Note: * See ***Figure 1-5***.

1.5 Location and Scale of Project

Location of Project

1.5.1 The landing point of the AAE-1 Cable at Cape D'Aguilar will be the existing BMH at the western end of the OU "Radio Communication Station" zone that covers the southern shoreline of Lap Sap Wan beach (the Site). This landing point has been selected based on an assessment of eight alternative options in ***Section 1.4***, above.

1.5.2 The majority of the land surrounding the Site is designated GB, however, north and south of the BMH is designated CPA. To the south of the BMH is the Cape D'Aguilar Marine Reserve and the Hok Tsui (Cape D'Aguilar) SSSI. The BMH itself, however, is within an area designated OU "Radio Communication Station" and therefore complies with the planning intent of the zoning.

1.5.3 Cape D'Aguilar Lighthouse, a declared Monument, is located about 25m above sea level and is some 470m southeast of the BMH; and SWIMS is 610m also to the southeast.

1.5.4 In the past, Cape D'Aguilar was a military area and in the vicinity of the BMH there are two Grade 2 historic buildings; Cape D'Aguilar Battery is located 480m east of the BMH; and Bokhara Battery is located 315m southeast of the BMH.

1.5.5 The route of the AAE-1 Cable within Hong Kong, including the landing point in Lap Sap Wan, is shown on ***Figure 1-6***. This is the optimal alignment that has been selected based on criteria described in ***Section 1.4***, above.

Scale of Project

1.5.6 Within Hong Kong, the AAE-1 Cable is some 27.65km in length and 40mm in diameter. There will also be a 30mm diameter 350m long electrical earthing cable at the break out point.

1.5.7 In order to use HDD for the first 300m of the alignment, a Temporary Working Platform must be constructed near to the BMH at Lap Sap Wan on which the HDD drilling rig and associated plant and equipment can be located and operated without causing adverse impacts to Lap Sap Wan beach. The components of the Temporary Working Platform (predominantly steel girders, decking and concrete pads) are too large to be brought in via Cape D'Aguilar Road and the temporary dirt access track and so must be brought in by barge. The HDD plant and equipment are also too large to be brought in via Cape D'Aguilar Road and the temporary dirt access track and so must also be brought to the Temporary Working Platform by barge.

1.6 Project Details

1.6.1 The Project will be constructed as follows:

- **HDD Works Near the BMH at Lap Sap Wan.** This comprises construction and removal of the Temporary Working Platform; mobilisation and demobilisation of the HDD plant and equipment to and from Site; and construction of the HDD duct.
- **Ch.0m to Ch. 300m: Installing the Cable Through the HDD Duct.** The AAE-1 Cable and the electrical earthing cable will be pulled through the HDD duct from the breakout point some 300m off shore to the break-in point on land near the BMH.

- **Ch. 300m to Ch. 500m: Surface Laying of Cable by Divers.** Starting from the breakout point some 300m off shore, divers will lay the AAE-1 Cable directly on the rocky seabed inside Articulated Pipe (AP) protection, secured by pinning onto the seabed. Divers will also pin the last 50m of the 350m electrical earthing cable on the seabed, without AP.
- **Ch. 500m to Ch. 27.65km: Cable Burial.** From where the rocky seabed gives way to soft marine deposits, the AAE-1 Cable will be installed using an "Injector Burial Tool" or "Sledge Tool", towed behind a cable-laying vessel, that mechanically buries the cable in a trench in the seabed approximately 500mm wide and 5m deep, and then back-fills in the trench – this is a standard cable burial technique.
- **Protection at Cable and Pipeline Crossings.** The intended burial depth of the AAE-1 Cable is 5m below the seabed, except where the AAE-1 Cable needs to cross the EAC-C2C-SEG-2A1 Cable, the EAC-C2C-SEG-2A Cable and the HKE Gas Pipeline. At these points, the AAE-1 Cable will be buried closer to the surface of the seabed and protected by AP or "Uraduct", which will be installed by divers.

1.6.2 The above construction methods are described in the following subsections. ***Figure 1-7*** shows schematically the three different installation methods – HDD duct, surface laying and cable burial – along the first part of the alignment.

HDD Works Near the BMH at Lap Sap Wan

1.6.3 In order for HDD to be carried out as proposed for the first 300m of the AAE-1 Cable alignment, there are a number of steps to be taken:

- Construct the Temporary Working Platform.
- Mobilise HDD Plant and Equipment to Site.
- Construct the Cable Duct Using HDD.
- Demobilise HDD Plant and Equipment from Site.
- Remove the Temporary Working Platform.

1.6.4 Each of the above steps is explained below. Photographs of the existing BMH, buried trench and temporary dirt access track at Lap Sap Wan are shown in ***Figure 1-8***.

Construct the Temporary Working Platform

1.6.5 Before HDD works can commence, a Temporary Working Platform must be constructed near to the existing BMH to provide a flat area for the HDD drilling rig and associated equipment to be located without causing adverse impacts to Lap Sap Wan beach.

1.6.6 At the top of the beach there is an existing temporary dirt access track, which was formed in early 2015 to allow equipment to reach the site of the BMH and buried trench for their construction. Although only narrow, it is possible to use this to bring in a small crawler crane and small backhoe to the site of the Temporary Working Platform.

1.6.7 However, the larger components of the Temporary Working Platform (predominantly steel girders, decking and concrete pads) are too large to be brought in via Cape D'Aguilar Road and the dirt access track and so must be brought in by derrick barge. To facilitate this, a landing pontoon will be utilised at high tide. The landing pontoon will float above the coral in Lap Sap Wan and no coral will be damaged by use of the landing pontoon. Equipment and material will be temporarily placed on the beach above the high water mark after being unloaded from the landing pontoon.

1.6.8 The Temporary Working Platform is expected to be around 510m^2 in size and will be constructed of steel beams arranged on top of a structural frame, designed according to the critical working load – the design will be checked by an Independent Checking Engineer. The Temporary Working Platform will be elevated above the beach at +3mPD (above high water) on concrete pads 1m x 1m in size, which will all be placed above the low water level so as not to touch any coral. The thickness of the pads will range from around 200mm at the top of the beach to around 3m at the low water line and will be of sufficient number to support the expected loading. No excavation or concreting works will be required for the pads as they will simply sit on the levelled surface of the beach.

1.6.9 The Temporary Working Platform, including its supporting pads, will not touch any coral and will not be within the CPA zone. The location of the Temporary Working Platform is shown on ***Figure 1-9***.

1.6.10 During high tides, the side of the Temporary Working Platform closest to the sea will be in about 3m depth of water, which is well above the top of the coral, all of which exist below the low tide level. A measure will indicate the water depth at this location. This area is the designated berthing location for barges to mobilise and demobilise HDD plant and equipment.

Mobilise HDD Plant and Equipment to Site

1.6.11 The coral dive surveys have indicated that while there is abundant coral in Lap Sap Wan, particularly near to the shore, none lives above low tide. There is no obvious channel for the barge through the coral to the Temporary Working Platform, however, the tidal range in Lap Sap Wan is more than 2m, which means that at high tide there will be more than 2m of water above the top of the coral anywhere within Lap Sap Wan.

1.6.12 It is therefore intended to mobilise the HDD plant and equipment during the highest tide after completion of the Temporary Working Platform. The day before this tide is due, all the HDD plant and equipment will be loaded on a landing barge, of approximately 2,000 tonnes displacement. The heavier HDD equipment will be pre-loaded onto crane lorries.

1.6.13 If the depth of water as measured at the edge of the Temporary Working Platform is not sufficient to avoid coral damage (i.e. the draught of the barge is too great) then a shallow draught flat-top barge will be employed as a “floating bridge” between the Temporary Working Platform and the landing barge, which will remain further off-shore in deeper water.

1.6.14 For safety reasons, the mobilisation of HDD plant and equipment from the landing barge to the Temporary Working Platform will only be carried out under calm weather and tidal conditions. As such, there will be no risk from significant undulation of waves causing the landing barge (or flat-top barge) to impact the underlying coral.

1.6.15 As soon as the landing barge (or flat-top barge) is moored at the Temporary Working Platform, the HDD plant and equipment will be moved over, starting with the crawler-mounted HDD rig. The mobile crane moves next and then the remaining plant and equipment is moved to the Temporary Working Platform by crane lorries and unloaded by the mobile crane. When all of the HDD plant and equipment have been moved onto the Temporary Working Platform, the crane lorries will drive back onto the landing barge and the barge will leave the area.

1.6.16 At this point, all the HDD plant and equipment has been arranged on the Temporary Working Platform as indicated on ***Figure 1-10***.

1.6.17 After connection of hoses and cables, the drilling fluid supply and recycling systems are tested (there is no discharge as this is a closed-circuit system). The drill rig position is fine-tuned with its mast aligned in the correct direction and the required inclination. The entry pit is filled with water to detect any leakage – if any leakage occurs the pit will be re-sealed. After commissioning of the overall set up and systems, HDD drilling work can commence.

Construct the Cable Duct Using HDD

1.6.18 The HDD duct will be around 300m in length and will be drilled approximately 5m to 10m below the seabed (and below the coral colonies) in the bedrock from near to the BMH to a point around 300m from the shore, following a pre-defined trajectory, as shown on ***Figure 1-11***. It can be seen from ***Figure 1-11*** that the distance from last coral colony to the HDD break-out point is some 37m to the start of the cable burial at Ch.500m is some 237m. A Paratrack II guidance system using the earth's magnetic field will steer the drill head along the required trajectory.

1.6.19 The duct will be approximately 200mm diameter, which is sufficient to accommodate both the AAE-1 Cable and the electrical earthing cable. As the duct is drilled, a steel conduit will be installed, which acts as a liner and provides structural support.

1.6.20 During the drilling process, the drill head is used to cut through the bedrock below the BMH and will then travel around 5m to 10m below the seabed, above which are the corals and amphioxus. Given the 5m to 10m depth and the small size of the drill head, vibration impacts at the seabed are not expected.

1.6.21 Drilling fluids will be used during duct construction to maintain the duct shape and stability (to avoid collapse), to remove rock cuttings and to lubricate the rotating drill bit. This drilling fluid (or "drilling mud") consists of environmentally-friendly water-based products – generally bentonite clay, which is mixed with freshwater to create slurry. The fluid is pumped through the drill, acting as a lubricant for the drilling process, and brings the rock cuttings back to the surface at the Temporary Working Platform.

1.6.22 At the Temporary Working Platform the returning drilling fluid will enter a centrifuge, which removes the heavier rock cuttings from the fluid, which flows into tanks for reuse. This process has proven to be effective on other projects in Hong Kong and has been found to be environmentally acceptable.

1.6.23 For reference, ***Figure 1-12*** illustrates the HDD drilling process and also shows photographs of HDD in operation on other projects.

1.6.24 The geophysical survey that has been carried out along the entire alignment of the AAE-1 Cable has not indicated any fractured or jointed bedrock beneath the seabed through which the HDD duct will be installed. As such, leakage of drilling fluid up through the seabed and into the marine environment is not anticipated. However, in the event that there are any fractures in the bedrock that could provide a pathway to the marine environment above, the water pressure would force seawater into the HDD duct rather than allow drilling fluid to escape into the marine environment. Any seawater leaking into the duct would thus be pumped out along with the drilling fluid and rock fines for treatment at the Temporary Working Platform.

1.6.25 Normally, HDD ducts are reamed after drilling, i.e. enlarged using a reamer that requires a receiving pit and a structure to pull out the metal conduit at the breakout point, which would be in the sea in this case. To avoid the environmental impacts resulting from the use of an off-shore receiving pit and structure, the HDD duct for the AAE-1 Cable will not be reamed but will simply breakout onto the seabed, with the steel conduit left in place.

1.6.26 To avoid any potential leakage of the drilling fluid into the marine environment at the breakout point, 5m before the drill head breaks out of the bedrock onto the seabed, drilling will stop and the drilled duct will be purged with water to remove all drilling fluid. For the final 5m prior to breakout, water will be used as "drilling fluid". Thus, there will be no leakage of drilling fluid into the marine environment as it will not be used for the final 5m of drilling. At the breakout point, divers will be present to ensure there are no problems.

Demobilise HDD Plant and Equipment from Site

1.6.27 Once the HDD duct has been constructed, the HDD plant and equipment can be demobilised. In a reverse operation to mobilisation, a barge will be brought in at high tide to remove all the heavy plant and equipment from the Temporary Working Platform.

1.6.28 The same precautions adopted during mobilisation to ensure vessel safety and avoid damage to corals will be adopted during demobilisation.

Remove the Temporary Working Platform

1.6.29 Once all of the heavy HDD plant and equipment has been removed from the Temporary Working Platform, the Temporary Working Platform will be dismantled and removed from the beach in a reverse operation to its construction, including use of the derrick barge and the dirt access track.

1.6.30 The beach will be reinstated to its original condition and any accumulated rubbish will be removed. Finally, the dirt access track will be reinstated to its original (pre-BMH construction) condition as far as practicable.

Ch.0m to Ch.300m: Installing the Cable Through the HDD Duct

1.6.31 Upon completion of the HDD works, a bell mouth will be attached to the end of the duct at the seabed, which will facilitate pulling the AAE-1 Cable through to the BMH. The guide and control wire that was attached to the HDD drill head will be left in place and used to pull the AAE-1 Cable through back through the steel-lined duct towards the break-in point, which intercepts an existing buried trench that connects to the BMH.

1.6.32 From the BMH, the cable will be fed into an existing buried trench that leads to the Cape D'Aguilar Submarine Cable Station, approximately 360m to the southeast of the BMH.

Ch.300m to Ch.500m: Surface Laying of Cable by Divers

1.6.33 From the point at which the HDD duct breaks out, approx. Ch.300m from shore, to approx. Ch.500m from shore, the seabed remains rocky, although a coral dive survey has confirmed that there are no corals on the cable alignment or either side of it.

1.6.34 For this 200m section, the AAE-1 Cable will be installed by divers, who will lay the cable inside AP for protection. The AP will be secured to the rocky seabed using screws. ***Figure 1-13*** shows a typical AP specification and photographs of diver installation.

1.6.35 As the seabed where AP will be installed is rocky, there will be very little silt to disturb. While the pinning of the AP to the seabed requires drilling holes in the rock for the bolts, the rock fines released from the drilling will not become suspended in the water column but will immediately settle. As such, no water quality impacts are anticipated from the AP installation.

Ch.500m to Ch.27.65km: Cable Burial

1.6.36 From approximately 500m from shore onwards, the seabed becomes mainly marine sediment in which the cable can be buried. Burial will be carried out using an "Injector Burial Tool" or "Sledge Tool" towed behind a cable-laying vessel. Both methods use a similar jetting technique.

1.6.37 The intended burial depth of the AAE-1 Cable is down to 5m below the seabed, except where the cable needs to cross the Hong Kong Electric (HKE) Gas Pipeline – all cables that cross this pipeline need to be buried at a shallower depth above the pipeline.

1.6.38 Jetting is undertaken automatically by the burial tool to liquefy the sediments at the desired installation level to aid with the burial at the target depth of 3m to 5m below the seabed as the tool is pulled along the route alignment by the cable-laying vessel. This method is designed to simultaneously lay and bury the cable with minimal disturbance to the seabed and will result in only localised impacts to the marine water quality at the seabed. ***Figure 1-14*** shows typical cable laying and burial equipment.

1.6.39 As with previous submarine cable installation projects in Hong Kong, a suitable weather time window will be forecasted and identified such that the whole cable burial operation by the working barge can be carried out continuously and completed swiftly in one go without interruptions, thus minimising the duration of the operation and disturbance to other marine users and to the environment.

1.6.40 The width of the trench created by the tool is narrow – expected to be 500mm or less – and so the disturbed area of the seabed will be limited to this width. A dive team will be on standby during the installation to ensure proper functioning and positioning of the cable installation tool.

1.6.41 Debris and obstacles along the cable laying route may pose a threat to the cable, or the burial machine. Therefore, as part of the installation of AAE-1 cable, a Route Clearance operation (RC) and Pre-lay Grapnel Run (PLGR) will be carried out to remove Out of Service cables and to remove any debris or obstacles. The RC and PLGR operations will to take place before actual cable laying operation. Grapnels will be towed along the seabed in the vicinity of Out of Service cables and any cables recovered will be kept on board the RC and/or PLGR vessels for proper disposal once ashore.

1.6.42 Whenever other seabed debris is encountered this shall, as far as practicable and reasonable, be cleared to ensure that a safe corridor exists for the cable alignment. In all circumstances, no towed equipment shall be used within 50m of any pipeline or in-use submarine cable system identified by the electronic survey. Recovery and launch of any towed equipment 50m before/after any crossing point is the normal industrial standard, and so will be followed during the PLGR.

1.6.43 The PLGR is carried out very quickly and does not result in significant disturbance to the seabed and no adverse environmental impacts are expected during the PLGR.

Protection at Cable and Pipeline Crossings

1.6.44 For the areas where the AAE-1 Cable needs to cross existing cables or pipelines, the cable burial tool will be readjusted about 50m from the target crossing location and to a depth sufficient to allow a cushion of seabed material to be in place above the target to be crossed.

1.6.45 Additional protection will be provided by either "Uraduct" or AP – agreement to the crossing and additional protection, if needed, will be agreed with other cable owners. Once crossed, the burial tool will be adjusted to re-achieve the target burial depth.

1.6.46 Close to the Hong Kong boundary in eastern waters, the cable will unavoidably cross a HKE Gas Pipeline, which is buried around 3m below the seabed. To avoid any interference with this pipeline, around 100m from the pipeline the AAE-1 Cable will rise to the surface of the seabed and will be laid over the top of the pipeline. At the surface, the AAE-1 cable will be protected by "Uraduct", AP or similar. ***Figure 1-13*** shows typical cable protection approaches.

1.6.47 The location operation for the HKE Gas Pipeline will be performed at the anticipated crossing point. To locate the exact position of the pipeline, a tone/magnet detector survey or diver survey by vessel with air-lifting/jetting will be conducted. As the pipeline is believed to be buried more than 2.5m deep, location will be performed by diver.

1.7 Designated Projects to be Covered by the Project Profile

1.7.1 Although there is no actual dredging required for the installation of the AAE-1 Cable, this Project Profile follows the classification as a Designated Project (DP) under the Environmental Impact Assessment Ordinance (EIAO), which has been applied to other cable projects that land in Hong Kong:

- **Schedule 2 (Part I), C.12.** This refers to a dredging operation which (a) is less than 500m from the nearest boundary of an existing or planned (i) site of special science interest; (ii) site of cultural heritage; (iii) marine park or reserve; and (vi) coastal protection area.

1.7.2 As shown on ***Figure 1-4***, the Cape D'Aguilar Lighthouse (a declared Monument), the Cape D'Aguilar Battery (a Grade 2 historic building) and the Bokhara Battery (also a Grade 2 historic building) are all located within 500m of the BMH at Lap Sap Wan. Also, the landing point of the cable (i.e. at the BMH) is within 10m of the CPA at Lap Sap Wan. The cable alignment passes 215m from the Hok Tsui (Cape D'Aguilar) SSSI and the Cape D'Aguilar Marine Reserve at its closest point.

1.8 Name and Telephone Number of Contact Person

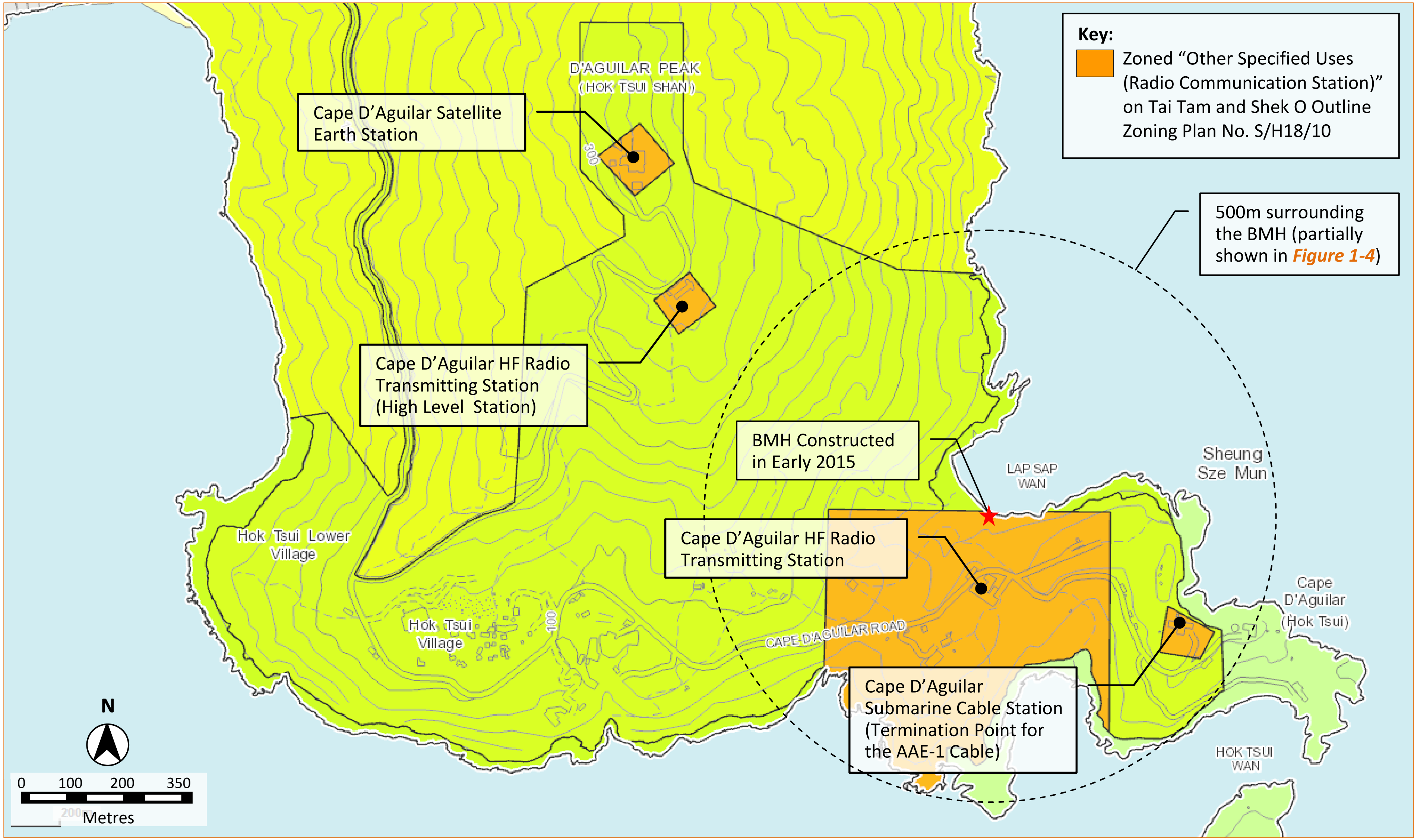
1.8.1 SMEC Asia Limited (SMEC) has been appointed to undertake the environmental permitting for this Project. All queries can be addressed to SMEC or to the Project Proponent at:

Ms Vivian CHAN
Associate, Water & Environmental Group
SMEC Asia Limited
Telephone 3995 8100
Fax 3995 8101

Mr Joseph CHAN
Vice President, Cable Planning
PCCW Global (HK) Limited
Telephone 2883 7515
Fax 2565 0881

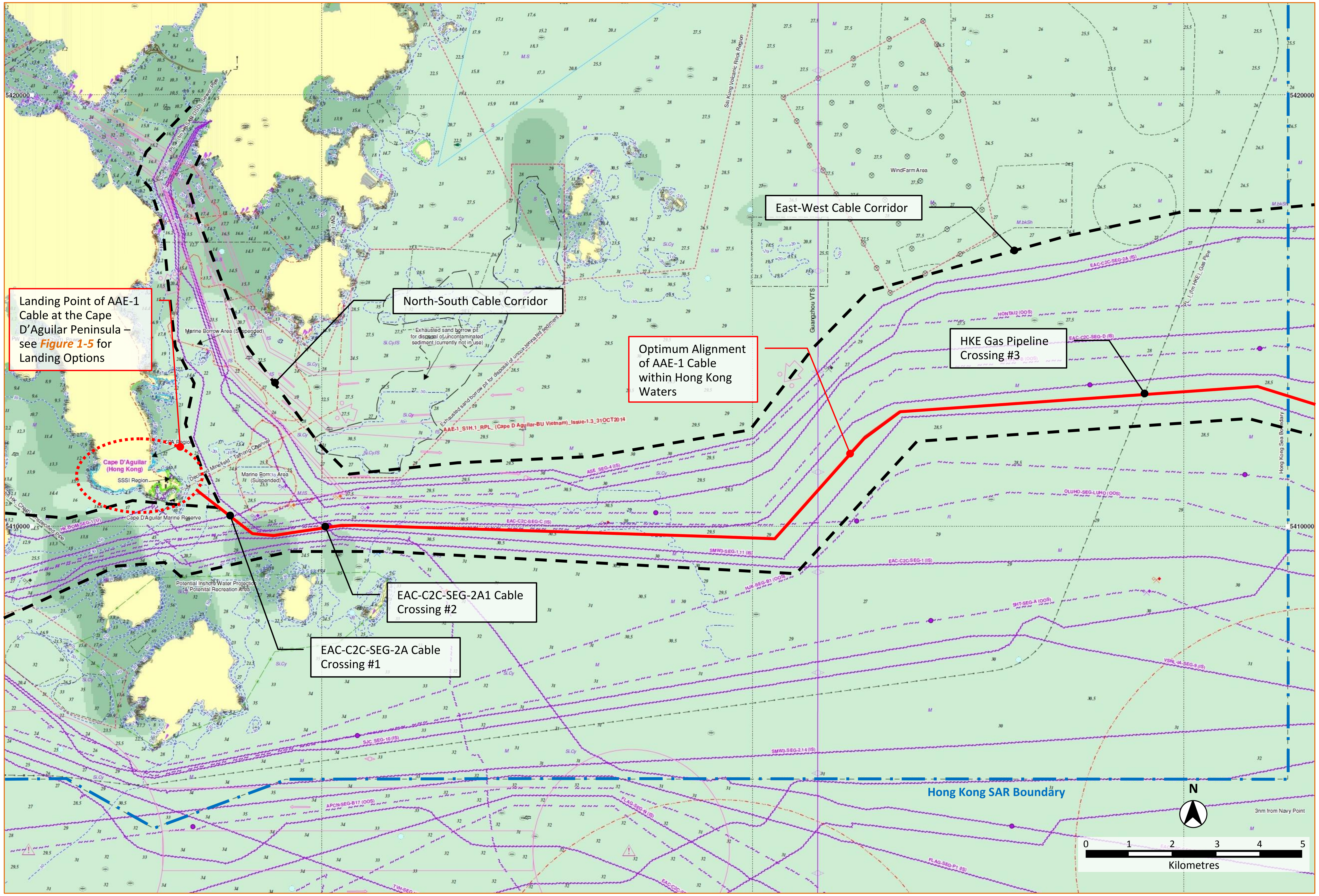
Figure 1-1 The AAE-1 Cable

Figure 1-2 Cable Stations Located On Cape D'Aguilar Peninsula



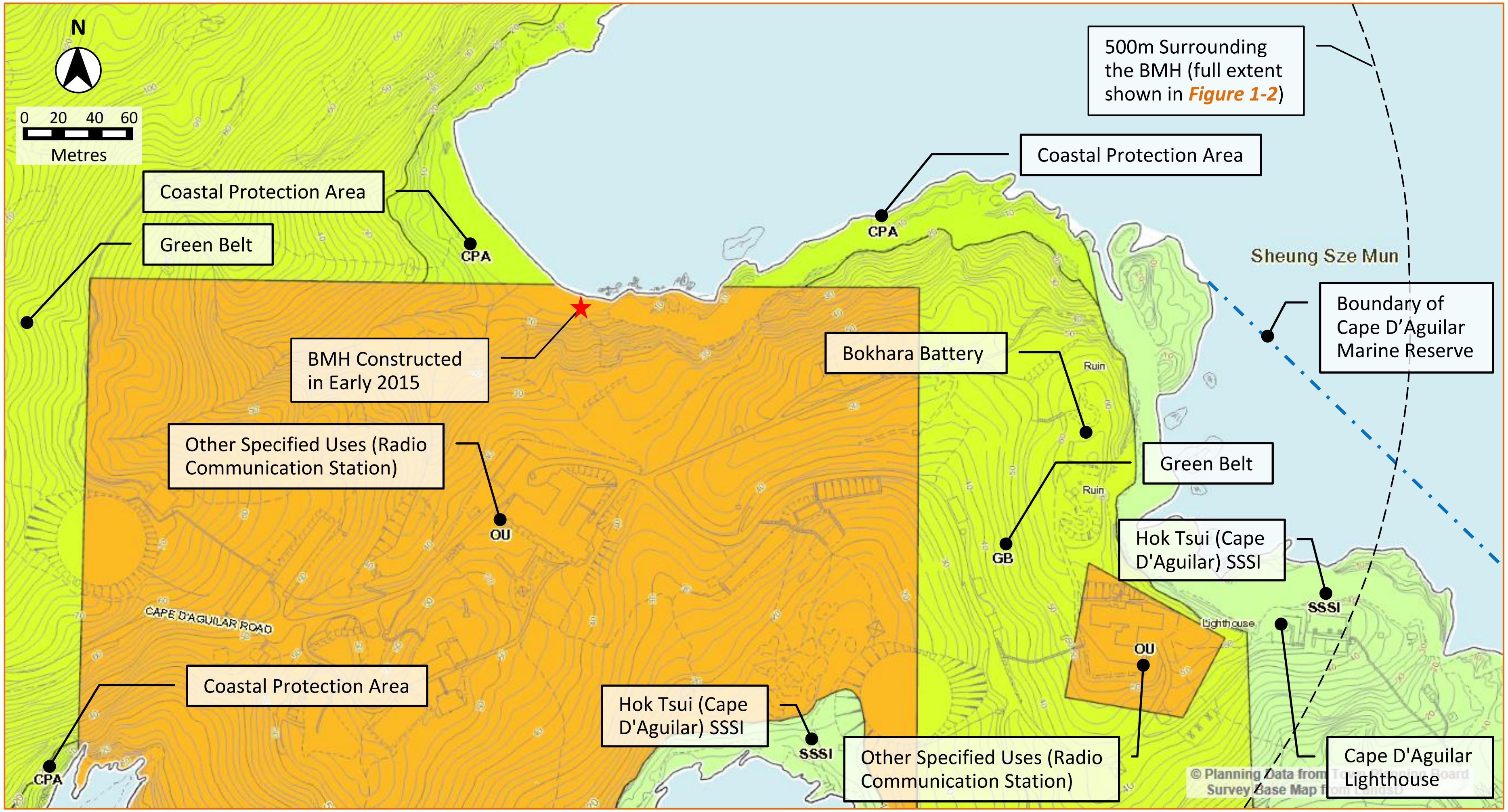
Source: Based on Tai Tam and Shek O OZP No. S/H18/10 from Town Planning Board Statutory Planning Portal 2 (http://www2.ozp.tpb.gov.hk/gos/default.aspx)

Figure 1-3 AAE-1 Submarine Cable (Hong Kong Section) Optimum Alignment to Cape D'Aguilar



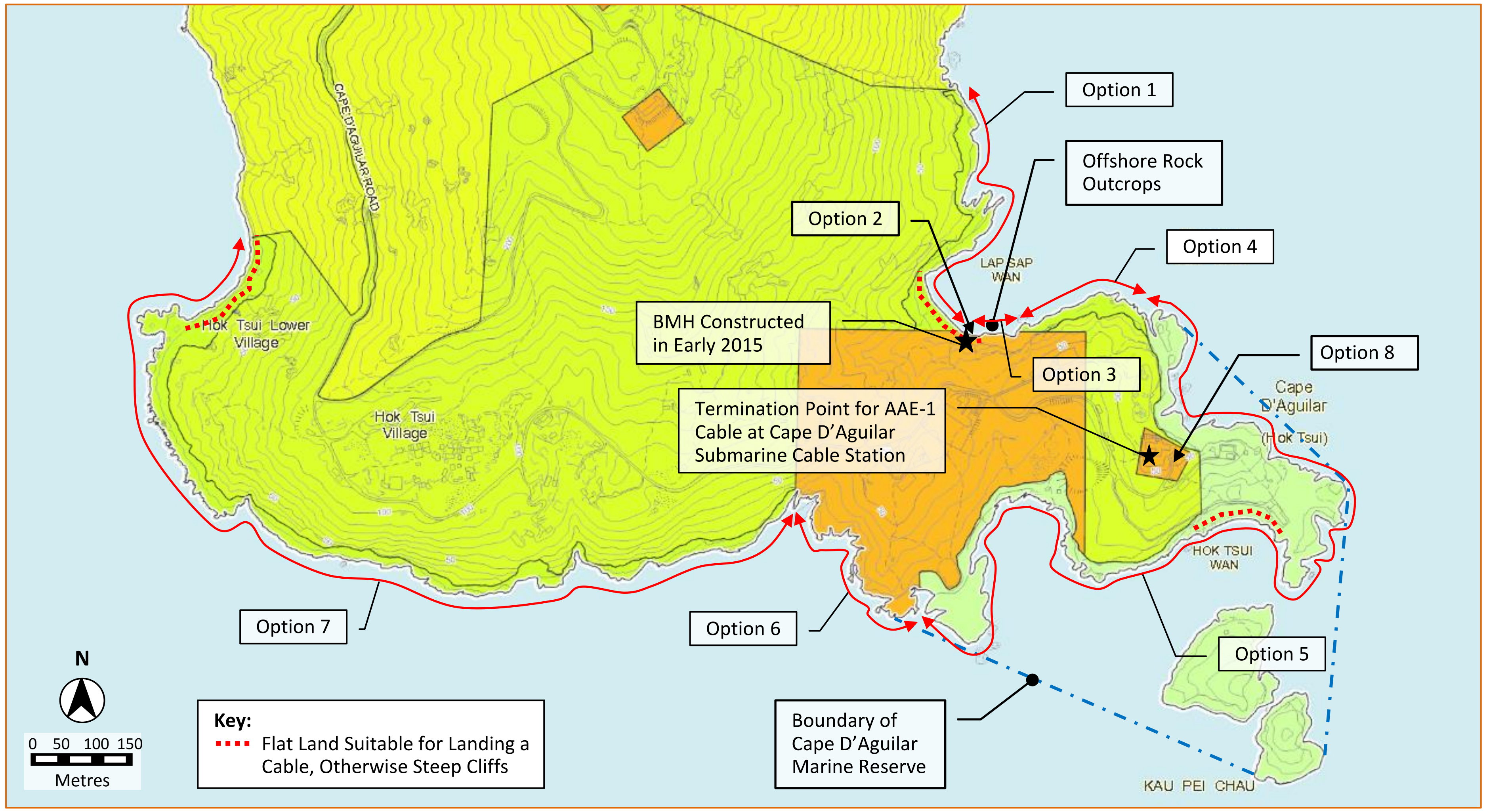
\\hksmecdf01\share\jobs\7076341 - oms - eiao and fsro support for aae-1 cable at cape d'aguilar\08 submission\3. project profile\rev 3.0 final to epd\english\7076341 aae-1 cable project profile v3.0 main text (final 29jan16).docx

Figure 1-4 Landuse and Other Features Within Cape D'Aguilar Peninsula



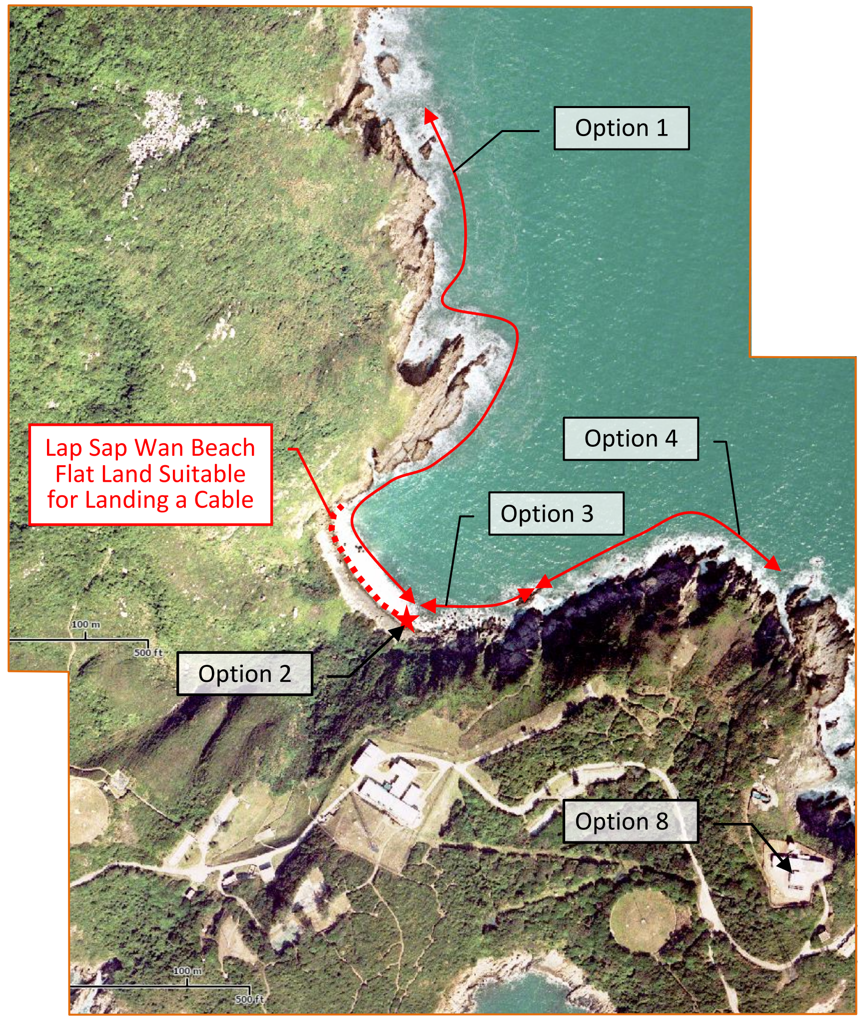
Source: Based on Tai Tam and Shek O OZP No. S/H18/10 from Town Planning Board Statutory Planning Portal 2 (http://www2.ozp.tpb.gov.hk/gos/default.aspx)

Figure 1-5 Alternative Options for Landing Point at Cape D'Aguilar

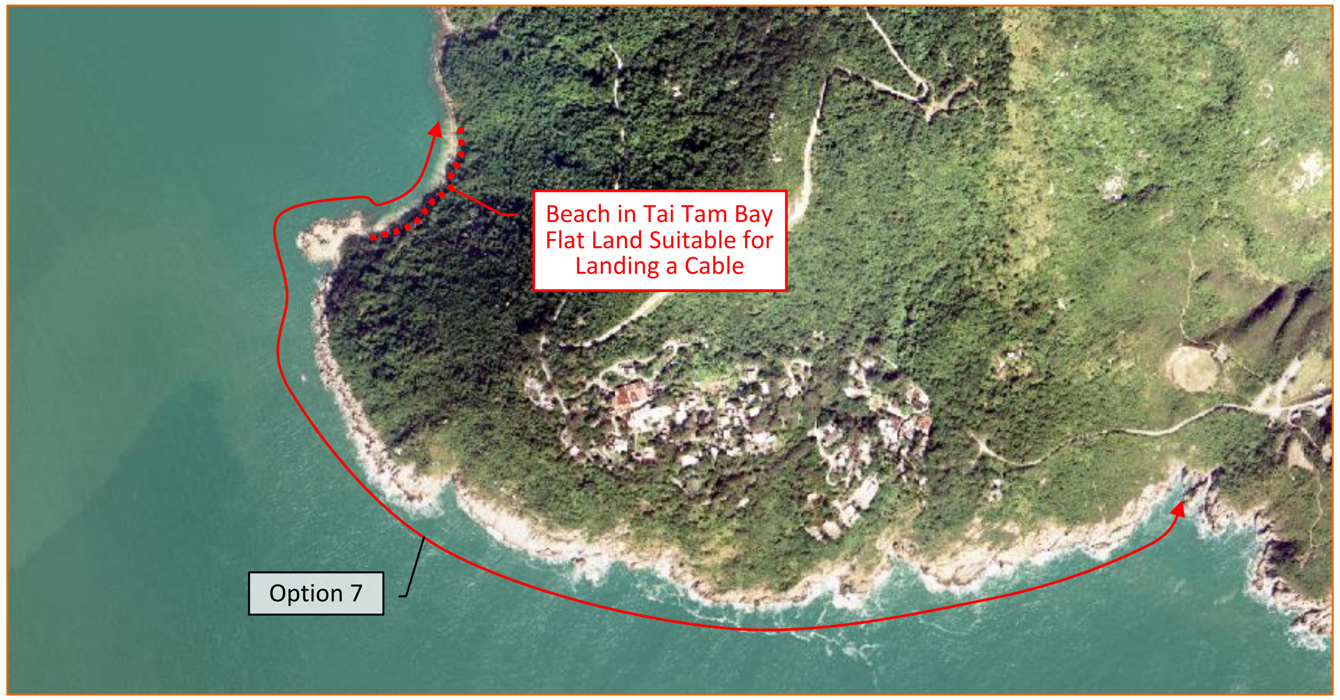


Source: Based on Tai Tam and Shek O OZP No. S/H18/10 from PlanD Statutory Planning Portal 2 (http://www2.ozp.tpb.gov.hk/gos/default.aspx)

Options 1, 2, 3, 4 and 8 – All Steep Cliffs Except Where Flat Land Indicated



Option 7 – All Steep Cliffs Except Where Flat Land Indicated



Options 5 and 6 – All Steep Cliffs Except Where Flat Land Indicated

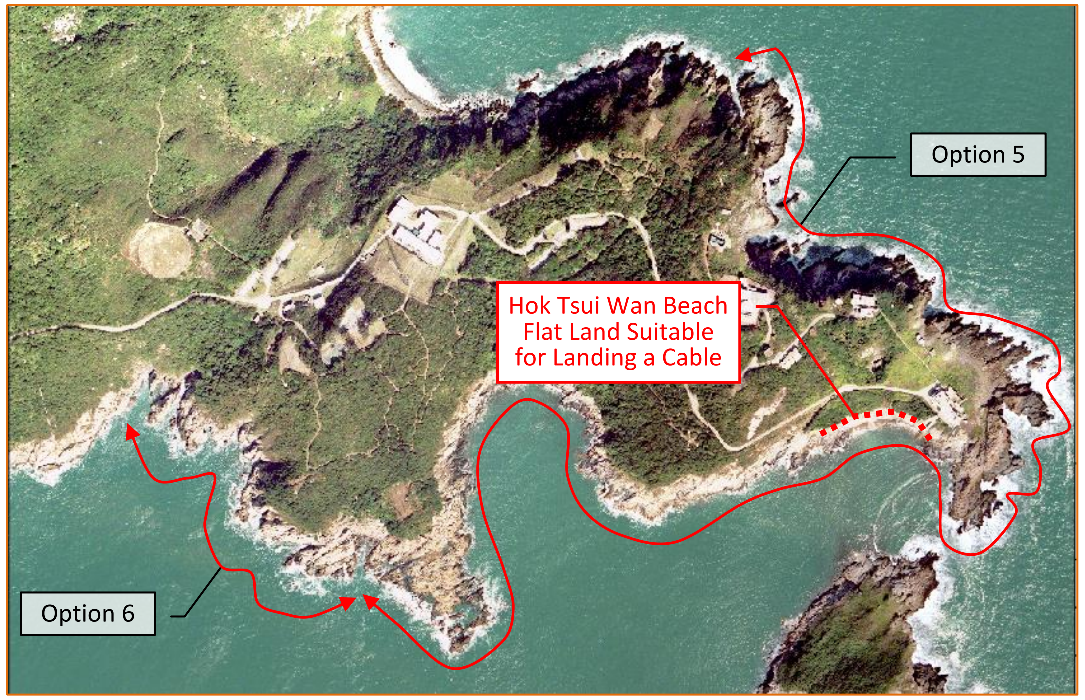
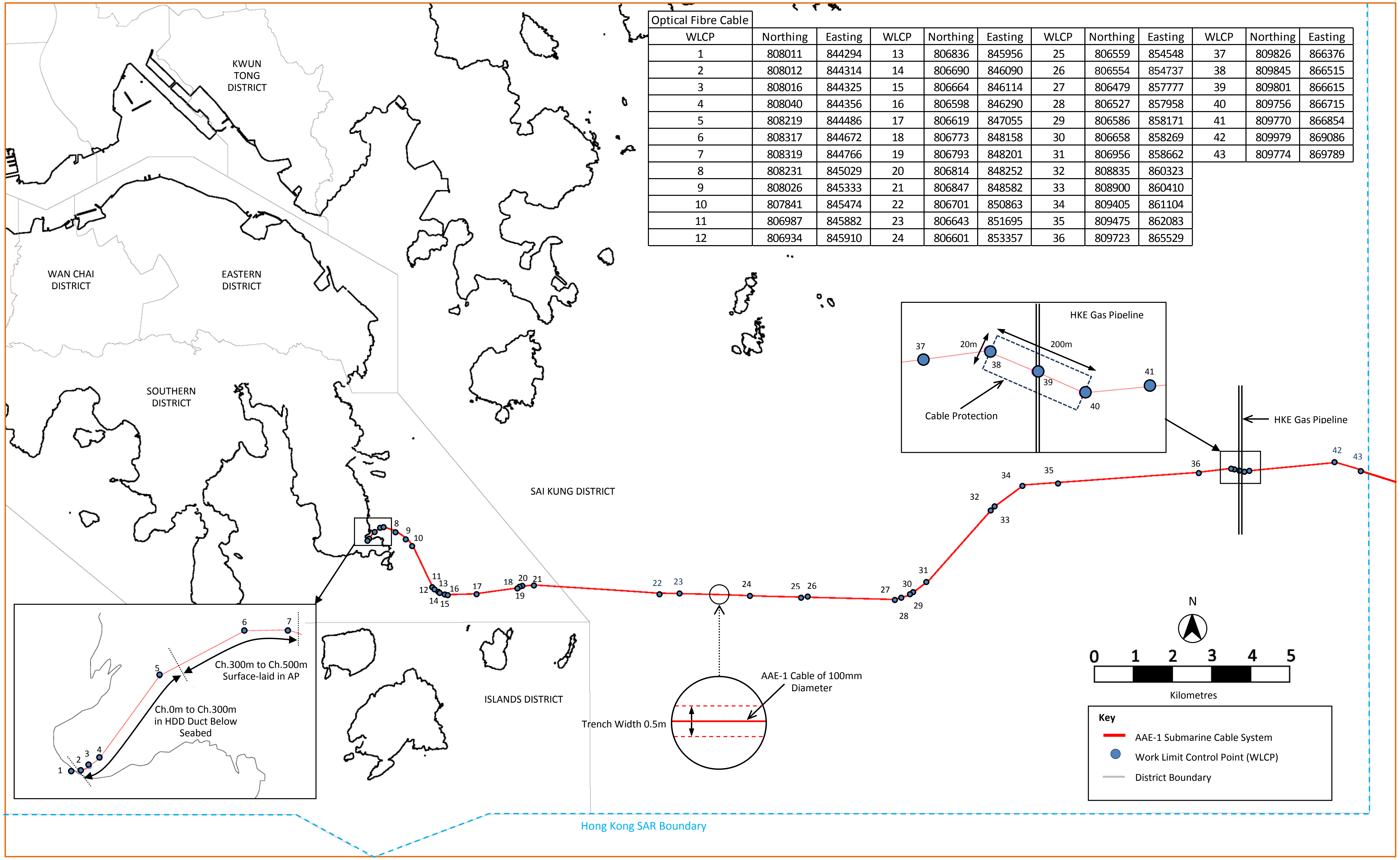


Figure 1-6 AAE-1 Submarine Cable (Hong Kong Section) Plan of Selected Alignment and Preferred Landing Point



Optical Fibre Cable

WLCP	Northing	Easting	WLCP	Northing	Easting	WLCP	Northing	Easting	WLCP	Northing	Easting
1	808011	844294	13	806836	845956	25	806559	854548	37	809826	866376
2	808012	844314	14	806690	846090	26	806554	854737	38	809845	866515
3	808016	844325	15	806664	846114	27	806479	857777	39	809801	866615
4	808040	844356	16	806598	846290	28	806527	857958	40	809756	866715
5	808219	844486	17	806619	847055	29	806586	858171	41	809770	866854
6	808317	844672	18	806773	848158	30	806658	858269	42	809979	869086
7	808319	844766	19	806793	848201	31	806956	858662	43	809774	869789
8	808231	845029	20	806814	848252	32	808835	860323			
9	808026	845333	21	806847	848582	33	808900	860410			
10	807841	845474	22	806701	850863	34	809405	861104			
11	806987	845882	23	806643	851695	35	809475	862083			
12	806934	845910	24	806601	853357	36	809723	865529			

Figure 1-7 Cable Installation Methods for the AAE-1 Cable

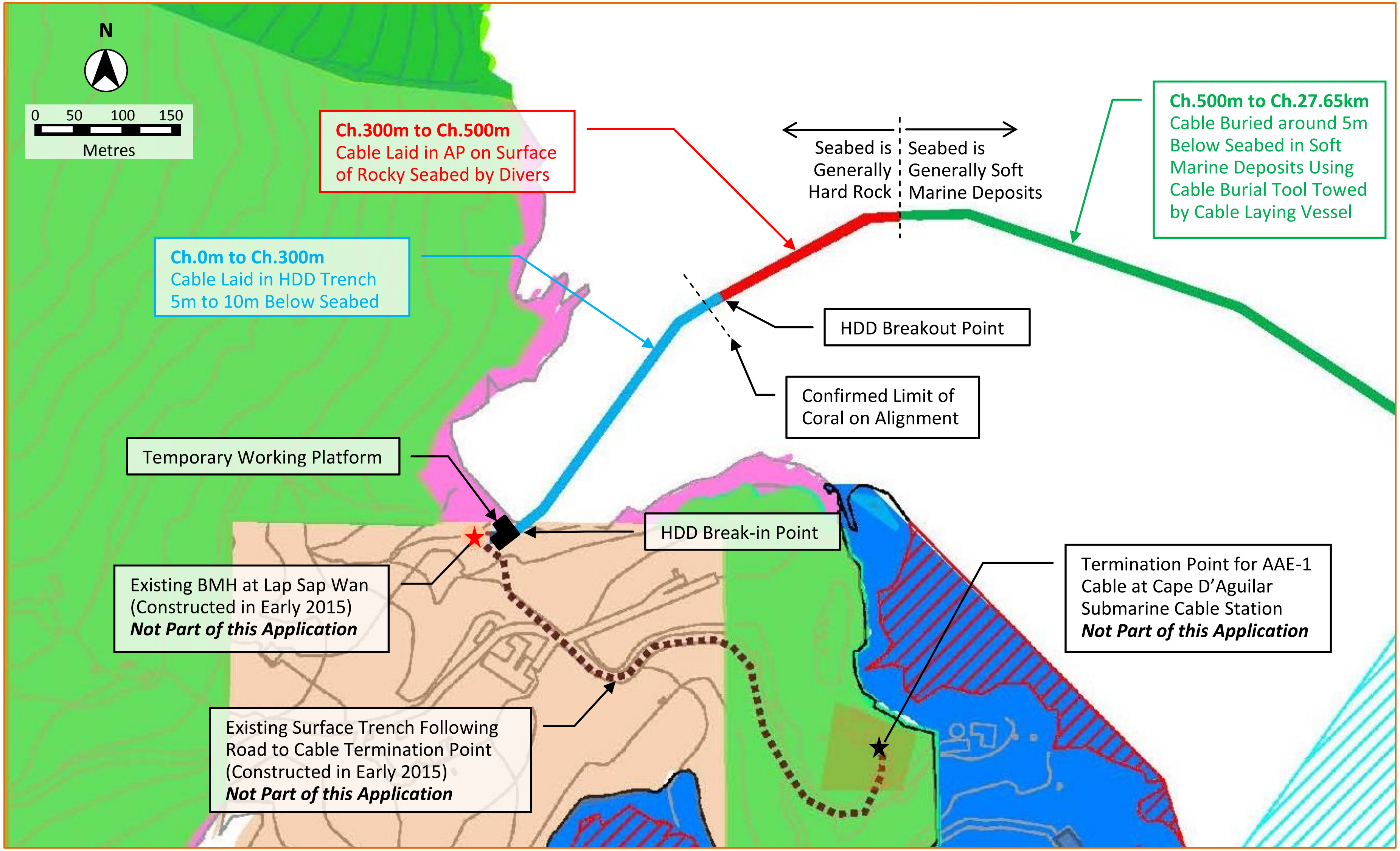


Figure 1-8 Lap Sap Wan Landing Point – Photographs

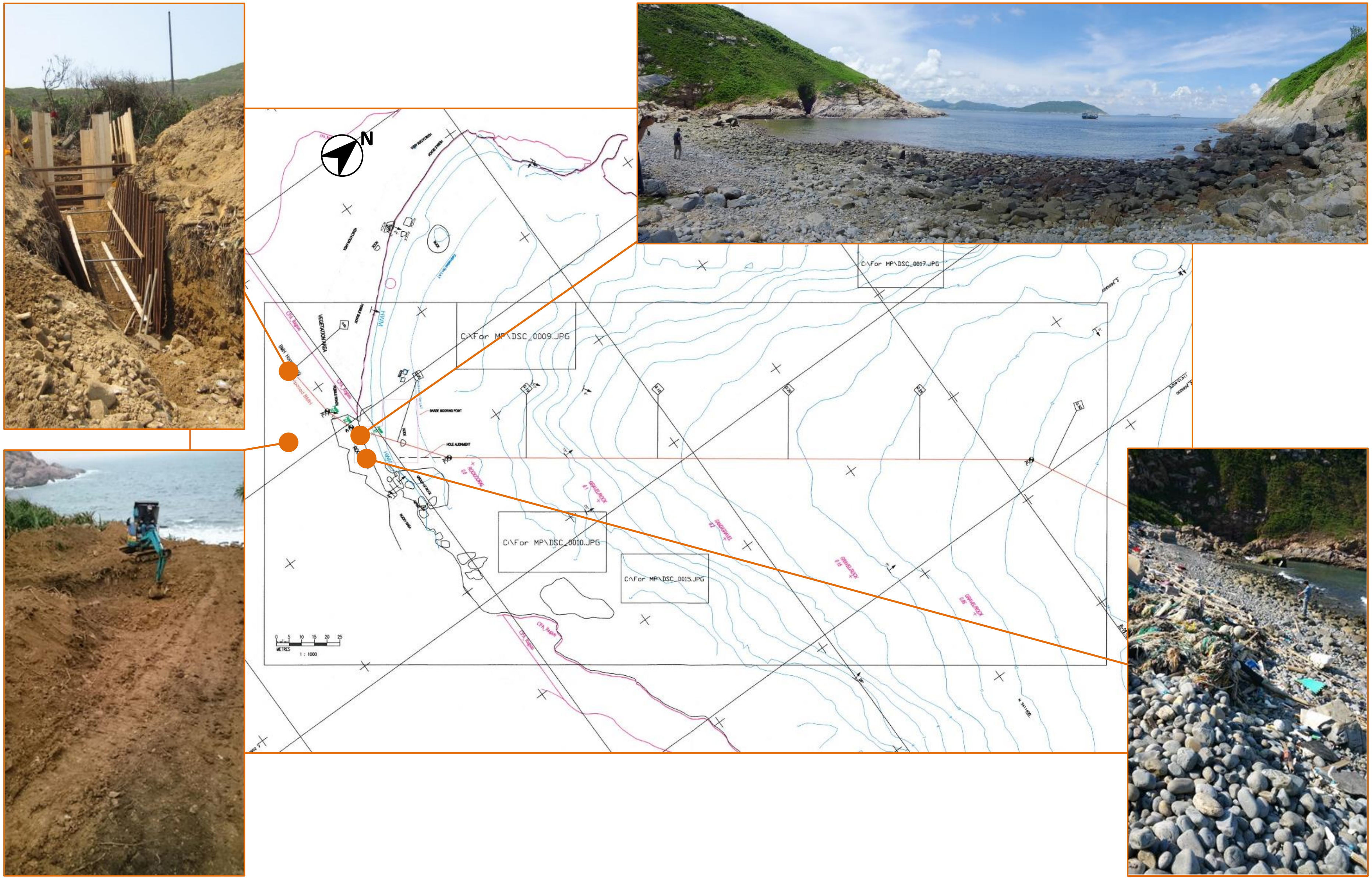


Figure 1-9 Location of Temporary Working Platform at Lap Sap Wan

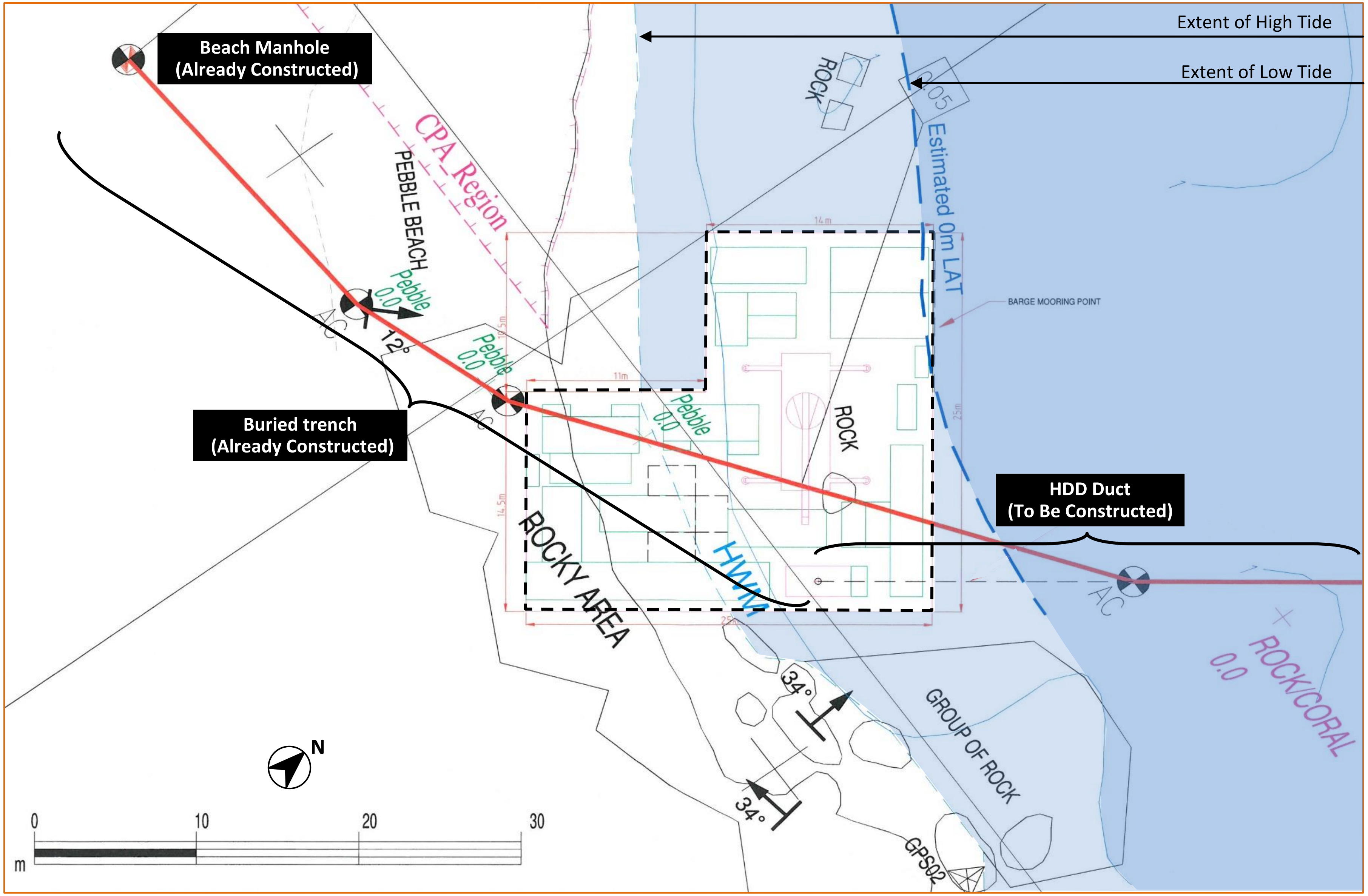


Figure 1-10 Proposed Arrangement of HDD Plant and Equipment on Temporary Working Platform

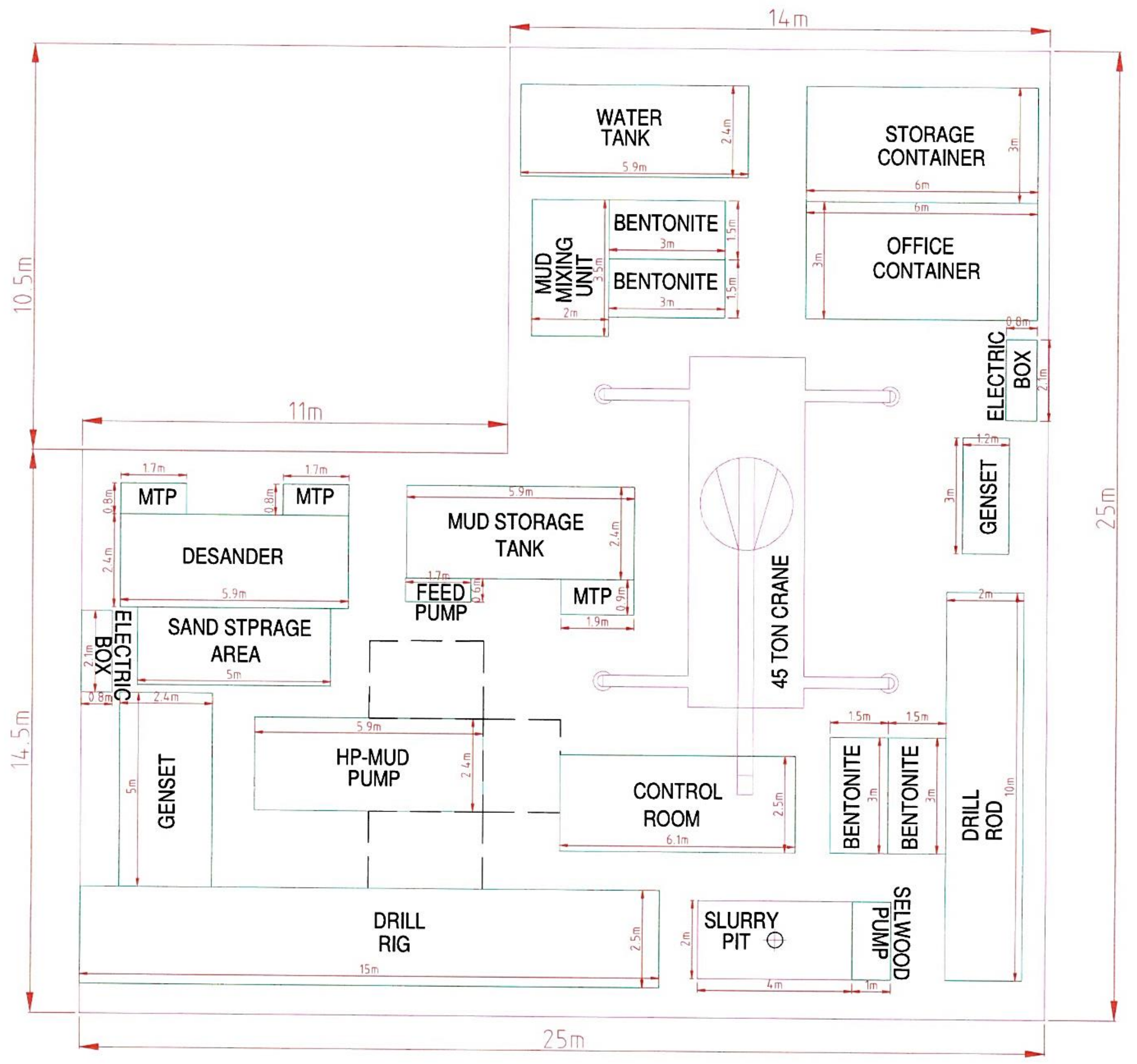
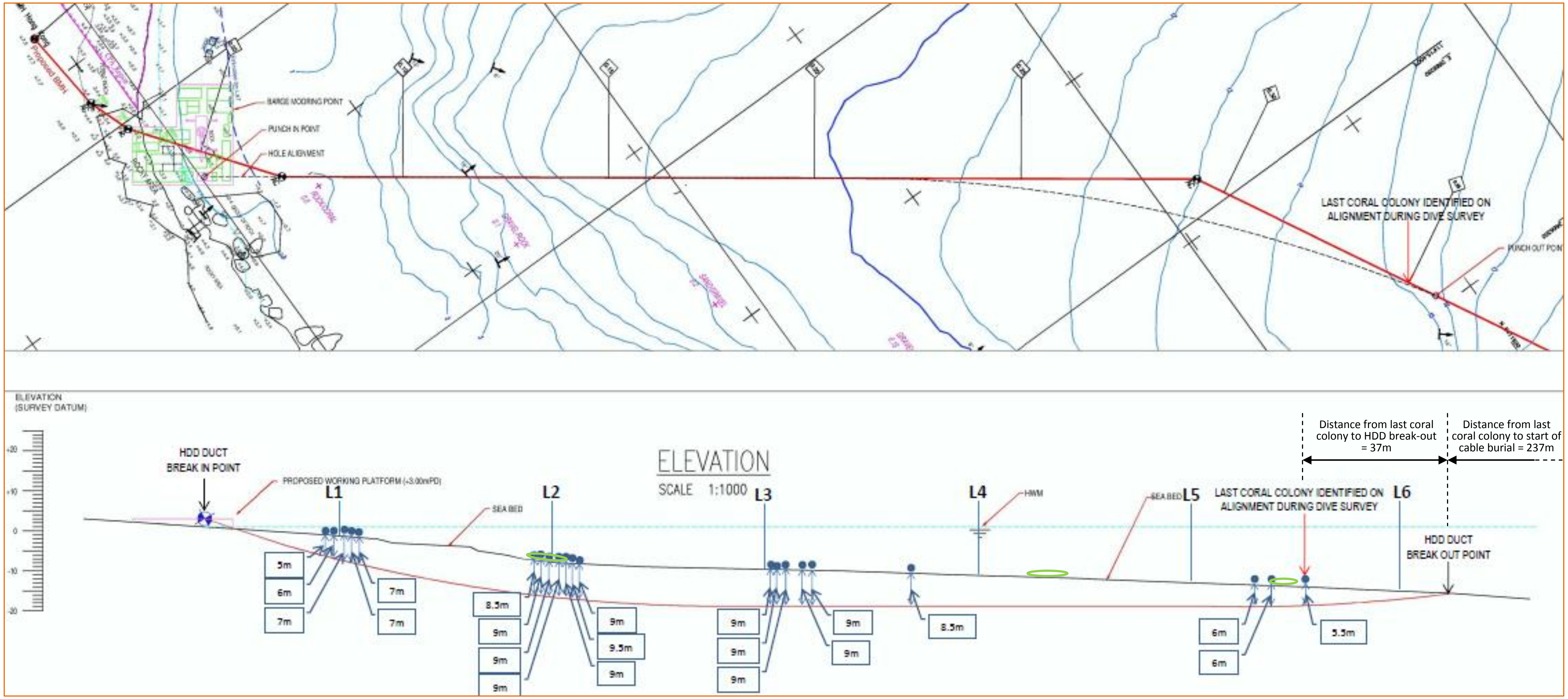


Figure 1-11 Vertical Profile/Trajectory of HDD Cable Duct



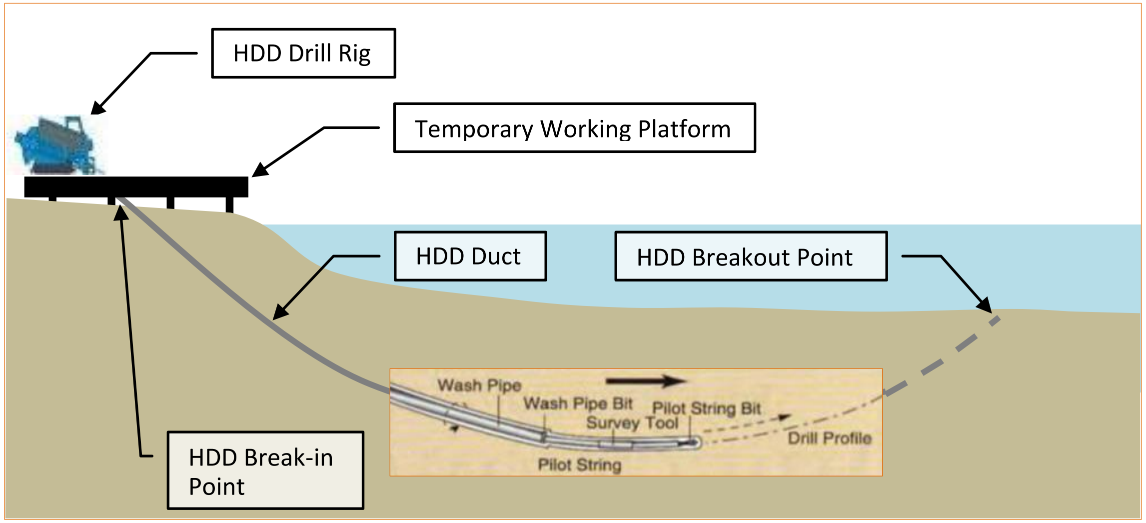
Key:

- ● Indicative location of coral colonies – none identified beyond HDD Duct break-out point (based on dive survey to Ch.500m)
- [5m] Vertical distance between HDD cable duct and seabed surface
- ⬭ Indicative location of Amphioxus – none identified beyond HDD Duct break-out point (based on benthic survey and dive survey to Ch.500m)
- **L1 –L6** Dive survey transects

(see *Annex B* for further details)

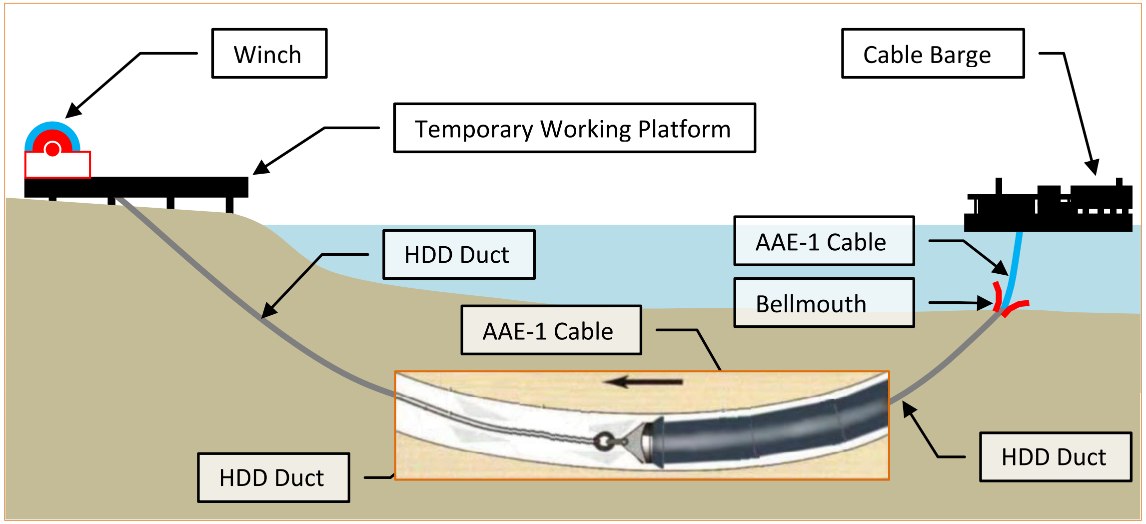
Figure 1-12 HDD In Operation

Drilling the Horizontal Duct from the Break-in Point



Inclined HDD Drill Rig

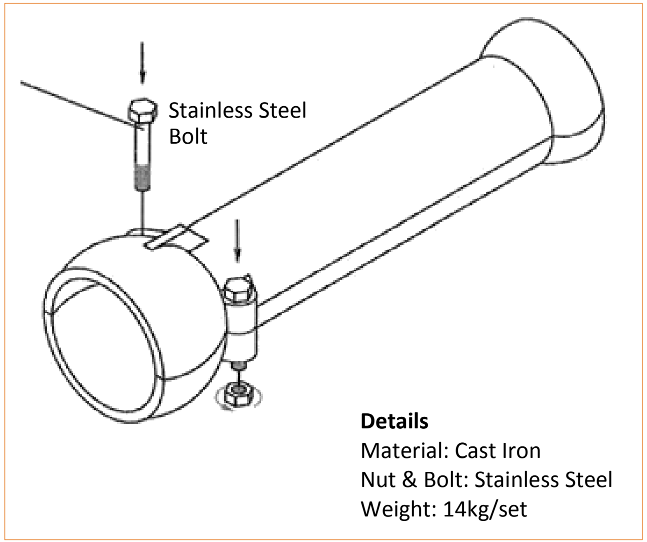
Pulling the Cable Through from the Breakout Point to the Break-in Point



View of the Break-in Point (Drill Rig in Foreground)

Figure 1-13 Articulated Pipe Specifications and Possible Cable Protection Measures at Crossing Locations

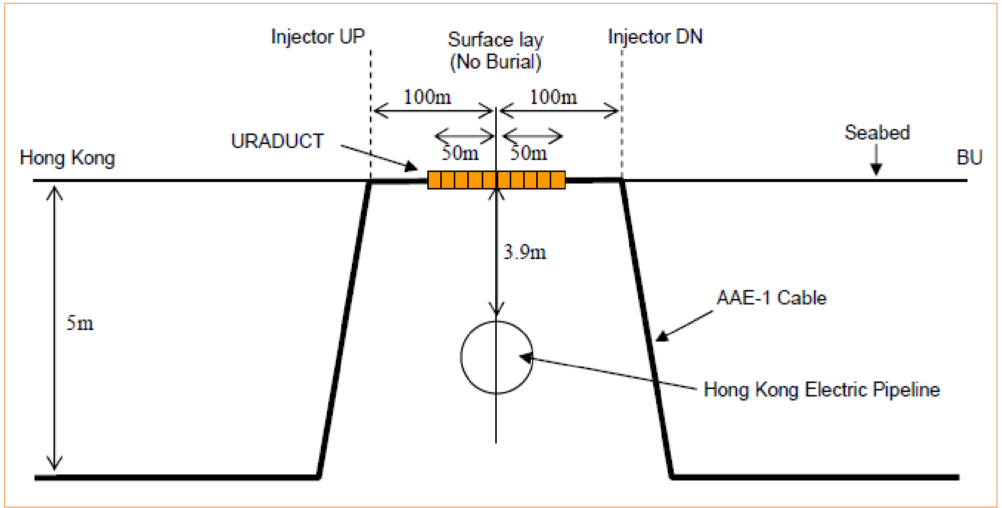
Articulated Pipe – Typical Specifications



Diver Installation of AP on Seabed

AP on Laid on Seabed

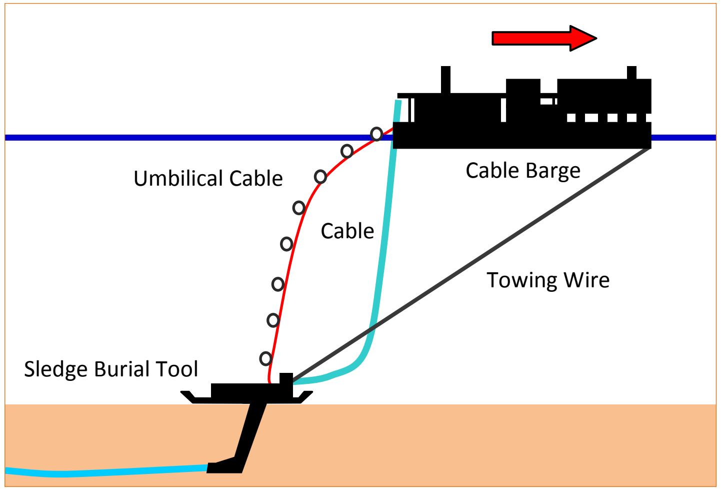
Installation of Uraduct Above HKE Gas Pipeline



Uraduct

Figure 1-14 Examples of Cable Laying Vessels and Burial Tools

Simultaneous Cable Laying and Burial Operation (Sledge Tool)

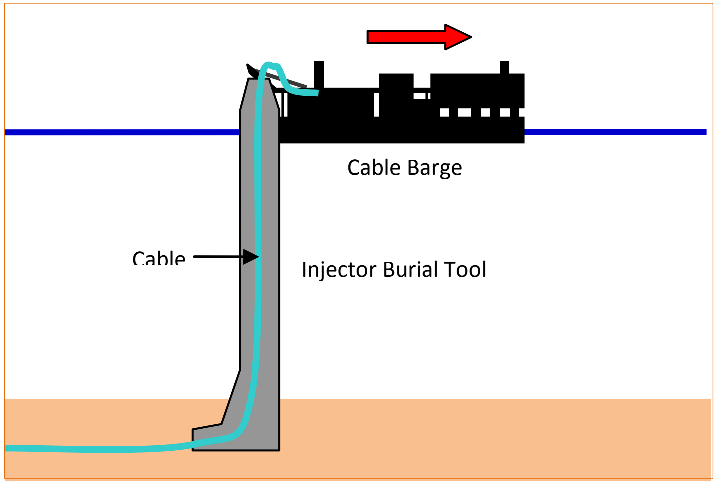


Typical Sledge Tool

Typical Cable Installation Barge (Sledge Tool)

Typical Injector Tool

Simultaneous Cable Laying and Burial Operation (Injector Tool)



Typical Cable Installation Barge (Injector Tool)

2 OUTLINE OF PLANNING AND IMPLEMENTATION PROGRAMME

2.1 Project Planning and Implementation

2.1.1 The Project is to be led, planned and managed by the Project Proponent, PCCWG. To assist in project planning and implementation, PCCWG has engaged:

- Consultants to:
  - obtain gazettal under the Seabed and Foreshore (Reclamation) Ordinance (FSRO) and liaise with Lands Department (LandsD) and District Councils (DCs).
  - address marine traffic issues and liaise with Marine Department.
- Contractors to:
  - carry out the HDD works.
  - carry out the cable laying works.
  - provide environmental monitoring and audit.

2.2 Project Programme

2.2.1 The original cable-laying operation in Lap Sap Wan was targeted to commence in April 2016 in order to meet the committed system "Ready For Service" date of November 2016. However, as the cable installation method is now changed to HDD to avoid impacts to corals, the cable laying operation is re-scheduled upon completion of the HDD works. The AAE-1 cable system is provisionally scheduled to be landed and installed in the second quarter of 2016, upon completion of the HDD works in Lap Sap Wan. The expected installation schedule (maximum no. working days) within Hong Kong is as follows:

- Construction of Platform + Mobilisation of HDD — 56 days
- HDD Works — 56 days
- Demobilisation of HDD Equipment + Removal of Platform — 42 days
- Cable Landing via HDD duct (0m to 300m) — 7 days
- Seabed Surface Laying in AP by Diver (300m to 500m) — 21 days
- Offshore Cable Installation (500m onwards) — 28 days
- Cable Protection Work (at HKE Gas Pipeline Crossing) — <7 days

2.2.2 The installation of the cable is expected to take approximately six to eight weeks to complete, excluding the works related to HDD.

2.3 Interactions with Other Projects

2.3.1 The *Offshore Wind Farm in Southeastern Waters* is planned to the north of the AAE-1 Cable, but according to CLP this project is currently at the feasibility study stage. Activities include engineering studies, collection of environmental data and stakeholder consultation. There is no firm date for the commencement of this project. The cable section of this project is therefore not likely to be installed until AFTER the expected completion of works for the AAE-1 Cable. As such, no interaction is envisaged.

3 MAJOR ELEMENTS OF THE SURROUNDING ENVIRONMENT

3.1 Cable, Pipelines, Outfalls and Intakes

3.1.1 There are a number of utilities located in the vicinity of the AAE-1 Cable alignment and these include:

- **Communication Cables.** There are four existing in-service cables and one planned telecommunication cable to be constructed near the project area:
  - EAC System. Three in-service cables landing at TKOIE to the north of the Project.
  - ASE System. One in-service cable parallel to the AAE-1 Cable above Waglan Island, landing within one of the existing ducts at TKOIE.
  - APG System. One planned cable system parallel to the AAE-1 Cable above Waglan Island, to be installed and landed within one of the existing ducts at TKOIE (expected to be installed late-2015).
- **Electrical Cables.** There are no existing electricity cables located in the vicinity of the AAE-1 Cable, however, there may be a future submarine electricity cable that is part of the proposed "*Hong Kong Offshore Wind Farm in Southeastern Waters*" (FEP-01/34/2009). Based on discussions with CLP, the expected timing of the cable construction is expected to occur after the AAE-1 Cable is installed.
- **Pipelines and Outfalls.** No sewer outfalls are located in the vicinity of the AAE-1 Cable alignment.
- **Seawater Intakes.** There are none in the vicinity of the AAE-1 Cable.

3.2 Designated Areas

3.2.1 There are a number of areas with special planning designation located in the vicinity of the AAE-1 Cable and these include:

- **Coastal Protection Area (CPA).** The coastline of Cape D'Aguilar includes a variety of intertidal and shallow subtidal habitats including exposed and semi-exposed rocky shores, large rock pools and subtidal rocky reef with a high diversity of hard corals and coral fishes. Much of this coastline is zoned as CPA. The intention of this zoning is to "to conserve, protect and retain the natural coastlines and the sensitive coastal natural environment, including attractive geological features, physical landform or area of high landscape, scenic or ecological value, with a minimum of build development". It should be noted, however, that the landing site at Lap Sap Wan is not zoned as CPA and there are no works associated with this Project within the CPA.
- **Gazetted Bathing Beaches.** The closest Gazetted Bathing Beaches are Big Wave Bay, Rocky Bay Beach and Shek O Beach. The AAE-1 Cable is around 3.9km, 2km and 1.2km from these three beaches, respectively. Due to this distance, the Gazetted Bathing Beaches will not be affected by the Project.

- **Marine Reserve.** The closest Marine Reserve is Cape D'Aguilar Marine Reserve, which is approximately 215m from the closest part of the AAE-1 Cable. The Marine Reserve occupies about 20ha of sea area around Cape D'Aguilar and was declared by Government in July 1996 for the purpose of conservation of marine resources, scientific studies and public education for the appreciation of precious marine resources. The AAE-1 Cable will not enter the Marine Reserve at any point and so the integrity of the Marine Reserve is not affected by the Project.
- **Site of Special Scientific Interest (SSSI).** The closest SSSI is Hok Tsui (Cape D'Aguilar) SSSI, which is approximately 215m from the closest part of the AAE-1 Cable. The area of sea covered by this SSSI is mostly the same as that protected under the Cape D'Aguilar Marine Reserve, discussed above.

3.3 Coral Communities

3.3.1 According to *Ecological Status and Revised Species Records of Hong Kong's Scleractinian Corals* (AFCD, 2004), a total of 28 hard coral species were recorded in the nearby Cape D'Aguilar Marine Reserve, which was less than the species numbers of the three then-existing Marine Parks, but is still comparatively high in diversity this part of Hong Kong.

3.3.2 Extensive coral dive surveys have been carried out in Lap Sap Wan as part of this Project and have confirmed extensive coral coverage out to around 275m from shore, due to the presence of extensive hard substrate, including the rocky seabed and large boulders.

3.4 Fish Culture Zone (FCZ)

3.4.1 The nearest Fish Culture Zones (FCZ) are the Tung Lung Chau FCZ and Po Toi FCZ, which are approximately 5.2km and 4.9km from the nearest part of the AAE-1 Cable. Due to this distance, the FCZs will not be affected by the Project.

3.5 Cultural Heritage

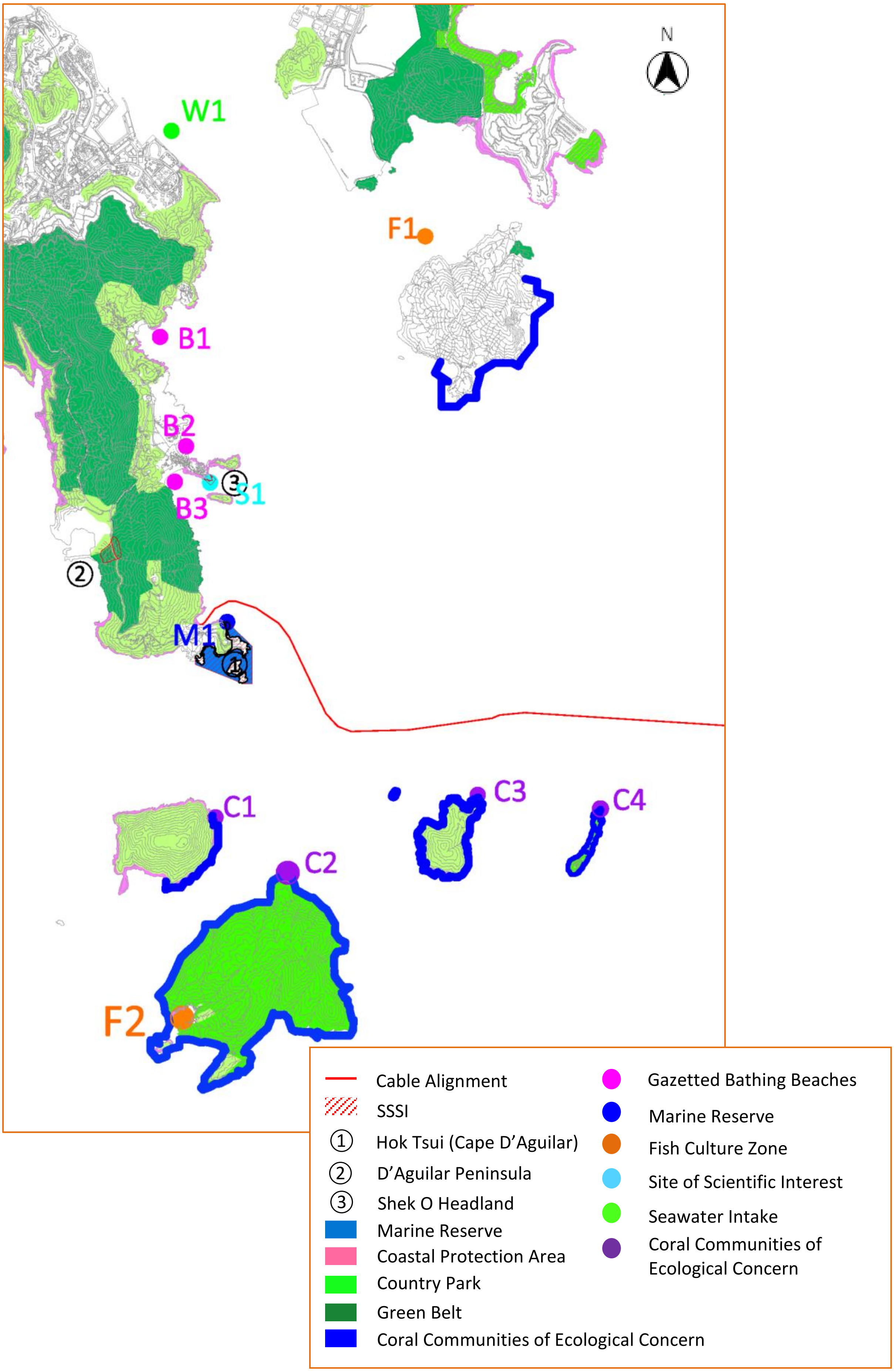
3.5.1 According to the list of *Declared Monuments in Hong Kong*, maintained by the Antiquities and Monuments Office (AMO) there is one declared monument located within 500m from the Project, namely Cape D'Aguilar Lighthouse. Furthermore, there are also two Grade 2 historic buildings located within 500m of the Project, namely Cape D'Aguilar Battery and Bokhara Battery.

3.5.2 Given that the Project comprises installation of a submarine cable, there may be artefacts with archaeological potential located on or beneath the seabed along the alignment of the cable.

3.6 Cumulative Impacts from Other Projects

3.6.1 The *Offshore Wind Farm in Southeastern Waters* is planned to the north of the AAE-1 Cable, but according to CLP this project is currently at the feasibility study stage. Activities include engineering studies, collection of environmental data and stakeholder consultation. There is no firm date for the commencement of this project. The cable section of this project is therefore not likely to be installed until AFTER the expected completion of works for the AAE-1 Cable. As such, no cumulative impact is envisaged.

Figure 3-1 Major Elements of the Surrounding Environment



4 POSSIBLE IMPACTS ON THE ENVIRONMENT

4.1 Summary of Potential Environmental Impacts

4.1.1 The potential environmental impacts associated with the cable system are summarised in *Table 4-1* below and likely impacts are assessed in the following sub-sections.

Table 4-1 Summary of Potential Environmental Impacts During Installation

Potential Installation Impacts	Construction	Operation	Remarks
Gaseous Emissions	✗	✗	No significant emissions
Dust	✗	✗	No significant emissions
Odour	✗	✗	No significant emissions
Noisy Operations	✗	✗	No sensitive receivers
Night-time Operations	✗	✗	Not required
Traffic Generation	✗	✗	Not anticipated – no roads
Liquid Effluents, Discharges, or Contaminated Runoff	✓	✗	Possible chance of surface water run-off from HDD works at Lap Sap Wan
Generation of Waste or By-products	✓	✗	Excavated materials from HDD works
Manufacturing, Storage, Use, Handling, Transport, or Disposal of Dangerous Goods, Hazardous Materials or Wastes	✗	✗	Not anticipated
Risk of Accidents Which Result in Pollution or Hazard	✗	✗	Not anticipated
Disposal of Spoil Material, Including Potentially Contaminated Materials	✗	✗	No contaminated mud and no disposal of spoil anticipated
Disruption of Water Movement or Bottom Sediment	✓	✗	Will occur during cable burial
Unsightly Visual Appearance	✗	✗	Not anticipated
Ecological Impacts:			
- Terrestrial	✗	✗	Not anticipated
- Inter-tidal	✗	✗	Not anticipated as HDD used
- Marine	✓	✗	Impacts along alignment and possibly at Cape D'Aguilar Marine Reserve/Hok Tsui (Cape D'Aguilar) SSSI
- Fisheries	✓	✗	Potential impacts along the alignment
Cultural Heritage Impacts:	✓	✗	Not anticipated for terrestrial sites, but there is potential marine archaeological impact

Key: ✓ = Potential to result in adverse impacts
✗ = Not expected to result in adverse impacts

4.1.2 This Project Profile will therefore comprise assessments of those potential impacts likely to occur, as identified by "✓" above:

4.2 Water Quality

4.2.1 A water quality assessment has been carried out and is provided in ***Annex A***. A summary is provided below.

4.2.2 Cable installation will involve the following activities that have the potential to generate suspended solids:

- **HDD Works Near the BMH at Lap Sap Wan.** Run-off from shore based HDD works at Lap Sap Wan duct construction.
- **HDD Seabed Breakout Point**. HDD equipment recovery and cable insertion through the bell mouth at the breakout point about Ch.300m offshore.
- **Surface Laying of Cable in AP by Divers.** Surface laying of cable directly on the rocky seabed inside AP protection, secured by pinning onto the seabed, from Ch.300m to Ch.500m.
- **Marine Installation by Cable Burial Tool.** Cable burial in marine deposits by cable burial tool from Ch.500m to Ch.27.65km.
- **Diver-assisted Protection at Cable and Pipeline Crossings.** Shallow burial by divers using hand-held equipment at cable crossings and at HKE Gas Pipeline crossing.

HDD Works Near the BMH at Lap Sap Wan

4.2.3 The potential impacts to water quality during the HDD works relate to surface water run-off from the Working Platform and loss of materials stored on the Working Platform.

4.2.4 Run-off can be controlled to acceptable environmental standards through the application of standard mitigation measures and good site practice, discussed under "Mitigation Measures", below.

4.2.5 There will be no discharge of HDD fluid muds associated with the project and drilling fluids will be recirculated through an on-site treatment system and will be tankered off-site upon completion of drilling.

4.2.6 No unacceptable impacts predicted to occur during the pit and duct construction at Lap Sap Wan Landing Site provided that standard mitigation measures and good site practice are adopted.

HDD Seabed Breakout Point

4.2.7 During construction of the marine duct breakout point, the drill hole will stop 5m from the surface and purged to ensure that the drilling cuttings and fluid do not break out in the marine environment. The drill hole will then be purged with water and the remaining 5m will be slowly drilled through and will be monitored from the marine vessel until the drill wire is near the surface. Divers will then be deployed with hand held jets to retrieve the drill wire and the cutter. A bell mouth will then be installed and the cable will then be winched through the cable duct.

4.2.8 This installation process will be carefully controlled by divers in the water. Suspended solids generated during the diver assisted installation are expected to be localised and short term in duration. A person in a vessel will be stationed along the drill route during drilling operations to assist with the detection of any escape of fluid.

4.2.9 Only minimal disturbance to water quality is expected and so the HDD process will not significantly affect the marine environment. No specific mitigation measures are required.

Surface Laying of Cable in AP by Divers

4.2.10 As the seabed where AP will be installed is rocky, there will be very little silt to disturb. While the pinning of the AP to the seabed requires drilling holes in the rock for the bolts, the rock fines released from the drilling will not become suspended in the water column but will immediately settle. As such, no water quality impacts are anticipated from the AP installation by divers.

Marine Installation by Cable Burial Tool

4.2.11 The majority of the cable will be installed using a cable burial tool to install the AAE-1 Cable at a target burial depth of 3m to 5m below the seabed. This installation method, which uses jetting techniques, has been used on most previous cable installation projects in Hong Kong waters without adverse water quality impact.

4.2.12 Prior to the cable installation the seabed will be checked with the tool to ensure there are no obstructions to cable installation. This will include a pre run of the cable route with the burial tool employed at shallow depth to ensure the seabed surface is clear. No unacceptable water quality impacts are expected to occur from this Route Clearance Operation (RC) and Pre-lay Grapnel Run (PLGR).

4.2.13 This is then followed by the cable installation where the cable burial tool is lowered onto the seabed and is placed at the desired burial depth. During the cable laying process the cable burial tool will fluidise the sediment at the burial depth level to assist with the laying process and the cable is simultaneously laid and buried. The installation tool is no more than 500mm in width and only minimal disturbance is anticipated to the seabed.

4.2.14 To account for site-specific current velocities in the waters surrounding the Cape D'Aguilar Peninsula, current data has been obtained from Marine Department (MD) for stations close to the Cape D'Aguilar Peninsula. Calculations (in ***Annex A***) show that from Ch.500m to approx. Ch.2.5km (where the AAE-1 Cable will be buried in proximity to Cape D'Aguilar Peninsula outside the established east-west cable corridor) any disturbed sediments will settle back onto the seabed within 60m of the cable alignment in less than 3.5 minutes – this smaller settlement distance is primarily due to the significantly lower current velocities indicated in the MD current data.

4.2.15 Where the AAE-1 Cable enters the established east-west cable corridor, current velocities have been adopted from approved Project Profiles for other cables that were also buried in the established east-west cable corridor. Calculations (in ***Annex A***) show that from approx. Ch.2.5km to Ch.27.65km (where the AAE-1 Cable will be buried in the established east-west cable corridor) any disturbed sediments will settle back onto the seabed within 180m of the cable alignment in less than 3.5 minutes.

4.2.16 All Water Sensitive Receivers (WSRs) in the vicinity of the Cape D'Aguilar Peninsula are located more than 60m from the alignment and so with the provision of a silt curtain as precautionary measure it is not anticipated that cable laying works will cause significant impacts to these WSRs – Cape D'Aguilar Marine Reserve is 215m from the AAE-1 Cable at its closest point. Other WSRs, including gazetted bathing beaches, FCZs, and seawater intakes range from 1.2km to 6.2km and so will not be affected by either the predicted 60m or 180m sediment settlement distances.

Diver-assisted Protection at Cable and Pipeline Crossings

4.2.17 Diver assisted burial will be required when the AAE-1 Cable has to cross the HKE Gas Pipeline, which is buried around 3m below the seabed. To avoid any interference with this pipeline, around 100m from the pipeline the AAE-1 cable will rise to the surface of the seabed and will be laid over the top of the pipeline. At the surface, the AAE-1 Cable will be protected by "Uraduct", AP or similar.

4.2.18 To locate the exact position of the pipeline, a tone/magnet detector survey or diver survey by vessel with air-lifting/jetting will be conducted. As the pipeline is believed to be buried more than 2.5m deep, location will be performed by diver.

4.2.19 It is anticipated that the burying by divers will not cause significant water quality impacts as only a small area will be disturbed (short lengths of approximately 20 to 30m) and the burial depth will be shallower for these area (around 2m).

4.2.20 Calculations indicates that the sediments disturbed during diver-assisted burial will settle onto the seabed within approximately 180m of the cable alignment and will settle within about 3.5 minutes.

Mitigation Measures

4.2.21 During cable installation the following mitigation measures will be undertaken:

- Any stockpiles will be covered with tarpaulin to minimise run off from rainfall.
- All construction waste and discharge from the Temporary Working Platform will be handled and disposed of in accordance with the *Practice Notes for Professional Persons, Construction Site Drainage* (ProPECC PN1/94).
- Best Management Practices (BMPs) will be applied to avoid and minimise contaminated runoff from work sites, marine plants and vessels
- All drilling fluid will remain within the drilled duct prior to breakout and will be treated/recycled at the Temporary Working Platform.
- 5m prior to breakout, all drilling fluid will be extracted from the duct and the duct will be purged with water such that there is no possibility for drilling fluid to enter marine waters during the breakout process..
- The crane barge used for the transport of any debris recovered from the seabed during route clearance shall be fitted with tight bottom seals in order to prevent leakage of material during loading and transport to the disposal site.
- The crane barge shall be filled to a level which ensures that material does not spill over during loading and transport and that adequate freeboard is maintained to ensure that the decks are not washed by wave action
- The forward speed of the cable laying vessel will be limited to a maximum of 300m $hour^{-1}$ from Ch.500m to approx. Ch.2.5km. Thereafter, the speed will be limited to a maximum of 1km $hour^{-1}$.
- As a precautionary measure, a silt curtain with an estimated silt removal efficiency of 85% will be deployed when cable burial is being carried out in proximity to the Cape D'Aguilar Peninsula, i.e. from Ch.500m (the start of cable burial) to Ch.2.5km (when the cable enters the established east-west cable corridor).

Cumulative Impacts

4.2.22 While there is one planned projects near AAE-1 Cable – the *Offshore Wind Farm in Southeastern Waters* – it is not expected to be in construction at the same time as the installation of the AAE-1 Cable and, therefore, there will be no cumulative impacts.

Conclusion

4.2.23 With the recommended mitigation measures in place, no adverse water quality impacts are anticipated from the cable installation works.

4.3 Waste

4.3.1 Waste will be generated from the HDD works in the form of rock that has been drilled out from the underground cable duct. Based on a length of 300m and a diameter of 200mm, the quantity of rock is estimated to be 9.4m^3 *in situ*. The drilled rock will be brought to the surface in small pieces in the drilling fluid from which it will be separated and stored prior to disposal. To allow for *ex situ* bulking, approximately 16m^3 of rock fines will be generated, equivalent to approximately 25.6 tonnes.

4.3.2 It is unlikely that this rock can be used for any purpose in the Project and so will need to be stored on the Working Platform until the HDD works are complete. With no use, the rock fines will need to be disposed of. The nearest disposal location is the Public Filling Area in Tseung Kwan O Area 137, which is around 30km from the BMH in Lap Sap Wan.

4.3.3 This quantity of waste rock is not considered to be significant and no adverse environmental impacts are likely to result from its handling, transport or disposal.

4.4 Marine Ecology

4.4.1 A review of marine ecological resources has been conducted for Lap Sap Wan, which is the landing site of the AAE-1 Cable. Field surveys, including intertidal surveys, submarine dive surveys and benthic grab surveys, were carried out to fill the identified information gaps. Based on the baseline information gathered from literature review and field surveys, potential ecological impacts of the Project were assessed, with corresponding measures proposed to mitigate the impacts.

4.4.2 All of the recorded intertidal species at Lap Sap Wan were typical rocky shore species that are common and widespread in the similar habitats in Hong Kong. No rare species or species of conservation concern were found. The first 300m of the submarine cable from Lap Sap Wan will be installed by HDD method without disturbing the intertidal area. Therefore construction of the AAE-1 Cable will have no impact on the intertidal community at Lap Sap Wan.

4.4.3 The subtidal hard bottom habitats at Lap Sap Wan support a coral community of low diversity. The percentage covers of both hard and soft coral communities were low in general. According to the dive survey results, there were no coral colonies found in the 10m corridor of the proposed cable alignment after 275m offshore. Given that the HDD duct will break out around 300m offshore all the recorded corals will be avoided and there will be no direct impact on their habitat. In terms of the indirect impact on corals due to the increased suspended solids during construction phase, no unacceptable impact is anticipated in view of the small scale and short term of the Project and also with the implementation of good operational practice of the cable laying barges.

4.4.4 Individuals of amphioxus *Branchiostoma belcheri* were collected during the grab surveys. Lap Sap Wan would be a suitable habitat for juvenile amphioxus and their first spawning, but life expectancy of the local population was not high and the population size was small. Hence the ecological significance of Lap Sap Wan to amphioxus was of low to moderate at a maximum extent. Use of HDD duct below the seabed for the first 300m will not disturb the important habitat of amphioxus. From 300m to 500m, the cable will be laid in AP by divers and any amphioxus present will swim away during installation.

4.4.5 As calculated in ***Annex A***, the maximum distance of transport for fine suspended sediments is predicted to be 60m from the cable burial tool in the waters surrounding the Cape D'Aguilar Peninsula. Such limited dispersion of sediment plume would not reach Hok Tsui (Cape D'Aguilar) SSSI or Cape D'Aguilar Marine Reserve, which are 215m from the nearest point of the alignment. Also given the small scale of the work and its short duration (no more than two weeks) in proximity to the SSSI and Marine Reserve, the indirect impact of cable installation due to the increase in suspended solids should not be significant. The functionality of the Marine Reserve shall also be maintained as no construction work to be carried out within or impacting upon the Marine Reserve.

4.4.6 Submarine noise generated by the jetting works would fall below the hearing range of finless porpoises, who are more likely to spend the wet season in the southeastern waters where the AAE-1 Cable will be laid. It is thus anticipated that no adverse impact on marine mammals would be caused by the cable installation works. However, as a precautionary measure, a "marine mammal exclusion zone" will be established during the cable installation works to prevent marine mammals from being adversely affected. The "marine mammal exclusion zone" is a 250m zone around the cable laying boat. If marine mammals are spotted within this zone (by a qualified observer) then cable burials works will be postponed until the marine mammals are no longer observed within the zone – see ***Section E.3*** in ***Annex E*** for further details).

4.4.7 In summary, the proposed cable installation works are small in scale and localized in nature. Impacts on the marine ecological resources have been largely avoided through the selection of landing site, cable route and construction methods that avoid impacts for the first 300m due to use of HDD duct and thereafter minimise impacts through alignment and cable burial methods. The impact of cable installation is a one-off occurrence, after which subtidal species/habitats will begin recovery immediately.

4.4.8 With the implementation of the suggested mitigation/precautionary measures, no unacceptable, adverse ecological impacts are expected to arise from the installation works of the submarine cable.

4.5 Fisheries

4.5.1 A fisheries assessment is provided in ***Annex C***. A summary is provided below.

Cable Installation Impacts

4.5.2 The cable laying vessel is some 70m x 25m in size and the cable burial works will be completed in 3 to 4 weeks. During this period, the cable laying vessel will follow the alignment, slowly feeding out the cable to the cable burial tool on the seabed.

4.5.3 As the cable laying vessel traverses 27.15km across Hong Kong waters it will occupy part of the sea surface, which is thus unavailable for use by other marine vessels, including fishing vessels. However, this "temporary loss" of fishing grounds will be limited to 70m x 25m at any one time (i.e. the "footprint" of the vessel) and impacts from the presence of the cable laying vessel are no different to those from any other marine vessel passing through Hong Kong waters. Other than area occupied by the cable laying vessel, there is no other temporary loss of fishing grounds.

Capture Fisheries Production

4.5.4 Fisheries production in the affected area ranges from >0 to 50 kg/ha to 400 to600 kg/ha in terms of catch weight of adult fish, in which the majority of the grids show >0 to 200kg/ha. Fisheries production of adult fish and fish fry was highest (at HKD 5,000 to HKD 10,000/ha) in the western half of the cable alignment and lowest (at >HKD 0 to HKD 5,000/ha) in the eastern half.

Spawning Grounds

4.5.5 This area was determined as important spawning grounds for commercial fisheries resources[Ref #1]. Generally, the seasonal abundance of fry in Hong Kong is at its highest between March and September for most commercial fish species with a peak between June and August; the majority of spawning of these species is concentrated between June and September. Commercially important crustaceans spawn between April and December.

4.5.6 Given the limited water quality impacts associated with cable burial and the relatively small area occupied by the cable laying vessel and cable burial works when compared to the area of the spawning grounds through which the cable passes, the impacts to spawning are unlikely to be significant.

Nursery Areas

4.5.7 Nursey areas in Hong Kong waters are important habitat area for a number of commercial juvenile fish and crustacean species, which have been previously identified across southern waters from Lantau Island to Lamma Island. However, there are no nursery grounds in the vicinity of the AAE-1 Cable alignment.

Culture Fisheries

4.5.8 There are no AFCD gazetted FCZs in proximity to the cable alignment. The nearest FCZs to AAE-1 are Tung Lung Chau FCZ and Po Toi FCZ, located approximately 5.2km and 4.9km, respectively, from the closest point of the cable alignment. Given this distance, no impact from cable installation works is expected at these FCZs.

Cumulative Impacts

4.5.9 While there is one planned project near AAE-1 Cable – the *Offshore Wind Farm in Southeastern Waters* – it is not expected to be in construction at the same time as the installation of the AAE-1 Cable and, therefore, there will be no cumulative impacts.

1. *Consultancy Study on Fisheries Resources and Fishing Operations in Hong Kong Waters*, prepared by ERM for AFCD, 1998.

Conclusion

4.5.10 The cable installation work at the Lap Sap Wan is not expected to result in unacceptable impacts to water quality. As such, on-shore works are not expected to result in any significant impacts to fisheries at these locations.

4.5.11 No long-term direct or indirect impacts to fisheries resources or fishing operations are expected to occur that would affect either fisheries resources or fishing operations. No specific mitigation measures are recommended other than those adopted for water quality.

4.6 Cultural Heritage

4.6.1 A cultural heritage assessment is provided in ***Annex D***. A summary is provided below.

4.6.2 There are no terrestrial cultural heritage resources that will be affected by the Project – sites that have been identified are at a sufficient distance that they would not be impacted.

4.6.3 However, there may be artefacts with archaeological potential located on or beneath the seabed along the alignment of the cable within Lap Sap Wan, which has not been previously surveyed for marine artefacts. Therefore, a Marine Archaeological Investigation (MAI) has been carried out in accordance with the *Guidelines for Marine Archaeological Investigation*. This comprised a Baseline Review, Geophysical Survey, establishing Archaeological Potential and Diver Survey.

4.6.4 The Baseline Review located documentary evidence indicating that there may be one cannon on the seabed off the beach at Lap Sap Wan. The side scan sonar data identified one sonar contact, which requires a diver survey to establish its archaeological value. Therefore, an application was made to the Antiquities and Monuments Office (AMO) for a *Licence to Excavate and Search for Antiquities.* Licence No. 395 was granted by AMO on 24th August 2015.

4.6.5 The diver survey was completed between 27th to 29th August 2015. A GPS was used to relocate one sonar contact and it was quickly identified as modern debris. A total of 16 dives were completed at 50m intervals along the cable corridor.

4.6.6 No object or feature with marine archaeological potential was located. It is therefore concluded that there is no underwater cultural heritage within the study area. As such there is no need for any further action or mitigation of any kind.

4.7 Others

4.7.1 The following impacts are not anticipated to result from the installation of the submarine cable and have not been assessed further in this Project Profile:

- **Gaseous Emissions.** Exhaust emissions from the construction plant will be insignificant due to the limited plant required for HDD works at the Working Platform. As such, adverse impacts on air quality will not result. The cable stations in the area are not air sensitive receivers. SWIMS, which does sometimes rely on open windows for ventilation, is located more than 600m from the Working Platform and so will not be affected.

- **Dust.** The HDD drilling process is essentially a "wet" process and will not result in the generation of dust. The BMH and cable trench to the Cape D'Aguilar Submarine Cable Station have already been constructed and do not form part of this Project.
- **Odour** – No odour impacts are expected to result from construction activities.
- **Noisy Operations.** There are no noise sensitive receivers in proximity to the cable installation works – the cable stations in the area are noise tolerant uses. SWIMS does have residential dorms but is located more than 600m from the Working Platform, there is no direct line of sight, and so it will not be affected.
- **Night-time Operations.** It is not anticipated that work will be undertaken during night-time. However, should this be necessary then a CNP will be obtained in advance.
- **Traffic Generation.** No significant construction traffic will be generated from the cable installation as there are no proper roads to access the BMH. All HDD plant and equipment will be mobilised and demobilised via barge. A Marine Traffic Impact Assessment (MTIA) of all barge and cable-laying vessel operations during will be prepared to address Marine Department's requirements.
- **Manufacturing, Storage, Use, Handling, Transport of Disposal of Dangerous Goods, Hazardous Materials or Wastes.** No dangerous goods or hazardous materials will be manufactured, stored, used or handled, transported or disposed of by this Project..
- **Risk of Accidents Resulting in Pollution or Hazard.** The laying of submarine cables is an established process in Hong Kong and the risk of accident is very low. As such, there is considered to be a minimal risk of accidents from cable laying activities that could result in pollution or hazard. HDD is also an established practice in Hong Kong and a separate Drilling Fluid Management Plan will be prepared to avoid the risk of accidental spillage.
- **Disposal of Spoil Material, Including Potentially Contaminated Materials.** No contaminated material is anticipated to be excavated or generated from the HDD. No dredging will be involved in the cable laying process and so there will be no sediment to be disposed of.
- **Unsightly Visual Appearance.** Since the cable will be buried in the seabed, its installation will not cause any visual obstruction or inconvenience to the public. The Working Platform around the BMH is a temporary structure. It will be removed after HDD work is complete and the beach will be reinstated. Lap Sap Wan is a remote area and not generally accessed by the public.
- **Ecological Impacts – Terrestrial.** No impacts to terrestrial ecology will arise from the installation of the submarine cable below the seabed. The BMH and buried trench have already been constructed and do not form part of this Project. The temporary Working Platform around the BMH will be raised off the beach by at least 200mm and so no significant impact to terrestrial ecology will occur.
- **Ecological Impacts – Intertidal.** No impacts to intertidal ecology as HDD will be used to enable the cable to be installed below the beach/seabed and so below intertidal habitat. The Temporary Working Platform will raised off the beach by at least 200mm and so no significant impact to intertidal ecology will occur.

5 ENVIRONMENTAL PROTECTION MEASURES AND ANY FURTHER IMPLICATIONS

5.1 Environmental Protection Measures

Installation Phase

5.1.1 The cable laying process requires minor works in the eastern waters of Hong Kong, and only small-scale construction works will be undertaken at the landing site. The cable alignment and landing site have been selected to avoid key environmental sensitive receivers, including CPA, Cape D'Aguilar Marine Reserve, and the Hok Tsui (Cape D'Aguilar) SSSI. The shortest cable alignment has been chosen to minimise the area of seabed that will be temporarily disturbed during installation.

5.1.2 From the BMH to 300m from shore, the AAE-1 Cable and electrical earthing cable will be installed in a duct drilled below the seabed by HDD. From 300m to 500m, the AAE-1 Cable will be installed by divers, who will lay the cable directly on the seabed inside AP protection, secured by pinning onto the seabed. Divers will also install the last 50m of the electrical earthing cable on the seabed, without AP. From 500m onwards, the cable will be installed using a "Injector Burial Tool" or "Sledge Tool", towed behind a cable-laying vessel, that mechanically buries the cable in a trench in the seabed approximately 500mm wide and 5m deep, and then back-fills in the trench.

5.1.3 Use of the HDD duct will avoid impacting the intertidal, shorelines, and near shore areas where hard and soft coral and amphioxus are present. Use of divers to lay the cable on the rocky seabed will have minimal impacts on the marine environment. The use of "Injector Burial Tool" or "Sledge Tool" have been shown not to cause significant water quality impacts for this Project (and for other cable laying projects).

5.1.4 As a precautionary measure, a marine mammal exclusion zone will be implemented during the cable installation works to avoid any potential impact on marine mammals as a result of the short-term increases in underwater noise from the cable installation barge and its water jet. The marine mammal exclusion zone within a radius of 250m from the cable installation barge will be implemented during the cable laying in day-time hours. It begins when the installation barge moves out of Lap Sap Wan (500m from shore), continues on a daily basis as the barge heads eastwards, and ceases 10km from Lap Sap Wan, when the water quality monitoring also ceases. Also, as a precautionary measure, a silt curtain will be deployed in proximity to Cape D'Aguilar Peninsula (i.e. from Ch.500m to Ch.2.5km) between the AAE-1 Cable burial and the Cape D'Aguilar Marine Reserve.

Operational Phase

5.1.5 Since no operational impact is predicted arising from the Project, no environmental protection measures are considered to be required.

5.2 Possible Severity, Distribution and Duration of Environmental Effects

5.2.1 The installation of the cable is expected to take approximately six to eight weeks, excluding the HDD works. This is a short period of time and no residual environmental impacts are anticipated.

5.2.2 Potential environmental impacts have been assessed in this Project Profile. Minor adverse environmental effects have been identified, although these are minimal, temporary in nature, and localised. There are no environmental impacts from the operation of the Project.

5.2.3 No secondary or induced effects have been identified. There are no cumulative effects as no other projects have been identified in the same area in the same timeframe as the AAE-1 Cable. The Project is located entirely within Hong Kong and so there are no transboundary concerns.

5.2.4 In terms of benefits, the AAE-1 Cable system will help meet the growing demand for high speed internet access services and greatly increase bandwidth capacity within Hong Kong. The Project will provide telecommunication infrastructure to support industries (such as financial, trading, logistics, media, and other data intensive industries) that have a far reaching effect on the economy of Hong Kong.

5.3 Further Implications

5.3.1 Cape D'Aguilar has been used previously as a landing site of several submarine cables. There is no record of complaints or incidents related to previous cable installation works.

5.3.2 The methods used for burying the cable have been widely used locally and globally for many years and are widely accepted to have very low impact to the surrounding marine environment. Previous cable installation projects, such as the *Tseung Kwan O Express – Cable System* and the *FLAG North Asian Loop*, also included HDD, and permission was granted for direct application of the EP.

5.3.3 No further implications are anticipated.

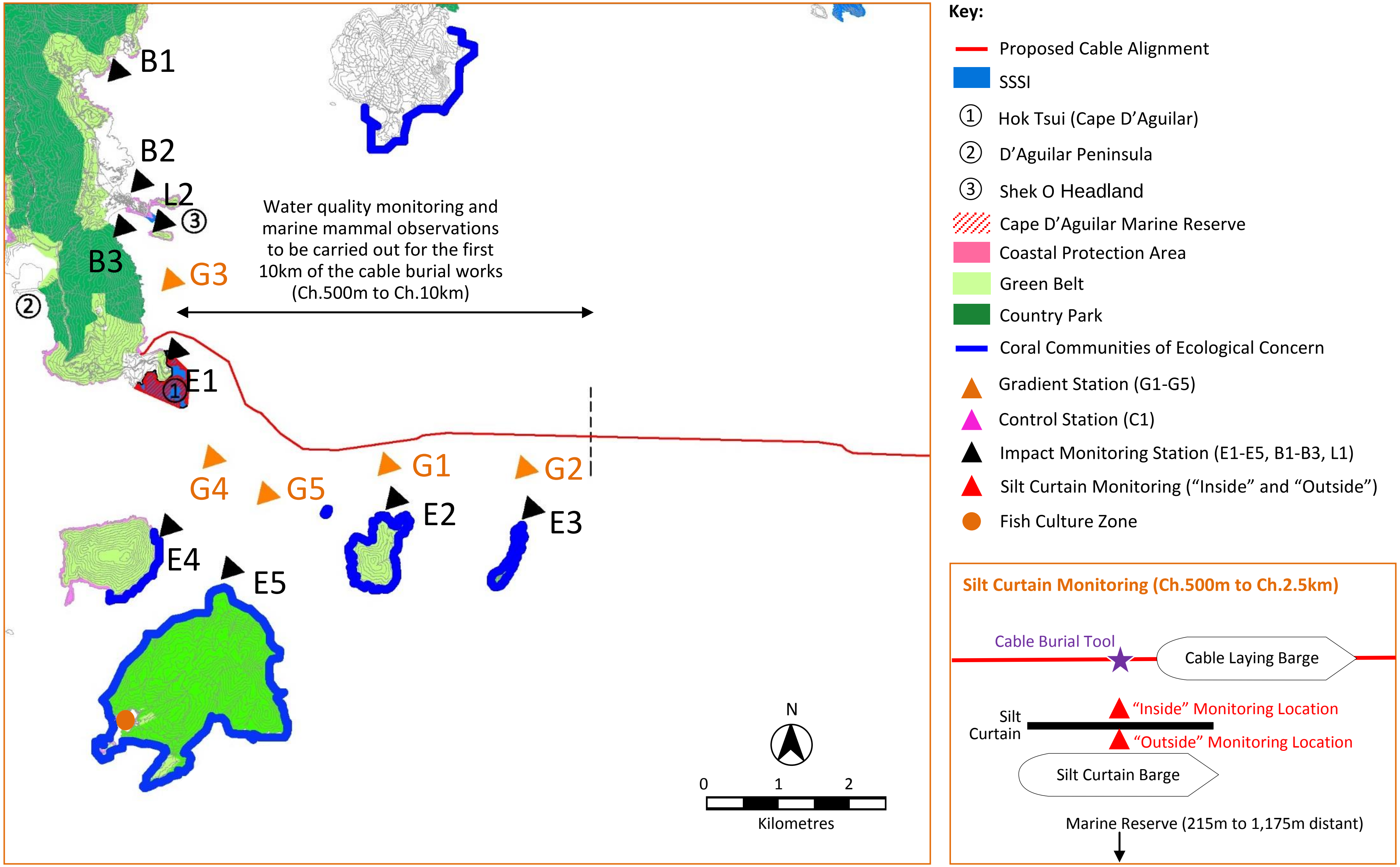
5.4 Environmental Monitoring and Audit

5.4.1 Although no unacceptable environmental impacts have been identified, it is recommended to carry out precautionary water quality monitoring to ensure that no adverse impacts to the water quality, marine ecology and fisheries. Details of the water quality monitoring programme are contained in ***Annex E*** and monitoring locations are shown on ***Figure 5-1***. Also, as a precautionary measure, a 250m "marine mammal exclusion zone" around the cable laying barge will be established during the cable installation works to prevent marine mammals from being adversely affected.

5.4.2 The Permit Holder will engage an Environmental Team (ET) to carry out the water quality monitoring works as proposed in ***Annex E***. The ET shall not be in any way an associated body of the Project Proponent, any works contractors or the Independent Environmental Checker (IEC). The ET shall be headed by an ET Leader who has at least 7 years of experience in EM&A or environmental management.

5.4.3 In addition to the ET, the Permit Holder will engage an IEC. The IEC shall not be in any way an associated body of the Permit Holder, the works contractors or the ET. The IEC shall have at least 7 years of experience in EM&A or environmental management. The IEC shall audit the overall EM&A performance of the ET, including the implementation of all environmental mitigation measures and shall be responsible for verifying the environmental acceptability of permanent and temporary works, including the proposed HDD operation from the start of mobilisation to the end of demobilisation.

Figure 5-1 Proposed Water Quality Monitoring Locations



6 USE OF PREVIOUSLY APPROVED EIA REPORTS

6.1.1 All cable laying projects that are DPs have secured EPs via Direct Application upon submission of a detailed Project Profile. It is the intention of the Project Proponent to also apply for the EP for this Project via Direct Application.

6.1.2 Although there are no previous EIA Reports, there are a number of previous Project Profiles that have been referenced in the preparation of this Project Profile:

- **Tseung Kwan O Express – Cable System (Superloop (Hong Kong) Ltd).** The Project Profile was submitted on 16 December 2015 (PP-532/2015). The length of cable in Hong Kong waters was around 2.7km. The study concluded that there would be no adverse long-term or cumulative effects/impacts to the environment. Permission to apply directly for the EP was given on 15 January 2016, and the EP will be granted within 30 days of application.
- **Asia Pacific Gateway (APG) – Tseung Kwan O (China Mobile International Ltd).** The Project Profile was submitted on 9 October 2013 (PP-496/2013). The length of cable in Hong Kong waters was around 35km. The study concluded that there would be no adverse long-term or cumulative effects/impacts to the environment. The EP was granted on 18 February 2014 (EP-485/2014).
- **Replacement of the Existing 11KV Submarine Cable Circuit Connecting Liu Ko Ngam and Pak Sha Tau Tsui at Kat O (CLP Power Hong Kong Ltd).** The Project Profile was submitted on 30 May 2013 (PP-489/2013). The length of cable in Hong Kong waters was around 880m. The study concluded that there would be no adverse long-term or cumulative effects/impacts to the environment. The EP was granted on 27 August 2013 (EP-461/2013).
- **Asia Submarine-cable Express (ASE) – Tseung Kwan O (NTT Com Asia Ltd).** The Project Profile was submitted on 7 October 2011 (PP-452/2011). The length of cable in Hong Kong waters was around 33.5 km. The study concluded that there would be no adverse long-term or cumulative effects/impacts to the environment. The EP was granted on 20 December 2011 (EP-433/2011).
- **South-East Asia Japan Cable System (SJC) Hong Kong Segment, Chun Hom Kok (China Telecom (Hong Kong) International Ltd).** The Project Profile was submitted on 22 June 2011 (PP-444/2011). The length of cable in Hong Kong waters was around 37 km. The study concluded that there would be no adverse long-term or cumulative effects/ impacts to the environment. The EP was granted on 24 October 2011 (EP-423/2011).
- **Asia-America Gateway (AAG) Cable Network, South Lantau (Reach Networks Hong Kong Ltd).** The Project Profile was submitted on 5 October 2007 (PP-331/ 2007). The length of cable in Hong Kong waters was around 10 km. The study concluded that there would be no adverse long-term or cumulative effects/impacts to the environment. The EP was granted on 20 December 2007 (EP-298/2007).
- **VSNL Intra Asia Submarine Cable System – Deep Water Bay (Videsh Sanchar Nigam Ltd).** The Project Profile was submitted to EPD on 31 August 2007 (PP-324/2007). The length of cable in Hong Kong waters was around 40 km. The study concluded there would be no adverse long-term or cumulative effects/impacts to the environment. The EP was granted on 23 November 2007 (EP-294/2007).

- **Proposed 132kV Submarine Cable Route for Airport "A" to Castle Peak Power Station Cable Circuit (CLP Power Hong Kong Ltd).** The Project Profile was submitted on 18 July 2006 (PP-295/2006). The length of the cable in Hong Kong waters was around 6.2 km. The study concluded that there would be no adverse long-term or cumulative effects/impacts on the environment. The EP was granted on 29 August 2006 (EP-267/2007).
- **Proposed 132kV Submarine Cable Installation for Wong Chuk Hang-Chung Hom Kok 132kV Circuits (Hong Kong Electric Co Ltd).** The Project Profile was submitted on 21 January 2002 (PP-159/2002). The length of the cable in Hong Kong waters was around 2.9 km. The study concluded that there would be no adverse long-term or cumulative effects/impacts on the environment. The EP was granted on 4 March 2002 (EP-132/2002).
- **HGC Optical Fibre Submarine Cable System between Tuen Mun and Chek Lap Kok (Hutchison Global Crossing Ltd).** The Project Profile was submitted on 19 April 2001 (PP-127/2001). The length of the cable in Hong Kong waters was around 500 m. The study concluded that there would be no adverse long-term or cumulative effects/impacts on the environment. The EP was granted on 9 June 2001 (EP-106/2001).
- **FLAG North Asian Loop, Tong Fuk (FLAG Telecom Asia Ltd).** The Project Profile was on 28 March 2001 (PP-121/2001). The length of cable in Hong Kong waters was around 10 km. The study concluded that there would be no adverse long-term or cumulative effects/impacts on the environment. The EP was granted on 18 June 2001 (EP-099/2001).
- **C2C Cable Network – Hong Kong Section: Chung Hom Kok (GB21 (Hong Kong) Ltd).** The Project Profile for this Study was submitted to EPD on 5 December 2000 (PP-109/2000). The length of each cable in Hong Kong waters was around 30 km. The study concluded that there would be no adverse long-term or cumulative effects/impacts on the environment. The EP was granted on 16 February 2001 (EP-087/2001).
- **New T&T Hong Kong Limited: Domestic Cable Route (New T&T Hong Kong Ltd).** The Project Profile was submitted on 5 December 2000 (PP-108/2000). The length of the Chung Hom Kok to Cheung Sha cable was around 37 km and the Chung Hom Kok to Sandy Bay cable was around 32 km in length. The study concluded that there would be no adverse long-term or cumulative effects/ impacts on the environment. The EP was granted on 16 February 2001 (EP-086/2001).
- **East Asian Crossing (EAC) Cable System, TKO (Asia Global Crossing Ltd).** Two Project Profiles for this project were submitted, one on 30 June 2000 (PP-094/2000) and the other on 11 Aug 2000 (PP-101/2000). The length of each of the two cables in Hong Kong waters was around 25 km. The studies concluded that there would be no adverse long-term or cumulative effects/impacts on the environment. The EPs were granted on 6 September 2000 (EP-79/2000) and on 4 October 2000 (EP-081/2000).
- **Cable Landing Work in Tong Fuk Lantau for Asia Pacific Cable Network 2 (APCN 2) Fibre Optic Submarine Cable System (EGS (Asia) Ltd).** The Project Profile was on 12 May 2000 (PP-089/2000). The length of the two cables in Hong Kong waters were around 24.6 km and 25.4km. The study concluded that there would be no adverse long-term or cumulative effects/impacts on the environment. The EP was granted on 26 July 2000 (EP-069/2000).

- **Telecommunication Installation at Lot 591SA in DD328, Tong Fuk, South Lantau Coast and the Associated Cable Landing Work in Tong Fuk, South Lantau for the North Asia Cable (NAC) Fibre Optic Submarine Cable System (Level 3 Communications Ltd).** The Project Profile was submitted on 29 March 2000 (PP-79/2000). The length of cable in Hong Kong waters was approximately 10 km. The study concluded that there would be no adverse long-term or cumulative effects/impacts on the environment. The EP was granted on 5 June 2000 (EP-064/2000).
- **Cable Landing Work in Deep Water Bay for SEA-ME-WE 3 Fibre Optic Submarine Cable System (Hong Kong Telecom International Limited).** The Project Profile was submitted in 26 May 1998 (PP-006/1998). The length of cable in Hong Kong waters was not mentioned but was probably more than 20km. The study concluded that there would be no adverse impacts on the environment. The EP was granted on 3 July 1998 (EP-001/2000). This project has the distinction of being the first Project Profile submitted for Direct Application (only 11 pages long) and also having the first EP issued under the EIAO.

6.1.3 Of particular note are the *FLAG North Asian Loop*, which included HDD to avoid surface impacts to a gazetted bathing beach, and the *Tseung Kwan O Express – Cable System*, which included HDD to avoid impacts to the foundations of an adjacent seawall. In both cases, a Project Profile was submitted for Permission to Apply Directly for EP, which was granted.

ANNEX A

Potential Impacts on Water Quality

CONTENTS

TABLES

FIGURES

A POTENTIAL IMPACTS ON WATER QUALITY

A.1 Relevant Legislation and Assessment Criteria

A.1.1 The following legislation and associated guidance or non-statuary guidelines are applicable to the evaluation of water quality impacts associated with the construction of the proposed submarine cable system.

- Water Pollution Control Ordinance (WPCO).
- Environmental Impact Assessment Ordinance (Cap. 499. S.16) and the Technical Memorandum on EIA Process (EIAO-TM), Annexes 6 and 14.
- Technical Memorandum for Effluents Discharge into Drainage and Sewerage Systems, Inland and Costal Waters (TM-ICW).
- Professional Persons Environmental Consultative Committee Practice Notes, Construction Site Drainage (ProPECC PN1/94).

A.1.2 These regulations and guidelines are applicable in assessing water quality impacts associated with the installation of the submarine cable.

Water Pollution Control Ordinance (WPCO)

A.1.3 The WPCO is the primary legislation for the control of water pollution and water quality in Hong Kong. There are a total of ten Water Control Zones (WCZ) and four supplementary WCZs in Hong Kong. Each WCZ has its own set of statutory Water Quality Objectives (WQO), set in the WPCO.

A.1.4 The alignment of the AAE-1 cable passes through the Southern and Mirs Bay WCZs and a summary of the WQOs for these WCZs are presented in ***Table A-1***. These WQOs are applicable as evaluation criteria for assessing the compliance of any discharge during the installation of the submarine cable system.

Table A-1 Summary of Water Quality Objectives for the Southern and Mirs Bay WCZs

Parameter	Southern and Mirs Bay WCZ
Temperature	Change not to exceed 2°C
Salinity	Change not to exceed 10% of natural ambient level
pH	To be in the range 6.5 to 8.5, change not to exceed 0.2
Suspended Solids (SS)	Not to raise the natural ambient level by 30% nor cause the accumulation of suspended solids which may adversely affect aquatic communities
Dissolved Oxygen (DO)	Bottom: Not less than 2mg/L for 90% samples Depth-averaged: Not less than 4mg/L for 90% samples
Nutrients (measured as total inorganic nitrogen)	Mirs WCZ: Not to exceed 0.3mg/L (annual mean depth-averaged) Southern WCZ: Not to exceed 0.1mg/L (annual mean depth-averaged)
Unionised Ammonia	Not to exceed 0.021mg/L (annual mean)
Chlorophyll-a	No criteria established for Mirs Bay and Southern WCZs
Toxicants	Not to be present at levels producing significant toxic effect
E. coli	Annual geometric mean not to exceed 610cfu/100mL (secondary contact recreation subzones in Mirs Bay WCZ and fish culture subzones in Mirs Bay and Southern WCZs)

EIAO-TM

A.1.5 Annexes 6 and 14 of the *EIAO-TM* provide general guidelines and criteria to be used in assessing water quality impacts. The EIAO-TM recognises that in the application of the above water quality criteria, it may not be possible to achieve all WQOs at the point of discharge as there are areas which are subjected to greater impacts (which are termed by the EPD as the mixing zones) where the initial dilution of an input of pollutants takes place. The definition of this area is determined on a case-by-case basis. In general, the criteria for acceptance of the initial dilution area are that it must not impair the integrity of the water body as a whole and must not damage the ecosystem.

TM-ICW

A.1.6 Under Section 21 of WPCO, all discharges during the installation of the submarine cable are required to comply with the TM-ICW. Effluents discharged into the drainage and sewerage systems, inshore and coastal waters of the WCZs are subject to pollutant concentration standards for particular volumes of discharge. These are defined by EPD and specified in licence conditions for any new discharge within a WCZ.

Seawater Intakes

A.1.7 Quality of seawater at seawater intake points should comply with the relevant WQO as shown in ***Table A-2***.

Table A-2 WQOs for Seawater for Flushing Supply at Intake Point

Parameter	Target
Colour (HU)	<20
Turbidity (NTU)	<10
Threshold Odour No. (TON)	<100
Ammoniacal Nitrogen (mg/L)	<1
Suspended Solids (mg/L)	<10
Dissolved Oxygen (mg/L)	>2
Biochemical Oxygen Demand (mg/L)	<10
Synthetic Detergents (mg/L)	<5
E.coli (cfu per 100mL)	<20,000

ProPECC PN 1/94

A.1.8 Apart from the above statutory requirements, the *Practice Notes for Professional Persons, Construction Site Drainage* (ProPECC PN 1/94), issued by the Environmental Protection Department in 1994, also provides useful guidelines on water pollution associated with construction activities.

A.2 Description of the Environment

Hydrodynamics

A.2.1 The eastern shore end part of the proposed submarine cable lies within Southern WCZ; other parts of the submarine cable are located in the south-eastern waters that are mainly influenced by the oceanic water from South China Sea.

Routine Water Quality Monitoring Results

A.2.2 There are three EPD routine water quality monitoring stations (EM3, MM8 and MM13) in the vicinity of the cable alignment, as shown on Figure ***A-1***. Water quality data from these stations between 2010 to 2014 has been collected and summarised in ***Table A-3***.

A.2.3 The data shows that the annual mean for both depth-averaged and bottom dissolved oxygen complied with the WQO during 2010 to 2014. Full compliance (100%) was achieved with the WQOs for total inorganic nitrogen and unionised ammonia at all stations. The levels of total inorganic nitrogen were observed to fluctuate at all stations from 2010 to 2014. The levels of unionised ammonia showed an increasing trend at Station EM3. The suspended solid concentrations were within a range from 0.5 to 16.0mg/L at all monitoring stations. *E.coli* levels also stayed in compliance with the WQOs at all stations between 2010 to 2014.

Routine Sediment Quality Monitoring Results

A.2.4 There are three EPD routine water quality monitoring stations (EM3, MM8 and MM13) in the vicinity of the cable alignment as shown on Figure ***A-1***. Sediment quality data from these stations between 2010 to 2014 has been collected and summarized in ***Table A-4***.

A.2.5 Sediment quality, management and classification specified under *Works Bureau Technical Circular (Works) No. 34/2002 Management of Dredged/Excavated Sediment* comprise two criteria for a broad range of Contaminants of Concern. The lower criterion is referred to as the Lower Chemical Exceedance Limit (LCEL) and the upper criterion is referred to as the Upper Chemical Exceedance Limit (UCEL). The sediment quality data (mean values) show that there were no exceedances of the LCEL and UCEL at all stations, from which can be concluded that the sediment in the vicinity of the cable alignment is not contaminated based on the existing sediment classification guidelines.

Water Sensitive Receivers

A.2.6 Water Sensitive Receivers (WSRs) in the vicinity of the cable alignment, shown on ***Figure A-1***, have been summarised in ***Table A-5***, which indicates the distance between the WSR and the closest alignment of the cable. WSRs comprise:

- Gazetted Bathing Beaches: Big Wave Bay, Rocky Bay, Shek O.
- Fisheries: Tung Lung Chau Fish Culture Zone (FCZ) and Po Toi FCZ.
- Sites of Special Scientific Interest (SSSI): Hok Tsui (Cape D'Aguilar) SSSI and Shek O Headland SSSI.
- Marine Reserve: Cape D'Aguilar Marine Reserve.
- Seawater Intake: Water Services Department (WSD) Intakes at Siu Sai Wan.

Table A-3 Summary of EPD Routine Water Quality Monitoring Data between 2010 to 2014 (EM3, MM8 and MM13)

Water Quality Parameter	Tathong Channel			Waglan Island			Mirs Bay		
	EM3			MM8			MM13		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Temperature (^{o}C)	22.7	14.8	29.5	22.7	14.7	30.3	22.9	14.5	30.1
Salinity	32.5	26.6	34.4	32.6	22.4	34.5	32.8	24.4	34.5
Dissolved Oxygen (mg/L)	6.5	2.5	10.5	6.4	2.4	10.1	6.5	2.2	12.8
Bottom	6.2	2.5	9.7	3.9	2.4	8.1	6.1	2.2	8.0
Dissolved Oxygen (% Saturation)	90.6	36.0	156.0	89.5	35.0	155.0	91.7	32.0	194.0
Bottom	84.9	36.0	116.0	81.6	35.0	108.0	83.5	32.0	112.0
pH	8.0	7.4	8.4	8.0	7.4	8.4	8.0	7.5	8.5
Suspended Solid (mg/L)	3.3	0.5	16.0	3.3	0.5	15.0	3.1	0.5	13.0
5-day Biochemical Oxygen Demand (mg/L)	0.79	0.10	7.00	0.50	0.10	3.40	0.53	0.10	5.50
Unionised Ammonia (mg/L)	0.002	0.001	0.008	0.001	0.001	0.007	0.001	0.001	0.008
Total Inorganic Nitrogen (mg/L)	0.117	0.010	0.400	0.110	0.010	0.830	0.091	0.010	0.460
Total Nitrogen (mg/L)	0.232	0.050	0.540	0.233	0.050	1.200	0.208	0.050	0.700
Chlorophyll-a (µg/L)	2.3	0.2	25.0	1.9	0.2	17.0	2.0	0.2	37.0
Escherichia coli (cfu/100mL)	40	1	1,600	3	1	16	7	1	40

Source: Compiled from Appendix B of *Marine Water Quality in Hong Kong in 2014*, EPD.

Notes:

1. Data presented is the depth-averaged value averaged over 5 years, unless stated otherwise.
2. Total Inorganic Nitrogen and Unionised Ammonia is presented as the depth averaged annual mean over 5 years and the depth averaged annual range.
3. *E.coli* is presented as depth averaged annual geometric mean.

Table A-4 Summary of EPD Routine Sediment Quality Monitoring Data between 2010 to 2014 (EM3, MM8 and MM13)

Sediment Quality Parameter	LCEL	UCEL	Tathong Channel ES2 Mean	Tathong Channel ES2 Min	Tathong Channel ES2 Max	Waglan Island MS8 Mean	Waglan Island MS8 Min	Waglan Island MS8 Max	Mirs Bay MS13 Mean	Mirs Bay MS13 Min	Mirs Bay MS13 Max
Chemical Oxygen Demand (mg/kg)	-	-	9,460	7,100	13,000	10,030	8,600	12,000	8,910	7,100	10,000
Total Kjeldahl Nitrogen (mg/kg)	-	-	435	300	650	478	360	550	458	320	550
Arsenic (mg/kg)	12	42	6.04	4.5	9.5	7.26	6.7	7.9	7.62	6.3	8.7
Cadmium (mg/kg)	1.5	4	0.2	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium (mg/kg)	80	160	25.2	17	49	31.4	28	33	30.3	24	34
Copper (mg/kg)	65	110	18.7	9	54	13.5	10	18	12	9	17
Lead (mg/kg)	75	110	25.5	18	38	33.3	30	37	31.1	25	35
Mercury (mg/kg)	0.5	1	0.09	<0.05	0.17	0.055	<0.05	0.06	0.06	<0.05	0.07
Nickel (mg/kg)	40	40	16.5	12	31	21.9	20	24	21.8	20	23
Silver (mg/kg)	1	2	<0	<0	<0	<0	<0	<0	<0	<0	<0
Zinc (mg/kg)	200	270	68.4	40	120	76.8	71	81	74.5	62	84

Source: Compiled from Appendix E of *Marine Water Quality in Hong Kong in 2014*, EPD.

Notes:

1. Data presented are arithmetic mean (except if specified differently)
2. Data is based on Government laboratory analysis of bulk samples collected twice per year.
3. LCEL – Lower Chemical Exceedance Level, UCEL – Upper Chemical Exceedance Level.
4. If concentrations are below the limit of detection, results are taken as half of the reporting limit.

Table A-5 Closest Distances of WSRs to the Cable Alignment

Category	ID	Water Sensitive Receivers	Closest Distance from Cable Alignment (m)
Gazetted Bathing Beaches	B1	Big Wave Bay Beach	3,944
	B2	Rocky Bay Beach	2,042
	B3	Shek O Beach	1,235
Marine Reserve / SSSI	M1 / S1	Cape D'Aguilar Marine Reserve (covers the same area of sea that is also protected under the Hok Tsui (Cape D'Aguilar) SSSI)	215
	S2	Shek O Headland SSSI	1,900
Coral Communities of Ecological Concern	C1	Coral communities along the coast of Beaufort Island	2,240
	C2	Coral communities along the coast of Po Toi	2,241
	C3	Coral communities along the coast of Sung Kong	1,025
	C4	Coral communities along the coast of Waglan Island	1,156
Fish Culture Zone	F1	Tung Lung Chau FCZ	5,522
	F2	Po Toi FCZ	4,890
Seawater Intake	W1	WSD Siu Sai Wan Seawater Intake	6,284

A.3 Impact Assessment

A.3.1 There will be no adverse impacts to water quality from the operation of the proposed submarine cable. The potential for any adverse direct and indirect impacts to water quality from the installation of the submarine cable have been assessed below.

Laying of the Cable at Landing Site

A.3.2 The seabed of Lap Sap Wan is generally rocky, out to a distance of around 500m from the shoreline. Thereafter, the seabed is predominantly marine sediment out to the boundary of Hong Kong waters.

A.3.3 To avoid adverse impacts to corals, which occur within the first 275m from the shore (as identified in the second coral dive survey – see ***Annex B***), to Amphioxus (a fish species of conservation value that occurs in greater numbers closer to the shore) and to avoid adverse water quality impacts at the nearby SSSI and Marine Reserve, it has been decided to install the first part of the AAE-1 Cable from near to the Beach Manhole (BMH) in a duct drilled using Horizontal Directional Drilling (HDD).

A.3.4 The geophysical survey that has been carried out along the entire alignment of the AAE-1 Cable has not indicated any fractured or jointed bedrock beneath the seabed through which the HDD duct will be installed. As such, leakage of drilling fluid up through the seabed and into the marine environment is not anticipated. However, in the event that there are any fractures in the bedrock that could provide a pathway to the marine environment above, the water pressure would force seawater into the HDD duct rather than allow drilling fluid to escape into the marine environment. Any seawater leaking into the duct would thus be pumped out along with the drilling fluid and rock fines for treatment at the Temporary Working Platform.

A.3.5 This duct will be drilled in the bedrock around 5m to 10m below the seabed and will breakout at a point some 300m from the shore, beyond the last of the corals. Since drilling fluid will not be used for the final 5m of drilling before breakout and the entire duct will be purged with water prior to breakout, there is no possibility of the drilling fluid polluting the marine environment. Thus no water pollution is anticipated for the HDD construction of the duct first 300m of the alignment.

A.3.6 From Ch.300m to Ch.500m from the shore, the cable will be installed by directly laying on the seabed with Articulated Pipe (AP) protection and secured by pinning onto the seabed using stainless steel bolts. There will be no significant water quality impacts from drilling the bolts into the rocky seabed – there is little sediment to displace and the rock fragments that are drilled out will settle almost instantly.

Route Clearance

A.3.7 After the first 500m and the remaining majority of the alignment, the cable will be buried by an “Injector Burial Tool” or “Sledge Tool”. Prior to doing this, a Route Clearance Operation (RC) and Pre-lay Grapnel Run (PLGR) will be conducted, in which a grapnel is dragged on the seafloor to remove large objects from the cable path.

A.3.8 RC and PLGR are carried out for all cable burial projects and in none of the previous Project Profiles submitted for these projects has the PLGR been predicted to cause unacceptable water quality impacts. As exactly the same methods are to be used for this Project, unacceptable water quality impacts are also not anticipated.

Installation of the Marine Sections of the Cable

A.3.9 After the first 500m and for the remaining majority of the alignment, the AAE-1 Cable will be buried by an “Injector Burial Tool” or “Sledge Tool” to a target burial depth of 5m below the seabed using jetting technique. The installation of surface-laid section of the cable above the crossings of existing cables and the HKE Gas Pipeline will be carried out by divers. These surface-laid section will only be about 200m in length, located away from any WSRs, and the cable laying will be carried out quickly. As such, it is not anticipated that any significant water quality impacts will be caused.

A.3.10 The cable installation works involving an “Injector Burial Tool” or “Sledge Tool” have been assessed in a quantitative manner. The assessment approach used to calculate the transportation of sediment in suspension is the standard approach that has been used in previously approved Project Profiles for similar cable burial projects for which Environmental Permits have been issued – these were listed in ***Section 6***.

A.3.11 Many of these cable burial projects have been located within the established east-west cable corridor shown on ***Figure 1-2***. For those sections of the AAE-1 Cable that are also located within the established east-west cable corridor (from approx. Ch.2.5km to Ch.27.65km) values from these projects have been used, in particular current velocity, for which a value of 0.9m s^{-1} has been adopted.

A.3.12 However, from Ch.500m to approx. Ch.2.5km the AAE-1 Cable will be buried in proximity to Cape D’Aguilar Peninsula, which is outside the established east-west cable corridor and there are no values from other projects that can be referenced. Therefore, to address this data gap, depth-averaged tidal stream prediction data at stations close to Cape D’Aguilar Peninsula (shown on ***Figure A-2***) for April to July 2015 were obtained from Marine Department (MD) – this is considered to be primary, site-specific and best available information.

A.3.13 No bottom data is available from MD, but as current speed immediately above the seabed is generally lower that surface current and depth-averaged current due to friction with the seabed, adopting depth-averaged data of 0.3m s^{-1} for seabed current is a more conservative approach, i.e., gives a greater current velocity. It should be noted that the approved Project Profile *for Replacement of the Existing 11KV Submarine Cable Circuit Connecting Liu Ko Ngam and Pak Sha Tau Tsui at Kat O* also used a value of 0.3m s^{-1} , also obtained from MD data, for waters around Kat O, which are also outside the established east-west cable corridor.

A.3.14 In the following subsections, calculations have been made for release rate, settling velocity and settling time and also the distance travelled for suspended sediment. Upper limits for the parameters have been used for a worst case scenario assessment. Separate calculations have been provided for the section of AAE-1 Cable to be buried in proximity to Cape D'Aguilar Peninsula outside the established east-west cable corridor (i.e. from Ch.500m to approx. Ch.2.5km) and for the section of the AAE-1 Cable to be buried within the established east-west cable corridor (i.e. from approx. Ch.2.5km to Ch.27.65km).

A.3.15 In the following calculations, all of the values adopted for the AAE-1 Cable lie within the range of values adopted in other recently approved Project Profiles; all of the formulae that have been used for the AAE-1 Cable are identical to those used in other recently approved Project Profiles; and the approach for calculating settling velocity and settling time is the same as that used in other recently approved Project Profiles.

Calculation of Sediment Release Rate

A.3.16 From Ch.500m to approx. Ch.2.5km, the AAE-1 Cable will be buried in proximity to Cape D'Aguilar Peninsula and the speed of the burial tool will be limited to a maximum of 300m $hour^{-1}$. This is not considered to be an unreasonably slow speed, as at least four other recently approved Project Profiles have adopted a speed of 300m $hour^{-1}$ or less in order to minimise sediment release rates in sensitive areas. From approx. Ch.2.5km to Ch.27.65km, the AAE-1 Cable enters the established east-west cable corridor, where the burial tool will travel at a maximum of 1km $hour^{-1}$. Calculation of sediment release rate is shown in ***Table A-6***, below.

Table A-6 Calculation of Sediment Release Rate

	Ch.500m to Approx. Ch.2.5km	Approx. Ch.2.5km to Ch.27.65km
Formula	Release Rate = Cross Sectional Area of Disturbed Sediment x Speed pf Burial Tool x Sediment Dry Density x Percentage Loss	
Depth of Disturbance	5m (burial depth of cable)	5m (burial depth of cable)
Width of Disturbance	0.5m (width of seabed disturbance as cable buried)	0.5m (width of seabed disturbance as cable buried)
Maximum Cross-sectional Area	5m x 0.5m = 2.5m^2	5m x 0.5m = 2.5m^2
Loss Rate	20% (majority of sediment not disturbed)	20% (majority of sediment not disturbed)
Maximum Speed of Burial Tool	0.083m s^{-1} (300m $hour^{-1}$)	0.278m s^{-1} (1km $hour^{-1}$)
In-situ Dry Sediment Density	600kg m^{-3} (typical of Hong Kong sediment)	600kg m^{-3} (typical of Hong Kong sediment)
Release Rate	**24.9kg s^{-1}**	**83.4kg s^{-1}**

Initial Concentration of Suspended Sediments

A.3.17 During the cable burial works, some seabed sediment from the bottom of the water column will be lost to suspension. This will result in increased localised suspended sediment concentrations near the seabed but with high settling velocities due flocculation, in which high concentrations of suspended sediments within a localised area will tend to form large aggregations of sediment particles. The larger aggregations of sediment particles will settle more quickly than the individual sediment particles, i.e. will have a higher settling velocity.

A.3.18 The suspended sediment is assumed to remain within 1m of the seabed, which is independent of water depth – this is the value adopted in most Project Profiles for cable laying projects.

A.3.19 The sediment is assumed to spread to a maximum of 6m along the centre-line of the cable alignment, which represents the longitudinal dimension of the injector. The formation of suspended solids will tend to remain around the cable laying works, however, as a conservative assumption, a cross-current carrying the sediment towards the sensitive receivers has been used to address the potential adverse impact.

A.3.20 Referring to the above, the worst case scenario is that the sediment initially mixes evenly over the lower 1m of the water column and over the initial length of spread of the sediment.

A.3.21 From Ch.500m to approx. Ch.2.5km, the AAE-1 Cable will be buried in proximity to Cape D'Aguilar Peninsula. The seabed current velocity in this area is 0.3m s^{-1}, based on MD data. Approximately 2.5km from shore, the AAE-1 Cable alignment enters the established east-west cable corridor, where the current velocity is 0.9m s^{-1}, based on the values adopted in other Project Profiles for cables in this location. Calculation of initial concentration of suspended sediments is shown in ***Table A-7***, below.

Table A-7 Calculation of Initial Concentration of Suspended Sediments

	Ch.500m to Approx. Ch.2.5km	Approx. Ch.2.5km to Ch.27.65km
Formula	Initial Concentration = Release Rate / (Current Velocity x Max Height of Sediment x Width of Sediment)	
Release Rate	24.9kg s^{-1}	83.4kg s^{-1}
Current Velocity	0.3m s^{-1}	0.9m s^{-1}
Height of Sediment	1m	1m
Width of Sediment	6m	6m
Initial Concentration	**13.83kg m^{-3}**	**15.44kg m^{-3}**

Settling Velocity and Settling Time

A.3.22 Generally, the relationship between initial concentrations and the cohesive nature of the sediment being disturbed will determine the settling velocity of suspended solids. This approach is applied in Hong Kong and typically, as suspended solids concentration increase, the settling velocity will also increase due to flocculation. However, this relationship does not apply when the initial concentration is higher than values such as 1kg m^{-3} [Ref.#1].

1. HR Wallingford (1992) *Estuarine Muds Manual* Report SR 309, Her Majesty's Stationary Office, UK.

A.3.23 As the estimated initial concentration of 13.83kg m^{-3} (from Ch.500m to approx. Ch.2.5km) and 15.44kg m^{-3} (from approx. Ch.2.5km to Ch.27.65km) exceeds this value, settling velocity of 10mm s^{-1} has been used for assessment based on previously approved projects which made reference to the *Estuarine Muds Manual*[Ref#1]. This standard approach has been adopted in all recently approved Project Profiles for cable burial projects within the established east-west cable corridor.

A.3.24 For cable burial works in proximity to Cape D'Aguilar Peninsula and the Cape D'Aguilar Marine Reserve, i.e. from Ch.500m to approx. Ch.2.5km, which are outside the established east-west cable corridor, a 10mm s^{-1} settling velocity is also considered to be applicable. Reference has been made to the Project Profile submitted for cable burial at Kat O[Ref.#2] in which a 10mm s^{-1} settling velocity was adopted for waters that were also outside the established east-west cable corridor. Furthermore, the current velocity of 0.3m s^{-1} at Kat O is the same as that in proximity to Cape D'Aguilar Peninsula, and the cable buried at Kat O was also within 500m of a Marine Park (Yan Chau Tong).

A.3.25 To address the difference in seabed (geological) characteristics between Cape D'Aguilar Peninsula and Kat O, and also to provide additional protection for ecological and water sensitive receivers, a silt curtain will be deployed as precautionary a measure when cable burial is being carried out in proximity to Cape D'Aguilar Peninsula, i.e. from Ch.500m to approx. Ch.2.5km . Further details of the silt curtain are provided in ***paragraphs A.4.4 to A.4.6***.

A.3.26 As the sediment progressively settles onto the seabed, the remaining suspended sediment concentrations will reduce. In order to take the gradually reducing concentrations into account, the former settling velocity is halved, which gives a value of 5.0mm s^{-1}. This value is also adopted in other recently approved Project Profiles for cable burial projects. Calculation of settling time is shown in ***Table A-8***.

Table A-8 Calculation of Sediment Settling Time

	Ch.500m to Approx. Ch.2.5km	Approx. Ch.2.5km to Ch.27.65km
Formula	Settling Time = Max Height of Sediment / Average Settling Velocity	
Height of Sediment	1m	1m
Settling Velocity	5.0mm s^{-1}	5.0mm s^{-1}
Settling Time	**200s** (less than 3.5 minutes)	**200s** (less than 3.5 minutes)

Distance Travelled

A.3.27 The distance dispersed by the sediment can be calculated by using the settling time multiplied the current velocity, as shown in ***Table A-9***.

Table A-9 Calculation of Distance Travelled by Sediments

	Ch.500m to Approx. Ch.2.5km	Approx. Ch.2.5km to Ch.27.65km
Formula	Distance Travelled = Settling Time x Current Velocity	
Settling Time	200s	200s
Current Velocity	0.3m s^{-1}	0.9m s^{-1}
Distance Travelled	**60m**	**180m**

2. ERM - Hong Kong, Ltd (2013) Project Profile for "*Replacement of the Existing 11kV Submarine Cable Circuit Connecting Liu Ko Ngam and Pak Sha Tau Tsui at Kat O*" (permission was granted to apply directly for the EP on 11 July 2013).

A.3.28 The above calculations show that from Ch.500m to approx. Ch.2.5km (where the AAE-1 Cable will be buried in proximity to Cape D'Aguilar Peninsula, outside the established east-west cable corridor) any disturbed sediments will settle back onto the seabed within approximately 60m of the cable alignment in less than 3.5 minutes. From approx. Ch.2.5km to Ch.27.65km (where the AAE-1 Cable will be buried in the established east-west cable corridor) any disturbed sediments will settle back onto the seabed within approximately 180m of the cable alignment in less than 3.5 minutes. These predicted maximum settlement distances are shown on ***Figure A-2***.

A.4 Mitigation Measures During Cable Installation

A.4.1 An enlarged plan showing the co-ordinates and location of the WSR M1 and cable alignment will be prepared before cable installation. A Global Positioning System (GPS) of typical real time horizontal accuracy within ±10cm will be used for the navigation system of the Cable Installation Barge.

A.4.2 The jetting method will either use Sledge Tool or Injector Burial Tool to lay and bury the cable. If a Sledge Tool is used, an underwater positioning system will be used for the burial tool positioning; if an Injector Burial Tool is used, the tool is directly below the vessel, so the vessel's positioning system can be used. In order to achieve the planned cable alignment, the vessel position is controlled by Dynamic Positioning (DP) system. During the cable installation, burial tool position will be logged automatically. This tracking record will be plotted on a map and will demonstrate the cable alignment has a distance of 215m away from the WSR M1 (Cape D' Aguilar Marine Reserve). An as-built plan can be prepared after the installation.

A.4.3 During cable installation the following mitigation measures will be undertaken and are considered to be will be sufficient to prevent adverse impacts to water quality:

- Any stockpiles will be covered with tarpaulin to minimise run off from rainfall.
- All construction waste and discharge from the Temporary Working Platform will be handled and disposed of in accordance with the *Practice Notes for Professional Persons, Construction Site Drainage* (ProPECC PN1/94).
- Best Management Practices (BMPs) will be applied to avoid and minimise contaminated runoff from work sites, marine plants and vessels
- All drilling fluid will remain within the drilled duct prior to breakout and will be treated/recycled at the Temporary Working Platform.
- 5m prior to breakout, all drilling fluid will be extracted from the duct and the duct will be purged with water such that there is no possibility for drilling fluid to enter marine waters during the breakout process.
- The crane barge used for the transport of any debris recovered from the seabed during route clearance shall be fitted with tight bottom seals in order to prevent leakage of material during loading and transport to the disposal site.
- The crane barge shall be filled to a level which ensures that material does not spill over during loading and transport and that adequate freeboard is maintained to ensure that the decks are not washed by wave action
- The forward speed of the cable laying vessel will be limited to a maximum of 300m $hour^{-1}$ from Ch.500m to approx. Ch.2.5km. Thereafter, the speed will be limited to a maximum of 1km $hour^{-1}$ (as shown on ***Figure A-2***).

A.4.4 In addition to the above, and as a precautionary measure, a silt curtain with an estimated silt removal efficiency of 85% will be deployed when cable burial is being carried out in proximity to Cape D'Aguilar Peninsula, i.e. from Ch.500m (the start of cable burial) to approx. Ch.2.5km (when the cable alignment enters the established east-west cable corridor). Details of the silt curtain shall be checked and verified by the Independent Environmental Checker (IEC) before deployment.

A.4.5 The silt curtain will be suspended from a silt curtain barge that moves in parallel with the cable laying barge at a close but sufficiently safe distance (to be confirmed by the barge operator). The silt curtain will be 3x the length of the cable burial tool (i.e. around 18m in total length) and will be positioned such that the cable burial tool is always in the middle (horizontally) of the silt curtain. The silt curtain will be 3x the height of the suspended sediment (i.e. 3m in height) and will be positioned to hang from the silt curtain barge just above the seabed without actually touching the seabed (which would cause further sediment release). The silt curtain barge will have an accurate water depth detector and the silt curtain shall be raised or lowered as required to follow the undulations of the seabed without touching the seabed.

A.4.6 An indicative arrangement of the proposed the silt curtain is shown on ***Figure A-3***. Water quality monitoring inside and outside of the silt curtain will also be carried out, as detailed in ***Annex E.***

A.5 Conclusion

A.5.1 To avoid adverse impacts to corals and to Amphioxus, and to avoid adverse water quality impacts at the nearby SSSI and Marine Reserve, the first part of the AAE-1 Cable from near to BMH in a duct drilled in the bedrock around 5m to 10m below the seabed using HDD.

A.5.2 From Ch.0m to Ch.300m from the shore, no water pollution is anticipated from construction of the duct below the seabed, nor from the breakout. Leakage of drilling fluid up through the seabed into the marine environment is not anticipated. As the mitigation measures listed in ***Section A.4*** will be fully implemented no water quality impacts are anticipated.

A.5.3 From Ch.300m to Ch.500m from the shore, the AAE-1 Cable will be installed by directly laying on the seabed with AP protection secured by pinning onto the seabed using stainless steel bolts. There will be no significant water quality impacts from drilling the bolts into the rocky seabed as there is little sediment to displace and the rock fragments that are drilled out will settle almost instantly.

A.5.4 From Ch.500m to Ch.27.6km, the AAE-1 Cable will buried using either a Sledge Tool or an Injector Burial Tool:

- From Ch.500m to Ch.2.5km (i.e. in proximity to Cape D'Aguilar Peninsula) any sediments suspended due to cable burial are predicted to travel up to 60m. The nearest WSR is the Cape D'Aguilar Marine Reserve / Hok Tsui (Cape D'Aguilar) SSSI, located at its closest point 215m from the alignment, or 155m from the maximum predicted extent of suspended sediments. As such, no adverse water quality impacts are anticipated at this WSR. Nevertheless, a silt curtain will be deployed as a precautionary measure when cable burial is being carried out in proximity to Cape D'Aguilar Peninsula.
- From approx. Ch.2.5km to Ch.27.65km (i.e. within the established east-west cable corridor) any sediments suspended due to cable burial are predicted to

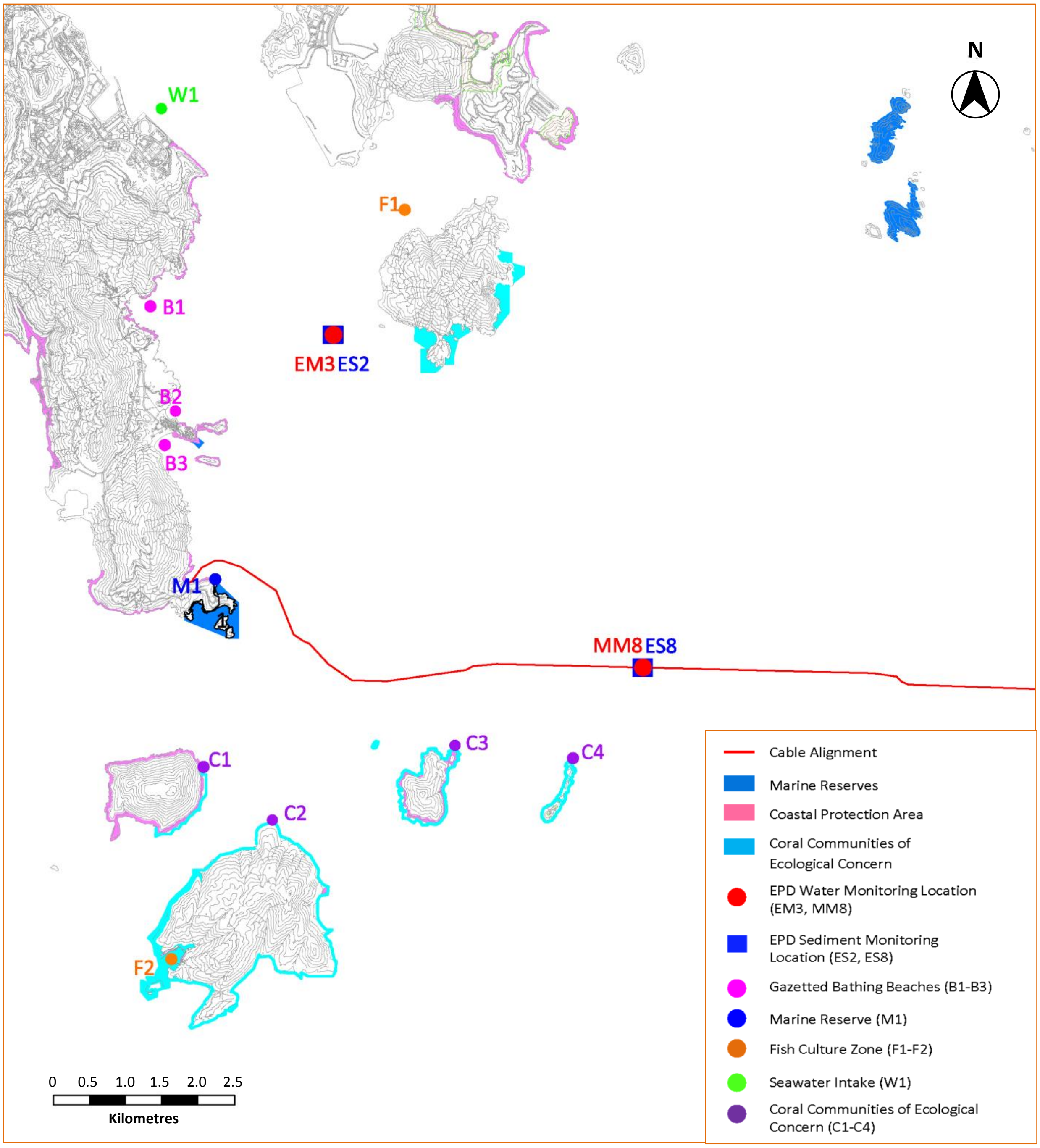
travel up to 180m. The nearest WSRs are the coral communities along the coast of Sung Kong, located at 1,024m from the alignment, or 844m from the maximum predicted extent of any suspended sediment, and the Cape D'Aguilar Marine Reserve, located at 1,175m from the alignment, or 995m from the maximum predicted extent of any suspended sediment. The nearest FCZ is Po Toi 4,890m from the alignment, or 4,710m from the maximum predicted extent of any suspended sediment. As such, no adverse water quality impacts are anticipated at these WSRs.

A.5.5 The installation surface-laid section of the cable above the crossings of existing cables and the HKE Gas Pipeline will be carried out by divers. These surface-laid section will only be about 200m in length, located away from any WSRs, and the cable laying will be carried out quickly. As such, no adverse water quality impacts are anticipated at WSRs.

A.5.6 No unacceptable water quality impacts are expected to occur from the Route Clearance Operation (RC) and Pre-lay Grapnel Run (PLGR).

A.5.7 It is anticipated that the cable installation works will not cause unacceptable impacts to water quality at the WSRs. However, for areas of high ecological importance and fisheries significance, assessments are presented in ***Annex B*** and ***Annex C***, respectively.

Figure A-1 Locations of EPD Monitoring Stations and WSRs in Proximity to the Cable Alignment



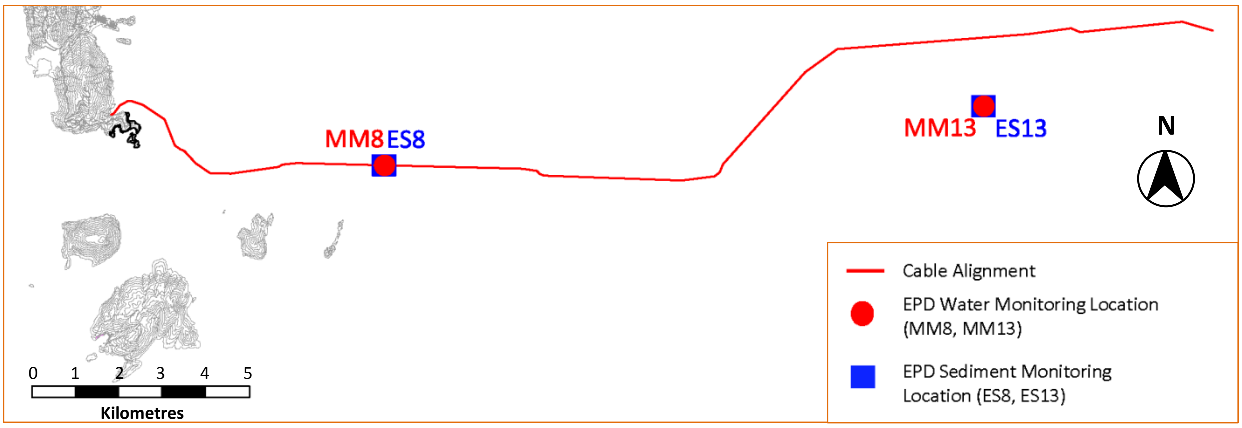


Figure A-2 Maximum Predicted Extent of Suspended Sediment from Cable Laying Operations

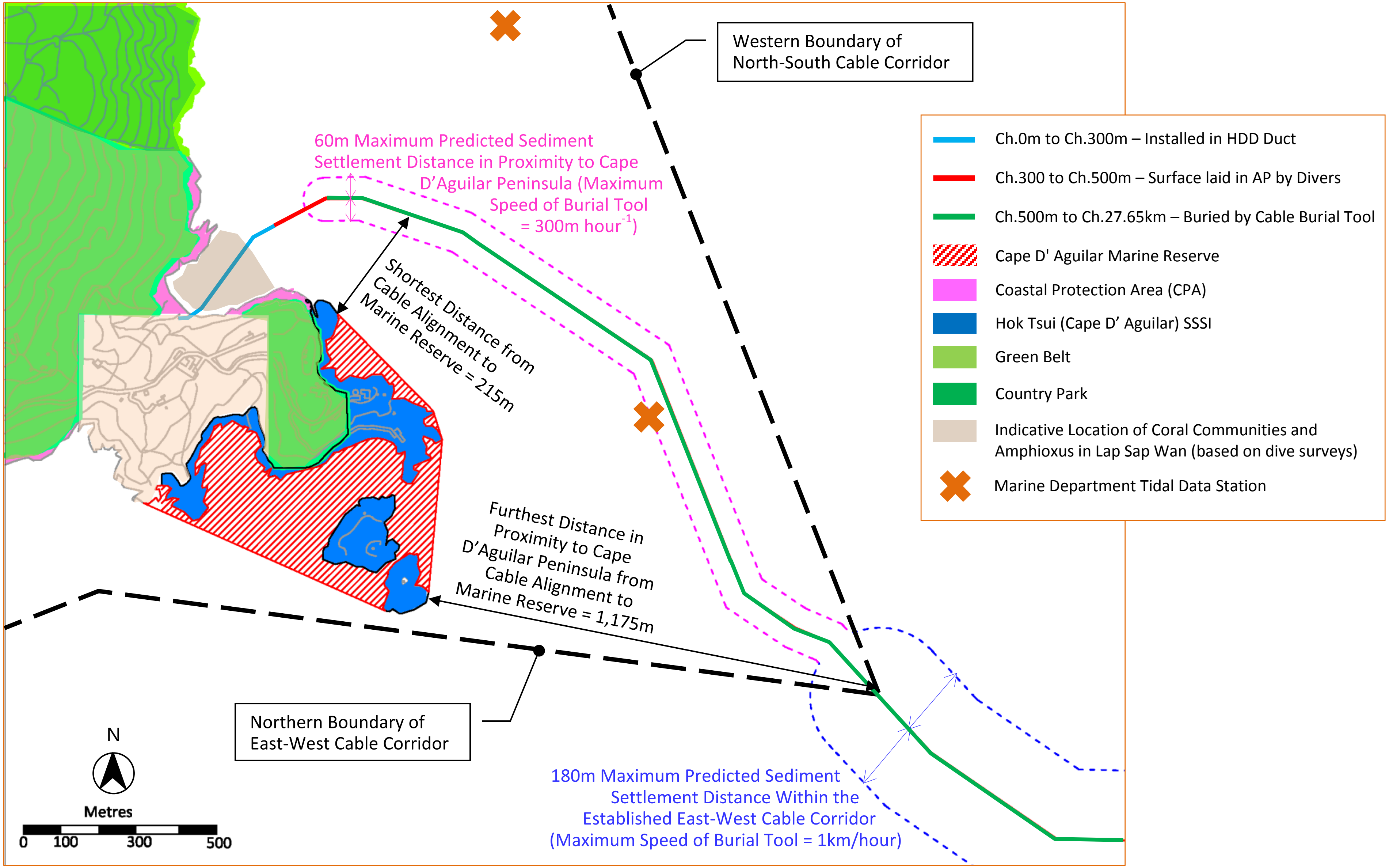
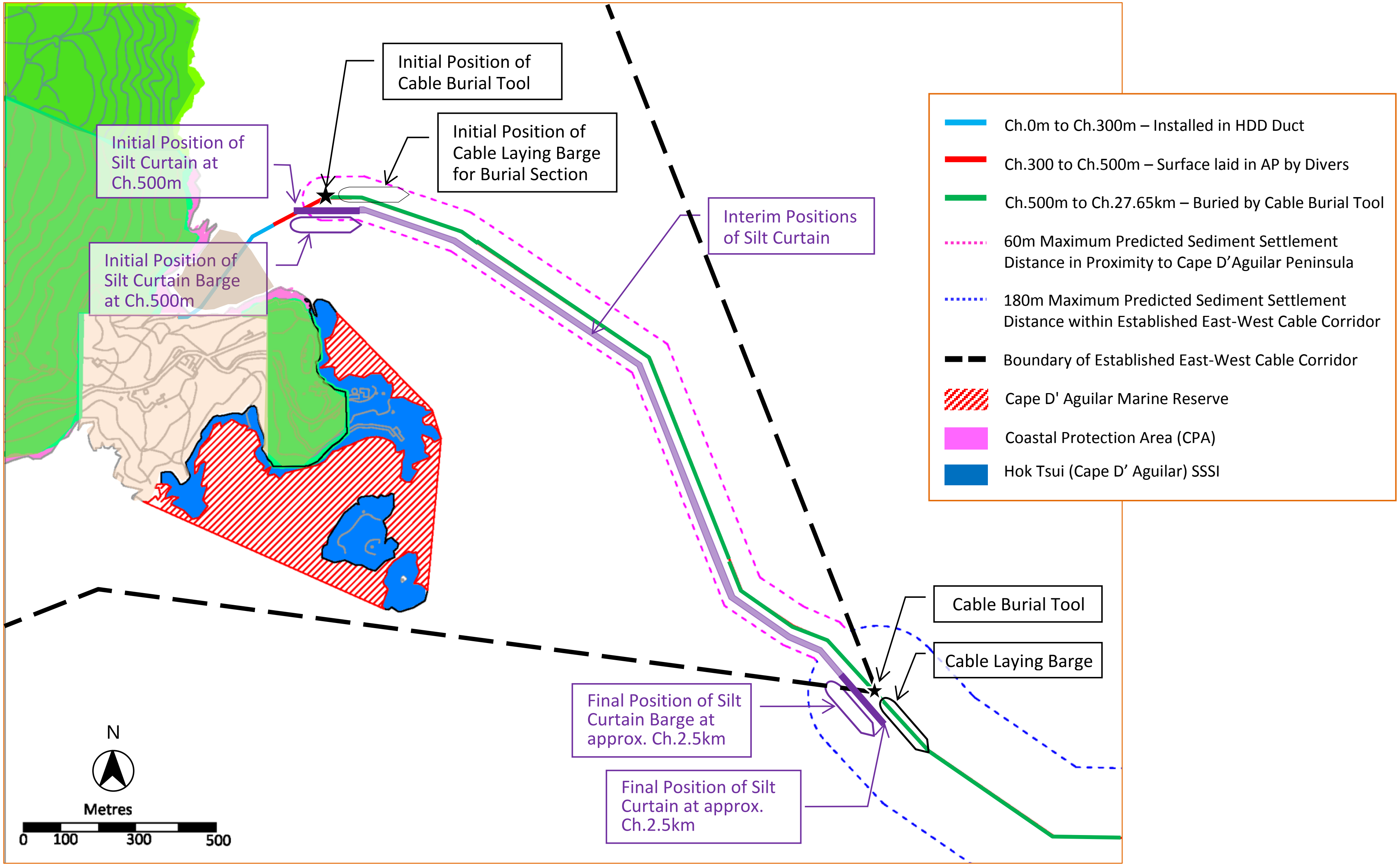


Figure A-3 Indicative Arrangement of Proposed Silt Curtain in Proximity to Cape D'Aguilar Peninsula



ANNEX B

Potential Impacts to Marine Ecology Resources

CONTENTS

TABLES

FIGURES

B POTENTIAL IMPACT TO MARINE ECOLOGY RESOURCES

B.1 Introduction

B.1.1 This Annex presents the baseline conditions of marine ecological resources along the alignment of the AAE-1 Cable, at the landing site in Lap Sap Wan and in the vicinity. It should be read in conjunction with the water quality assessment in ***Annex A***. Baseline conditions are evaluated based on information from literature and recent field surveys conducted specifically for this Project.

B.1.2 Potential ecological impacts arising from the cable installation works are assessed. Measures required to mitigate any identified adverse impacts are then recommended, where appropriate.

B.2 Relevant Legislation, Guidelines & Assessment Criteria

B.2.1 The criteria for evaluating marine ecological impacts are set forth in the *Technical Memorandum on Environmental Impact Assessment Process (EIAO-TM)*.

- Annex 8 sets out the criteria for evaluating such potential ecological impacts.
- Annex 16 describes the general approach and methodology for assessment of impacts to marine ecological resources arising from a project or proposal to allow a complete and objective identification, prediction and evaluation.

B.2.2 Other than these, several international conventions, local legislation and guidelines provide the framework for the protection of species and habitats of marine ecological importance, which include:

- EIAO Guidance Notes No. 6/2010 Some Observations on Ecological Assessment from the Environmental Impact Assessment Ordinance Perspective.
- EIAO Guidance Notes No. 7/2010 Ecological Baseline Survey for Ecological Assessment.
- EIAO Guidance Note No. 11/2010 Methodologies for Marine Ecological Baseline Surveys.
- Marine Parks Ordinance (Cap. 476).
- Wild Animals Protection Ordinance (Cap. 170).
- Protection of Endangered Species of Animals and Plants (Ordinance (Cap. 586).
- The Convention on Biological Diversity (1992) and the Strategic Plan for Biodiversity 2011-2020 and Aichi Biodiversity Targets.
- The International Union for Conservation of Nature (IUCN) Red List of Threatened Species.
- Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES).

B.3 Literature Review of Existing Marine Ecological Resources

B.3.1 A desktop review of the Study Area and its environs was conducted, with emphasis on the key ecological issues and presence of any species or habitats of high ecological importance. The literature review also covered Marine Reserve, SSSIs, marine mammals and other marine ecological resources (notably benthos and corals). Given the proximity of the proposed landing site to the Swire Institute of Marine Science of the University of Hong Kong, consultation was also made on their extensive knowledge of the area and Project location.

B.3.2 A number of Government and private sector reports and studies have been reviewed in relevance to this assessment of the potential impacts on marine ecological resources, among which the key literature are listed as follows:

- Plan D (2013) Register of Sites of Special Scientific Interest.
- Hung, S.K.Y. (2014) *Monitoring of Marine Mammals in Hong Kong Waters (2013-14)*. Final report to Agriculture, Fisheries and Conservation Department (AFCD).
- CityU Professional Services Limited (2002) *Consultancy Study on Marine Benthic Communities in Hong Kong*. Final Report to AFCD.
- Morton B. and Morton J. (1983) *The Sea Shore Ecology of Hong Kong*. HKU Press.
- Morton B (2003) *Marine Protected Areas in Hong Kong: Progress towards Coastal Zone Management (1977-2002)* in Perspectives on Marine Environmental Change in Hong Kong and Southern China 1997-2001 (ed. B Morton), Hong Kong 2001, HKU Press, pp. 797-824.
- ERM (2009) *2008 Update of Terrestrial Habitat Mapping and Ranking Based on Conservation Value*. Report submitted Sustainable Development Unit.
- ERM (2014) *Asia Pacific Gateway (APG) - Tseung Kwan O. Project Profile for China Mobile International (CMI)* submitted for Application for Permission to Apply Directly for an Environmental Permit (DIR-233/2013).
- BMT Asia Pacific Ltd (2009) *Environmental Impact Assessment of Hong Kong Offshore Wind Farm in Southeastern Waters*. Final Report for HK Offshore Wind Limited. (EIA-167/2009).

B.4 Important Areas

Sites of Special Scientific Interest (SSSIs)

B.4.1 Hok Tsui (Cape D'Aguilar) SSSI, comprising 10.5ha of land and 21ha of sea, is situated to the southeast of the landing site of the AAE-1 Cable, with the shortest distance of about 215m (***Figure B-1***). The site was designated as a SSSI in appreciation of its high biological, geomorphological and geological value.

B.4.2 D'Aguilar Peninsular SSSI, which is entirely terrestrial and is rich in orchids and *Keteleeria fortunei*, is approximately 1.3km to the northwest of the BMH. The Shek O Headland SSSI, covering 0.66ha of intertidal and submarine area, is located about 2km to the north. Other SSSIs, such as Tai Tam Harbour (Inner Bay) and Tai Tam Reservoir Catchment Area, are located at least 4.3km away from the BMH.

Marine Reserve

B.4.3 Geographically, the Cape D'Aguilar Marine Reserve is largely situated within the boundary of Hok Tsui (Cape D'Aguilar) SSSI, covering a total sea area of about 20ha. The Marine Reserve is set up for the purpose of conservation of marine resources, scientific studies and public education for the appreciation of marine resources. It is located approximately 215m from the closest proposed submarine cable segment. To minimise the potential impacts on the habitats of marine fish, stony corals, soft corals and gorgonians etc., appropriate construction methods and precautionary/mitigation measures will be proposed, as discussed in ***Section B.9***.

Coastal Protection Area (CPA) and Green Belt (GB)

B.4.4 The coastlines stretching to the northwest and east of the landing site of the submarine cable and most of the hinterland behind the coastlines are designated as Coastal Protection Area (CPA) and Green Belt (GB) respectively under the Tai Tam and Shek O OZP no. S/H18/10, with the shortest distance from the cable alignment to the CPA of less than 10m.

B.4.5 There is a general presumption against development in both zones; development in CPA zone is not allowed unless it is in favour of conservation or having overriding public interest, whilst development proposals within the CPA zone will be scrutinized and assessed on individual merits. Both CPA and GB zones are terrestrial in nature, while the major works of the Project are the installation of the submarine cable. Good site practices will be implemented strictly during cable installation.

B.4.6 Other than the above, intertidal and subtidal fauna of the landing site of AAE-1 and its vicinity have been assessed through literature review and field surveys, the results of which were presented in ***Section B.3*** and ***Section B.4***. Mitigation measures deemed necessary based on the baseline conditions and predicted impacts are discussed in ***Section B.6***.

B.5 Intertidal and Subtidal Faunal Assemblages

Coral Community

B.5.1 The landing site of the cable and its vicinity are not among sites with the highest hard coral cover of Hong Kong (Lun, 2003). AFCD (2004) conducted a study of *Ecological Status and Revised Species Records of Hong Kong's Scleractinian Corals*. Underwater surveys were conducted around Hong Kong's coastline between 2001 and 2002.

B.5.2 A total of 28 hard coral species were recorded in Cape D'Aguilar Marine Reserve (***Table B-1***), which was less than the species numbers of the three then-existing Marine Parks (i.e. Tung Ping Chau Marine Park, Yan Chau Tong Marine Park and Hoi Ha Wan Marine Park), but is still comparatively high in diversity in the general Southern WCZ.

Table B-1 Hard Coral Species Recorded in Cape D'Aguilar (AFCD 2004)

Species Number	Name of Species	Species Number	Name of Species
1	*Acanthastrea lordhowensis*	15	*Goniastrea aspera*
2	*Acanthastrea hemprichii*	16	*Goniastrea stutchburyi*
3	*Coscinaraea* n.s.p.	17	*Hydnophora exesa*
4	*Cyhastrea serailia*	18	*Leptastrea purpurea*
5	*Cyhastrea chalcidicum*	19	*Leptastrea pruinosa*
6	*Cyhastrea jaonica*	20	*Micromussa minuta*
7	*Favia speciosa*	21	*Oulastrea cripata*
8	*Favia lizardensis*	22	*Pavona decussata*
9	*Favia rotumana*	23	*Platygyra verweyi*
10	*Favites pentagona*	24	*Platygyra acuta*
11	*Favites chinensis*	25	*Porites M1 (lutea)*
12	*Favites abdita*	26	*Psammocora superficials*
13	*Favites flexuosa*	27	*Psammocora haimeana*
14	*Favites paraflexuosa*	28	*Turbinaria peltata*

B.5.3 Based on the coral cover and species composition, coral communities in Hong Kong can be divided into five types, which are:

- Type A: *Platygyra – Favia* Community
- Type B: *Acropora solitaryensis – Montipora peltiformis* Community
- Type C: *Psammocora* – Bryozoan Community
- Type D: *Porities deformis – Cyphastrea* Community
- Type E: Soft coral – Mollusc Community

B.5.4 In the vicinity of the AAE-1 Cable, Sung Kong and Waglan Island area supports Type B coral community with 10-30% coral cover, while the coral area in the waters off Hok Tsui Village and Hok Tsui Lower Village belongs to Type D (< 1% coral cover) (Lun, 2003). Type B coral community, developing in exposed areas of low sedimentation, moderate to high water clarity and salinity, has the second highest average coral cover and species diversity among the five types. Type D community has a moderately high coral cover and diversity, mainly found in deeper waters of moderate clarity and sediment deposition. Other than this, historic data of direct relevance to the coral community at Lap Sap Wan could not be found. Therefore site-specific dive survey was undertaken for the Project, the result of which is presented in ***Sections 1.6 and 1.7***.

Marine Benthic Infaunal Community

B.5.5 In 2002, City University was commissioned by AFCD to carry out a territory-wide field survey of the benthic infaunal communities, with 120 sampling stations set up across the Hong Kong waters. It was concluded that the benthic infaunal communities in Hong Kong waters are diverse, comprising mainly polychaete annelids, crustaceans and bivalves. The spatial pattern of species diversity is that eastern and southern waters in general have comparatively higher diversity, which reflects the response of benthic communities to local hydrography and sediment quality conditions (CityU 2002).

B.5.6 Among the 120 sampling stations, the proposed alignment of AAE-1 submarine cable runs between Stations no. 70-73 and 75-78, as shown on ***Figure B-1***. ***Table B-2*** below lists the numbers of species and individuals, biomass, species richness, diversity and evenness of the eight sampling stations.

Table B-2 Abundance, Diversity and Evenness of Benthic Infaunal Communities in Vicinity of the AAE-1 Cable (CityU 2002)

Sampling Station	No. Species (per 0.5m^2)	Number of Individuals (per m^2)	Wet Weight (g per m^2)	Species Richness (d)	Species Diversity (H')	Species Evenness (J)
Wet Season (Summer Survey)						
70	50	720	10.80	8.32	1.63	0.42
71	30	174	5.72	6.72	2.88	0.84
72	32	182	6.84	6.86	2.97	0.86
73	30	144	8.06	6.78	3.03	0.89
75	76	594	43.36	13.17	3.50	0.81
76	58	724	21.54	9.67	2.06	0.51
77	29	98	2.40	7.19	3.10	0.92
78	31	150	42.28	6.95	3.07	0.90
Range of All Sampling Stations	**2 to 80**	**16 to 12,014**	**0.16 to 1,382.66**	**0.48 to 13.17**	**0.38 to 3.92**	**0.20 to 0.96**
Dry Season (Winter Survey)						
70	56	2,590	39.26	7.68	1.53	0.38
71	27	176	28.64	5.81	2.76	0.84
72	27	148	27.46	6.04	2.84	0.86
73	25	110	13.08	5.99	2.66	0.83
75	77	1,140	32.00	11.98	2.96	0.68
76	52	302	14.18	10.16	3.54	0.90
77	13	54	3.84	3.64	2.31	0.90
78	25	144	22.18	5.61	2.66	0.83
Range of All Sampling Stations	**0 to 86**	**0 to 7,202**	**0 to 263.38**	**1.17 to 13.89**	**0.63 to 3.73**	**0.25 to 0.97**

B.5.7 As shown in table above, the eight sampling stations ranked at the higher ends of the diversity indices, suggesting environmentally undisturbed benthic communities in these areas. City U (2002) also found that, of the 603 species identified in the study, none of them are rare or endangered, except amphioxus *Branchiostoma belcheri*, an important species of high conservation value because of its primitive morphology and previous over-exploitation as a fishery resource in South China Sea. However, amphioxus did not occur in any of the eight sampling stations near to the submarine cable alignment.

B.5.8 Other than this whole-territory study, there is limited information specifying the benthic community of Lap Sap Wan or Cape D'Aguilar; most studies in the southeastern waters of Hong Kong have been conducted in the Junk Bay area, as a result of a number of landfill, power and harbour water treatment projects in recent years. But yet, these studies are not considered of high relevance to the current Project in view of the long distance between the proposed landing site/submarine cable alignment and Junk Bay. In the light of the general paucity of information, therefore, a benthic grab survey has been conducted in Lap Sap Wan for the current Project to obtain more site-specific data. The results are presented in ***Sections B.6 and B.7***.

Intertidal Community

B.5.9 Similar to that of marine benthic infaunal community, information of intertidal communities in vicinity of the proposed landing site of AAE-1 is also limited. Although many studies have been conducted by Swire Institute of Marine Science in Cape D'Aguilar Marine Reserve, most of them are manipulative, exploring certain mechanism evolved by a species/species group in the intertidal zone, rather than describing the baseline ecological conditions of the area.

B.5.10 The most relevant study is the ecological surveys that were carried out on a monthly basis during low tides between November 1996 and October 1998 at the semi-exposed rocky shore of Cape D'Aguilar Marine Reserve (Hutchinson, 1999). According to the study, the shore is consisted of sloping rock surfaces, sparsely covered with sessile invertebrates. It received limited anthropogenic disturbance due to prohibition of public access. In summer, the rocky shore was dominated by algae *Ralfsia expansa*, *Hapalospongidion gelatinosum* and *Hilderbrandia rubra*. In winter, it was dominated by mollusc grazers *Acanthopleura japonica*, *Cellana toreuma*, *Patelloida saccharina*, *Monodonta labio* and *Nerita albicilla*. All species recorded were typical semi-exposed shore species that are common and widespread in Hong Kong. No rare species were found.

B.5.11 In the light of the general paucity of information, an intertidal survey has been conducted along the coastline of Lap Sap Wan for the current Project to obtain more site-specific data. The results are presented in ***Sections B.6 and B.7***.

Marine Mammals

B.5.12 The Indo-Pacific Hump-backed Dolphin *Sousa chinensis*, locally known as Chinese white dolphin, and the finless porpoise *Neophocaena phocaenoides* are the two marine mammal species most regularly sighted in Hong Kong waters. They are also the only two residential marine mammal species in Hong Kong.

B.5.13 Chinese white dolphins mainly inhabit the western waters around Pearl River estuary. Within their habitat range, there are some areas that are used more frequently than the others and are considered as key dolphin habitats, which include one existing marine park around Sha Chau and Lung Kwu Chau, three proposed marine parks at the Brothers Islands, Fan Lau (i.e. Southwest Lantau) and Soko Islands, and two "dolphin hot spots" (Tai O and Black Point) where they were regularly sighted in the past decade (Hung 2014). The southeastern waters of Hong Kong where the AAE-1 Cable will be located, however, are not considered as an important habitat for Chinese white dolphins.

B.5.14 In contrast to Chinese white dolphins, finless porpoises appear to avoid the western waters of Hong Kong, which are substantially influenced by the freshwater input from the Pearl River. They frequent the southern and eastern waters, exhibiting a profound temporal and spatial pattern of distribution. Their abundance in Hong Kong appears to be highest in spring and lowest in autumn (Jefferson *et al*. 2002). In the dry season (winter and spring, December to May), finless porpoises appear to be most abundant between South Lantau and South Lamma waters, while in the wet season (summer and autumn, June to November) there is a dramatic decrease in abundance in this area but an increase in the southeastern waters of Hong Kong such as Po Toi, Sung Kong, Waglan Island and Ninepins. These data suggest that the installation of the AAE-1 Cable may pass through some porpoise active area (e.g. the waters east of Cape D'Aguilar and north of Sung Kong and Waglan Island), in particular if the construction period includes part of the wet season. Therefore, mitigation measures, such as marine mammal exclusion zone, will be implemented – this will be discussed in more details in ***Sections B.8 and B.9***.

B.6 Ecological Field Survey

Survey Methodologies

B.6.1 The habitats of the proposed landing site of AAE-1 Cable are mainly rocky shore and coastal vegetation, which are generally known to be of low ecological interest, however, existing knowledge of the intertidal and subtidal marine environment is limited.

B.6.2 Ecological surveys were therefore carried out to cover the dry and wet seasons to fill in the identified information gaps. Detailed marine surveys were conducted in the areas where direct impacts on the seabed and coastlines are predicted.

Intertidal fauna

B.6.3 A combination of qualitative and quantitative techniques was used for the intertidal survey. Qualitative spot checks were conducted in the intertidal zone of Lap Sap Wan by recording the occurrence of species from visual reconnaissance surveys at three shore heights, i.e. high-shore, mid-shore and low-shore. Organisms encountered were recorded and their relative abundance noted. For the quantitative transect survey, a 20m horizontal (belt) transect (10m on either side of the cable alignment) along the shore was surveyed at each of the three shore heights, as shown on ***Figure B-2***.

B.6.4 At each height, five quadrats (25cm x 25cm) were placed with an interval of 5m to assess the abundance and diversity of flora and fauna (Sn = 5 quadrats x 1 transect x 3 heights = 15). Wherever sandy bottom was present in the quadrat, sediment (in a depth of 20 cm) was wet-sieved *in situ* (mesh size of 2 mm) to obtain all mobile organisms living on, or in, the sediment within each quadrat.

B.6.5 All organisms found in each quadrat were identified and recorded to the lowest possible taxonomic level to allow density per quadrat to be calculated. Sessile species, such as algae (encrusting, foliose and filamentous), barnacles and oysters, in each quadrat were also identified and estimated as percentage cover on the rock surface.

Benthic Grab Survey

B.6.6 Four sampling sites with an inter-distance of approximately 50m were located along the alignment from inshore to offshore, as shown on ***Figure B-2***. The four sampling sites were fixed with a GPS device on board (***Table B-3***). At each sampling site, three sediment samples were taken with a Van Veen Grab (surface area 0.1 m^2). The sediment texture and colour were recorded and photographed on board.

Table B-3 AAE-1 Cable Project – Benthic Survey Details (2015)

Site	Co-ordinates		Dry Season (29 March 2015)			Wet Season (3 May 2015)		
	Latitude (N)	Longitude (E)	Time	Depth	Tide	Time	Depth	Tide
CD1	22˚ 12.706' N	114˚ 15.341' E	11:00	7.8	Flood	8:20	9	High
CD2	22˚ 12.721' N	114˚ 15.379' E	11:25	11.9	Flood	8:35	10.5	High
CD3	22˚ 12.757' N	114˚ 15.451' E	11:38	14	Flood	9:25	17	High
CD4	22˚ 12.788' N	114˚ 15.526' E	12:00	19	Flood	9:35	22	High

B.6.7 The sediment samples were washed gently with sea water through a sieve box with mesh size of 0.5mm. After the fine sediment portion was washed away, the sediment residuals with benthic fauna were transferred into a labelled plastic container. Large or fragile fauna (if found) were kept in another labelled plastic vial. Rose bengal solution (10-20ml, 0.5%) and ethanol (70%) were added to the containers and vials for fauna staining and preservation.

B.6.8 After arrival at laboratory, the samples were stored for one day to allow for sufficient staining and preservation. The preserved fauna were sorted out from the sediment residues and identified to the lowest possible taxonomic level. For every sample, the number of individuals of every species/taxon was recorded by counting the number of anterior portion. The total wet weight of every species/taxon was recorded by weighing the specimens to nearest 0.0001g after air-drying on a filter paper for three minutes.

Subtidal Dive Survey

B.6.9 In April 2015, a Rapid Ecological Assessment (REA) survey was undertaken at six selected locations (L1-L6) where direct impact is anticipated along the cable alignment and four subtidal sites (L7-L10) along the coastal areas of Lap Sap Wan, as shown on ***Figure B-2***.

B.6.10 The REA survey was performed along a 50m transect parallel to the coastline at each location/site. Substrate type along the transect was recorded at 1m intervals. The benthic cover, taxon abundance, and ecological attributes along the transect were recorded in a swathe of 2m wide, 1m either side of the transect. In terms of corals, their locations and associated substrates were recorded, size and health status (including percentage cover of bleaching, mortality and sedimentation) noted. The locations of the REA transects were recorded on site using handheld GPS unit (Garmin GPSMap 60CS). Pictures of representative taxa along the transects were taken during the surveys.

B.6.11 Two major types of information were recorded: (1) Cover of the major benthic groups, and (2) Inventory of sessile benthic taxa; and they were assessed according to Tier I and Tier II levels of information.

Tier I: Categorization of Ecological (Benthic Cover) and Environmental Variables

B.6.12 To describe the benthic cover, six substrate and seven ecological attributes (Column A of ***Table B-4***) were assigned. Each attribute was given a rank from 0 to 6 (Column B of ***Table B-4***), based on the overall cover along the survey area.

Tier II: Taxonomic Inventories to Define Types of Benthic Communities

B.6.13 An inventory of benthic taxa was compiled during each survey. Taxa were identified either *in situ* or with the aid of photos to confirm identification afterward. Each taxon in the inventory was given a rank (0 to 5) on the basis of its abundance in the community at the site (Column C of ***Table B-4***):

- Hard corals (Order Scleractinia): to genus and species level where possible;
- Soft corals (Subclass Octocorallia): to genus level where possible;
- Other benthos (such as sponges, zoanthids, bryozoans and macroalgae, etc.): to genus level where possible or phylum with growth form.

Table B-4 Benthic Survey Tier I and Tier II Information

A. Benthic Attributes		B. Percentage Cover		C. Taxon Abundance	
Substrate	Ecological Attributes	Rank	%age Cover	Rank	Abundance
Bedrock	Hard Corals	0	Not recorded	0	Absent
Boulders (>50cm)	Dead Coral Skeleton	1	1-5%	1	Sparse
Dead Corals	Soft Corals	2	6-10%	2	Uncommon
Rubble (<50cm)	Sea anemone beds	3	11-30%	3	Common
Sand with gravel	Encrusting Algae	4	31-50%	4	Abundant
Mud & Silt	Coralline Algae	5	51-75%	5	Dominant
	Erect Macroalgae	6	76-100%		

B.6.14 In September 2015, an additional dive survey was conducted along the cable alignment to assess the presence of corals from L3 (approximately 150m offshore) to 500m offshore (waypoints A-H on ***Figure B-2***, total survey distance of 350m), with a swathe of 10m wide, 5m on either side of the cable alignment.

B.6.15 The whole 350 x 10m area along the cable route was divided into seven sections (S1 to S7 on ***Figure B-2***). Divers conducted the underwater survey in a zigzag pattern in each section; the presence of any corals was recorded in a swathe of 5m wide, 2.5m either side of the zigzag line. The same information as that collected in the REA survey in April was recorded. For any corals found, the feasibility of translocation was also assessed.

B.6.16 The occurrence of amphioxus was examined qualitatively, by placing 50 x 50cm quadrats at 10m intervals in each section. In each 50 x 50cm quadrat, the divers examined the presence of amphioxus by slightly disturbing the upper layer (1-2cm) of the sediment.

Survey Schedule

B.6.17 A summary of all surveys undertaken for the Project is provided in ***Table B-5***.

Table B-5 AAE-1 Cable Project – Ecological Survey Programme (2015)

2015 Survey	Dry Season	Wet Season		Dry Season
	March	April	May	September
Intertidal Survey	✓	✓		
Benthic Grab Survey	✓		✓	
Subtidal Dive Survey		✓		✓

B.7 Survey Results

Intertidal Biota

B.7.1 Lap Sap Wan is a small bay stretching some 140m along the eastern coast of the D'Aguilar Peninsular. Sheltered by the headland, it is a gently sloping bay with limited vertical environmental variances. The substratum of the bay is dominated by rocks and occasionally large boulders, though coarse grains of sand gradually become prevalent in the lower intertidal zone and the sub-tidal zone.

B.7.2 A moderate diversity of intertidal biota was observed during the surveys, with a total of 62 species recorded. Of these, the most abundant species were the topshell *Monodonta labio*, the Sea Slater *Ligia exotica*, and an unidentified amphipod species, which were recorded from all transects from high shore to low shore, with the highest densities of 128, 80, and 78.7 individuals per m^2, respectively. Other dominant species in each defined shore height include the limpet *Cellana grata* in the high shore, the limpet *Patelloida pygmaea* in the middle shore, and the limpet *Cellana toreuma* in the low shore. The mean densities of each recorded fauna species (1.3 – 128 individuals per m^2) and mean percentage cover of sessile biota (0.1 – 16.7%) are considered to be low.

B.7.3 All of the recorded species are typical rocky shore species common and widespread in the similar habitats in Hong Kong. The intertidal biota assemblage found at Lap Sap Wan also resembles largely those in other rocky shore habitats in Hong Kong. No rare species or species of conservation concern were recorded during the surveys.

Benthic Grab Survey Results

B.7.4 Species number, density and biomass at each sampling site are summarised in ***Table B-6***. The taxa distribution was quite even at most sampling sites (especially CD2-CD4); hence no dominant taxon was determined.

Table B-6 AAE-1 Cable Project – Benthic Grab Survey Results

	Dry Season				Wet Season			
	CD1	CD2	CD3	CD4	CD1	CD2	CD3	CD4
Species number (spp. 0.3 m^{-2})	12	31	31	33	16	38	44	42
Density (ind. m^{-2})	137	460	403	510	160	720	680	627
Biomass (g m^{-2})	0.69	5.16	8.8	18.24	4.44	12.12	16.49	12.17
Shannon-Weaver Diversity Index *H'*	1.73	2.89	2.9	2.64	2.29	2.61	3.13	2.89
Pielou's Species Evenness *J*	0.69	0.84	0.84	0.76	0.83	0.72	0.83	0.77

B.7.5 In general, the biodiversity value and species evenness of the present survey were similar to that of the 'Eastern and Southern waters' group reported in the study of CityU 2002, which indicates an unpolluted status in the survey area, as shown in ***Table B-7***.

B.7.6 The benthic community at Lap Sap Wan is healthy due to good water quality. Without pollution stress, some sensitive species (intolerant to organic pollution) were found. Typically, amphioxus *Branchiostoma belcheri* (dominant at CD1, approximately 54% and

33% in terms of relative abundance at CD1 in the dry season and the wet season respectively) was a sensitive species distributing in clean sand of eastern waters of Hong Kong (Chen 2007). Sipunculan *Apionsoma trichocephalus* (dominant at CD4) was also reported to inhabit clean, fine sand of Tung Lung Chau waters (Lam 2007). Moreover, other commonly occurring polychaetes in the present survey were reported not correlated with organic enrichment such as *Eunice indica*, *Lumbrineris shiinoi* and *Onuphis eremita* (Borja *et al*. 2000).

Table B-7 Comparison of Lap Sap Wan Survey with Other Surveys

	Season	Lap Sap Wan	Shek O Quarry*	Tolo Harbour†	Eastern & Southern Waters†	Victoria Harbour†	Deep Bay†
H'	Wet	2.73	2.66	1.42	2.87	1.79	1.46
	Dry	2.54	2.77	1.36	2.82	1.64	2.32
	All	**2.63**	**2.72**	**1.39**	**2.85**	**1.72**	**1.89**
J	Wet	0.79	0.93	0.73	0.82	0.47	0.53
	Dry	0.78	0.93	0.83	0.81	0.44	0.73
	All	**0.78**	**0.93**	**0.78**	**0.82**	**0.46**	**0.63**

Notes:

* Neanthes, 2013. Benthic survey report of Shek O Quarry submitted to AECOM Asia Co. Ltd. Neanthes Eco-consultant Limited, pp 78.

† CityU (2002). Consultancy Study on Marine Benthic Communities in Hong Kong (Agreement No. CE 69/2000) submitted to Agriculture, Fisheries and Conservation Department, HKSAR Government. Centre for Coastal Pollution and Conservation, CityU Professional Services Limited.

B.7.7 In the survey carried out for the AAE-1 Cable, a total of 28 and 48 individuals of amphioxus *Branchiostoma belcheri* were collected in dry season and wet season samplings, respectively. The maximum site density was 73 ind/m^2 in the wet season and 53 ind/m^2 in the dry season, with lower densities further from the beach. It should be noted that this density is relative low, compared to more significant populations elsewhere – densities of 460 ind/m^2 and 290 ind/m^2 were reported at Tai Long Wan and Pak Lap Wan in Sai Kung (Chen, 2007). *B. belcheri* is the most common amphioxus species in Hong Kong; elsewhere it is reported in South China Sea and is abundant in Xiamen (Chin, 1941).

B.7.8 The life expectancy of *B. belcheri* is about three to five years (Chin, 1941). It becomes sexually mature at age two (Chen *et al.* 2008) and its spawning period in Hong Kong is between June and July (Chen, 2007). In the wet season sampling (May 2015), three individuals (body length 30-38 mm, about two years old) were sexually mature. It indicated larger-sized individuals in this area, if any, would reach sexual maturity for spawning in the coming months.

B.7.9 However, there were very few large individuals (two to three years old) of *B. belcheri*, which suggests that most of the individuals might have survived only one to two years after their first spawning. In general, Lap Sap Wan would be a suitable habitat for juvenile amphioxus and their first spawning. But life expectancy of the local population was not high while the overall population size maintained at a low level.

B.7.10 Given the above, the ecological significance of Lap Sap Wan to amphioxus is considered to be low to moderate at a maximum extent, i.e. the populations of amphioxus within Lap Sap Wan is not considered to be significant, either in regional or local terms.

B.7.11 Amphioxus is listed as a Category II protected species in Mainland China, however, there is currently no statutory protection for amphioxus in Hong Kong.

Subtidal Dive Survey Results

REA Survey in April 2015

B.7.12 The locations of all corals surveyed are shown on ***Figure B-3***. A selection of photographs from the dive survey sites and corals along each transect are shown in ***Figure B-4***.

B.7.13 All hard substrates including bedrock, boulders and rubble were mainly observed in shallow water (>6.5m below Chart Datum). Seabed at lower depth was dominated by coarse sands or fine sands, with sparse distribution of rubble and boulders. All corals were only observed on hard substrates in shallow water; no coral was found on soft (sandy) seabed.

B.7.14 A total of 126 hard coral colonies was found along seven of the ten transects at Lap Sap Wan. Sizes of the hard coral colonies ranged from 50 to 6,000 cm^2. All hard coral colonies were generally healthy, with only few colonies showing low levels of sedimentation (0-10%), bleaching (0-10%) and partial mortality (0–10%). Most of the hard and soft coral colonies were associated with boulders and bedrock; only few colonies were associated with rubble.

B.7.15 The species diversity of coral community at Lap Sap Wan was low. Colonies were medium to large in size, with encrusting growth form and patchy distribution. A total of 14 hard coral species in seven families were observed. The hard coral species were *Plesiastrea versipora* (Family: Faviidae*)*, *Cyphastrea serailia* (Faviidae), *Favites rotumana* (Faviidae), *Favites pentagona* (Faviidae), *Leptastrea pruinosa* (Faviidae), *Favia favus* (Faviidae), *Goniopora stutchburyi* (Poritidae), *Porites* sp. (Poritidae), *Psammocora superficialis* (Siderastreidae), *Psammocora* sp. (Siderastreidae), *Montipora turgescens* (Acroporidae), *Turbinaria peltata (*Dendrophylliidae*)*, *Pavona decussata* (Agariciidae) and *Hydnophora exesa* (Merulinidae).

B.7.16 Among the above hard coral species, *Montipora turgescens (*recorded at Site L1) is considered to be rare and is prevalent in eastern and northeastern waters of Hong Kong (Chan et *al.,* 2005). Except for *Psammocora superficialis*, which is abundant and identifiable during the dive survey*,* there are three other *Psammocora* sp. present in Hong Kong, namely *Psammocora haimeana*, *Psammocora profundacella, and Psammocora nierstraxzi.* All of these (recorded at Sites L1 and L3*)* are considered to be either uncommon or rare. The genus *Porites* is represented by five species in Hong Kong, of which *Porites aranetai*, *Porites deformis*, and *Porites solida* are considered to be either uncommon or rare in a local context (Chan *et al.*, 2005). *Porites* sp. was recorded at Sites L1, L2, L7, L8, L9 and L10 during the dive survey.

B.7.17 However, in terms of the status of IUCN Red List of Threatened Species, all of these rare and uncommon hard coral species are considered to be of “Least Concern”, except for two *Potrites* species – *Porites aranetai* is considered to be “Vulnerable” and *Porites deformis* to be “Near Threatened”.

B.7.18 Among the seven sites with hard corals, Site L10 had the highest number of hard coral colonies (32 colonies of six species), followed by Sites L8 (29 colonies of ten species), L1 (27 colonies of eight species), L2 (20 colonies of seven species), L7 (seven colonies of seven species), and L9 (seven colonies of two species).

B.7.19 A total of 17 soft coral colonies was found along three of the ten transects at Lap Sap Wan. The colony size ranged from 15 to 50 cm in height. All soft coral colonies were generally healthy, without any observed sedimentation, bleaching or partial mortality. Among the three sites with soft corals, Site L10 had the highest number of soft coral colonies (11 colonies), followed by Sites L2 (five colonies) and L8 (one colony). Only one species *Dendronephthya* sp. (Family: Nephtheidae) was recorded, which is a very common species in Hong Kong.

B.7.20 No other sessile taxa of high conservation interest were recorded in the Study Area.

Additional Dive Survey in September 2015

B.7.21 The locations of all corals surveyed are shown on ***Figure B-3***. A selection of photographs from the dive survey sites and corals along each transect are shown in ***Figure B-5***

B.7.22 The further study, which examined in detail the presence of corals along the AAE-1 Cable alignment after L3 to 500m offshore, confirmed that among the seven sections, only two hard coral colonies (*Psammocora superficialis* and *Plesiastrea versipora*) were found at S1 and three soft coral colonies (two colonies of *Euplexaura* sp. and one colony of *Dendronephthya* sp.) at S3. All of these colonies were generally healthy and small in size (size of the hard coral colonies from 150 to 400 cm^2, height of the soft coral colonies from 4 to 10cm), and all of them are common species in Hong Kong waters. No hard or soft corals were observed in the other sections.

B.7.23 All of the hard and soft coral colonies recorded along the AAE-1 Cable alignment from L3 onwards were associated with rubble (<50 cm in diameter), and therefore are considered feasible for translocation if needed.

B.7.24 Neither amphioxus nor other sessile taxon of conservation interest was recorded along the seven sections of the AAE-1 Cable alignment from L3 onwards during the additional dive survey.

B.8 Impact Assessment

B.8.1 Potential impacts on marine ecological resources arising from installation of the submarine cable include those caused by direct disturbance to habitats and their associated marine organisms and those resulting into perturbation to water quality parameters through sediment plumes generated during cable laying.

Direct Impacts During Installation

B.8.2 Installation of the AAE-1 Cable will combine three methods, namely, in a HDD duct around 5m below the seabed for the first 300m; surface laying on rocky seabed by divers for 300m to 500m; and simultaneous cable laying and burial at 5m below marine deposits by a cable burial tool towed behind a cable-laying barge from 500m onwards.

Ch.0m to Ch.300m – HDD Duct

B.8.3 For the first 300m, the cable will be located in a duct drilled 5m below the seabed using HDD. At this depth, there should be no vibration from drilling at the seabed surface.

B.8.4 As explained in ***Section 1.6***, to avoid any potential leakage of the drilling fluid into the marine environment when the drill head breaks out of the bedrock, drilling fluid will not be used for the final 5m of drilling. Divers will be on hand to ensure that there are no environmental problems when the drill head breaks out of the seabed.

B.8.5 As suggested by the results of dive surveys in April and September 2015, all of the corals in the vicinity of the AAE-1 Cable alignment occur in the first 275m from shore. By using a HDD duct for the first 300m (i.e. beyond the three soft coral colonies at S3 shown on ***Figure B-3***), there will be no impact on the coral community in the first 300m.

B.8.6 The amphioxus *B.belcheri* inhabit the surface layer of sand sediment (Chen, 2007) and was identified during the benthic survey in Lap Sap Wan, however, numbers were not locally or regionally significant. Nevertheless, because the AAE-1 Cable will be installed in a duct drilled into rock below the seabed, there will be no impact to any amphioxus in the top layer of the seabed in the first 300m.

B.8.7 Overall, there will be no impacts to marine ecology or habitat in the first 300m.

Ch.300m to Ch.500m – Surface Laying by Divers

B.8.8 The cable is only 100mm in diameter and will be placed inside an Articulated Pipe (AP) for protection. The AP has a slightly larger diameter than the AAE-1 Cable. The AP will be affixed to the rocky seabed by divers using steel bolts.

B.8.9 The additional dive survey in September 2015 did not identify any coral species present within the 10m corridor centred around the AAE-1 Cable alignment from Ch.300m to Ch.500m where the AP will be laid. The additional survey did not identify amphioxus, although they may have been present but unseen.

B.8.10 As noted by Chen (2007), however, amphioxus is an agile benthic animal, which when disturbed will quickly leave their burrow, swim a short distance and rapidly burrow again. Thus, any amphioxus will move from the location where divers are affixing the AP to the seabed and return when the divers have moved on.

B.8.11 Overall, there will be no significant impacts to marine ecology or habitat from Ch.300m to Ch.500m.

Ch.500m Onwards – Burial in Marine Deposits by Cable Burial Tool

B.8.12 Prior to the actual cable laying operation, a Route Clearance (RC) operation and Pre-lay Grapnel Run (PLGR) operation are scheduled, aiming at removing Out of Service cables and any debris or obstacles which may have been deposited in the cable corridor. The clearance area for the RC and PLGR operations will cover 5m on both sides of the centreline of the cable alignments (i.e. a total width of 10m). The PLGR is carried out very quickly and does not result in significant disturbance to the seabed and no adverse environmental impacts are expected during the PLGR.

B.8.13 After the RC and PLGR operations, “Injector Burial Tool” or “Sledge Tool” will be employed to lay and bury the cable.

B.8.14 From 500m onwards there will be no coral as there is no hard substrate. In terms of amphioxus, as mud becomes more abundant the habitat becomes less suitable and their density would further decline. In view of the small-scale and temporality of the cable laying works, the low to moderate habitat value of Lap Sap Wan to amphioxus, as well as the agility of this benthic animal, the impact on amphioxus due to the potential habitat loss is considered to be of low significance.

B.8.15 For other benthic infauna present along the AAE-1 Cable alignment, during cable laying and burial those that are less mobile may be damaged by the high pressure water jet, which may also uncover previously buried species and expose them to predation while suspended in the water column. However, such invertebrate mortality would be localised within the jetting width of 0.5m and only occur after 500m from shore. As the water jet passes over the seabed the cable will sink through the fluidised mud on its own weight, with the sediment consequently reconsolidating as the Burial Tool passes.

B.8.16 As revealed by past studies of benthic re-colonisation of seabed areas subject to mechanical disturbances, it can be expected that initial recolonisation would occur within several weeks to a couple of months following jetting (Santos and Simon, 1980). Field survey data indicated that the characteristics of the benthic infauna community at Lap Sap Wan are rather consistent across most of the sampling sites. In view of such low spatial heterogeneity, as well as the narrow width of the jetting zone which facilitates re-colonisation by species from adjacent seabed areas, the overall direct impact on the benthic infauna community is anticipated to low.

Indirect Impacts During Construction

B.8.17 Indirect impacts on marine ecological resources during construction include sediment release associated with the jetting works, the increase in underwater sound from marine vessels, and potential collision of marine mammals with the cable laying vessel.

Suspended Solids and Other Water Quality Induced Impacts

B.8.18 The cable laying works 500m from shore by jetting will have an influence on sediment transport, discussed in ***Annex A***, which concluded the maximum distance of transport for fine suspended sediments would be 60m from the cable burial machine in proximity to Cape D'Aguilar Peninsula and 180m within the established east-west cable corridor.

B.8.19 Frequently disturbed by storms, seabed currents and from previous trawling activities in Hong Kong, which all rework the sediments and create high suspended sediment loads in water column, the infaunal community in mobile subtidal soft bottom habitats such as mud and sands are generally well adapted to regular disturbances and quite tolerant to increased turbidity and suspended sediments. Benthic invertebrates are therefore not likely to be adversely affected by the jetting works in terms of sediment suspension and settlement.

B.8.20 Amphioxus is relatively vulnerable to increased silt deposition on substratum. Its oral cirri could be damaged by elevated suspended solid concentration (≧100 mg/L) in water (Chen 2007). However, the population size of amphioxus at Lap Sap Wan is small and it comprises only the most common amphioxus species in Hong Kong. Although Lap Sap Wan would be a suitable habitat for juvenile *B. belcheri* and their first spawning, similar recruitment sites for amphioxus were not uncommon in Hong Kong waters. Amphioxus populations of similar density (<100 ind. m^{-2}) were reported in other areas. Some of them have even experienced anthropogenic disturbance (e.g. dredging or coastal modification) such as Hoi Ha Wan Marine Life Centre (Neanthes 2008), Shek O Quarry (Neanthes 2009, 2013), Yim Tin Tsai (Neanthes 2014a) and Sharp Island (Neanthes 2014b). It reflects that amphioxus could tolerate the disturbance at limited scale and in a short term, as long as desirable water quality and suitable substratum can be maintained in a long run.

B.8.21 Installing the cable in a duct below the seabed and then surface laying by divers will not result in a significant elevation of suspended solids for the first 500m. However, movement and operation of the cable laying barge from 500m onwards may stir up the sea bottom and re-suspend sediment. However, since there are no coral communities at 500m from shore, there will be no adverse impacts.

B.8.22 With the implementation of good operational practice of the cable laying barge e.g. no overloading and avoid movement during low tide in shallow water, no unacceptable adverse impacts on the coral communities are expected.

B.8.23 In terms of marine mammals which routinely travel long distances through Hong Kong waters, they would be able to swim into open waters to avoid the short term and small scaled sediment impact. Also, as marine mammals surface to breathe, their respiratory surfaces are not affected by suspended sediment in the water (BTM, 2009). Therefore, the impact of water quality on marine mammals as a result of the increased suspended solids near the submarine cable route is unlikely.

Underwater Noise

B.8.24 An increase in underwater noise and vibration is anticipated to occur during the cable installation works, resulting from both marine vessels and water jet. Marine mammals, in particular finless porpoises which frequent the southeastern waters of Hong Kong during the wet season (June - November), are sensitive to the impacts of marine noise, because they use sonar clicks for communication, navigation and prey location.

B.8.25 Studies of the finless porpoise suggest that it produces sonar clicks at a peak frequency of 142 kHz (Goold and Jefferson, 2002). With regard to the potential construction phase impacts, marine jetting works and large marine vessels typically emit sound in the range of 0.02 to 1 kHz (Goold and Jefferson, 2002; Popper *et al*. 2003), which is generally below the hearing range of finless porpoises. Construction noise levels are also generally below the 8 - 90 kHz hearing range of Chinese White Dolphins as reported by Richardson *et al*. (1995), although this species is uncommon outside its preferred estuarine habitat in the western waters of Hong Kong. It is therefore anticipated that there would be no significant adverse impact on marine mammals caused by the cable installation works, which will be temporary and carried out by one slow moving cable installation barge.

Collision with Marine Vessels

B.8.26 Surveys of marine mammals in Hong Kong on a regular basis since 1995 have revealed a correlation between the decline of marine mammal population and the increase in high-speed traffic in some areas of Hong Kong waters, such as northern Lantau waters (Hung, 2012). However, compared to high-speed vessels, whose speed can reach 40 to 80km/hr, the speed of the cable laying vessel is estimated at 300m/hour to 1km/hour only. In view of such slow speed of the cable burial vessel whilst working, collisions between marine mammals (especially finless porpoises in this case) and the vessel are therefore considered to be unlikely.

Impacts on SSSI and Marine Reserve

B.8.27 As calculated in ***Annex A***, the maximum distance of transport for fine suspended sediments is predicted to be 60m from the cable burial machine in proximity to Cape D'Aguilar Peninsula. Such limited dispersion of sediment plume would not reach Hok Tsui (Cape D'Aguilar) SSSI or Cape D'Aguilar Marine Reserve, which are 215m from the nearest point of the alignment. Also given the small scale of the work and its short duration in proximity to the SSSI and Marine Reserve, the indirect impact of cable installation due to the increase in suspended solids should not be significant.

B.9 Mitigation Measures

Guiding Principles

B.9.1 Annex 16 of the EIAO TM sets out the principles of mitigation for significant ecological impacts on marine ecological resources, which, in order of priority, are:

- **Avoidance.** Potential impacts should be avoided to the maximum extent practicable by adopting suitable alternatives.
- **Minimisation.** Unavoidable impacts should be minimised by taking appropriate and practicable measures such as constraints on intensity of works operations or timing of works operations.
- **Compensation.** The loss of important species and habitats may be provided for elsewhere as compensation. Enhancement and other conservation measures should always be considered whenever possible.

Avoidance

B.9.2 Cable laying requires minor works in the eastern waters of Hong Kong, and only small-scale engineering works associated with HDD will be undertaken at the landing site. The alignment of the AAE-1 Cable and the location of the landing site have been selected to avoid impact to key sensitive receivers, including CPA, Marine Reserve and SSSIs.

B.9.3 Also, most significantly, the first 300m of the cable from Lap Sap Wan will be installed by HDD method to avoid disturbing the ecologically sensitive habitats such as shorelines, intertidal and near shore areas where hard and soft coral are present. This represents full avoidance of impacts by significantly re-engineering the project to address ecological and environmental concerns.

Minimisation

B.9.4 Having avoided impacts to shorelines, intertidal and near shore areas where hard and soft coral are present, impacts from cable laying have been minimised by optimising the length of the AAE-1 Cable within Hong Kong waters. This has been achieved by identifying an alignment that minimises the cable length and also minimises the number of crossings of other cables.

Compensation

B.9.5 Given that avoidance and minimisation have been implemented, compensation is not considered necessary for this Project.

Precautionary Measures

B.9.6 As a precautionary measure, a Marine Mammal Exclusion Zone will be set up during the cable installation works, to avoid any impact on marine mammals (mainly expected to be finless porpoises) as a result of the short-term increases in underwater noise from the cable installation barge and its water jet.

B.9.7 A marine mammal exclusion zone within a radius of 250m from the cable installation barge will be implemented during the cable laying works in day-time hours. It begins when the installation barge moves out of Lap Sap Wan (500m from shore), continues on a daily basis as the barge heads eastwards, and ceases 10km from Lap Sap Wan, when the water quality monitoring also ceases. Monitoring details are presented in ***Annex E***.

B.10 Conclusion

B.10.1 A review of marine ecological resources has been conducted for Lap Sap Wan, which is the landing site of submarine cable AAE-1. Field surveys, including intertidal surveys, submarine dive surveys and benthic grab surveys, were carried out to fill the identified information gaps. Based on the baseline information gathered from literature review and field surveys, potential ecological impacts of the Project were assessed, with corresponding measures proposed to mitigate the impacts.

B.10.2 All of the recorded intertidal species at Lap Sap Wan were typical rocky shore species that are common and widespread in the similar habitats in Hong Kong. No rare species or species of conservation concern were found. The first 300m of the submarine cable from Lap Sap Wan will be installed by HDD method without disturbing the intertidal area. Therefore construction of the AAE-1 submarine cable would have no impact on the intertidal community at Lap Sap Wan.

B.10.3 The subtidal hard bottom habitats at Lap Sap Wan support a coral community of low diversity. The percentage covers of both hard and soft coral communities were low in general. According to the dive survey results, there were no coral colonies found in the 10m corridor of the proposed cable alignment after 275m offshore. Given that the HDD duct will break out around 300m offshore all the recorded corals will be avoided and there will be no direct impact on their habitat. In terms of the indirect impact on corals due to the increased suspended solids during construction phase, no unacceptable impact is anticipated in view of the small scale and short term of the Project and also with the implementation of good operational practice of the cable laying barges.

B.10.4 Individuals of amphioxus *Branchiostoma belcheri* were collected during the grab surveys – this is a species of conservation concern. Lap Sap Wan would be a suitable habitat for juvenile amphioxus and their first spawning, but life expectancy of the local population was not high and the population size was small. Hence the ecological significance of Lap Sap Wan to amphioxus was of low to moderate at a maximum extent. Use of HDD duct below the seabed for the first 300m will not disturb the important habitat of amphioxus. From Ch. 300m to Ch. 500m, the cable will be laid in AP by divers and any amphioxus present will swim away during installation.

B.10.5 Submarine generated by the jetting works would fall below the hearing range of finless porpoises, who are more likely to spend the wet season in the southeastern waters where the AAE-1 Cable will be laid. It is thus anticipated that no adverse impact on marine mammals would be caused by the cable installation works. However, as a precautionary measure, a marine mammal exclusion zone established during the cable installation works will prevent marine mammals from being adversely affected.

B.10.6 In summary, the proposed cable installation works are small in scale and localized in nature. Impacts on the marine ecological resources have been largely avoided through the selection of landing site, cable route and construction methods that avoid impacts for the first 300m due to use of HDD duct and thereafter minimise impacts through alignment and cable burial methods. The impact of cable installation is a one-off occurrence, after which subtidal species/habitats will begin recovery immediately. With the implementation of the suggested mitigation/precautionary measures, no unacceptable, adverse ecological impacts are expected to arise from the installation works of the submarine cable.

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Figure B-1 Major Ecological Elements of the Areas in the Vicinity of the AAE-1 Cable

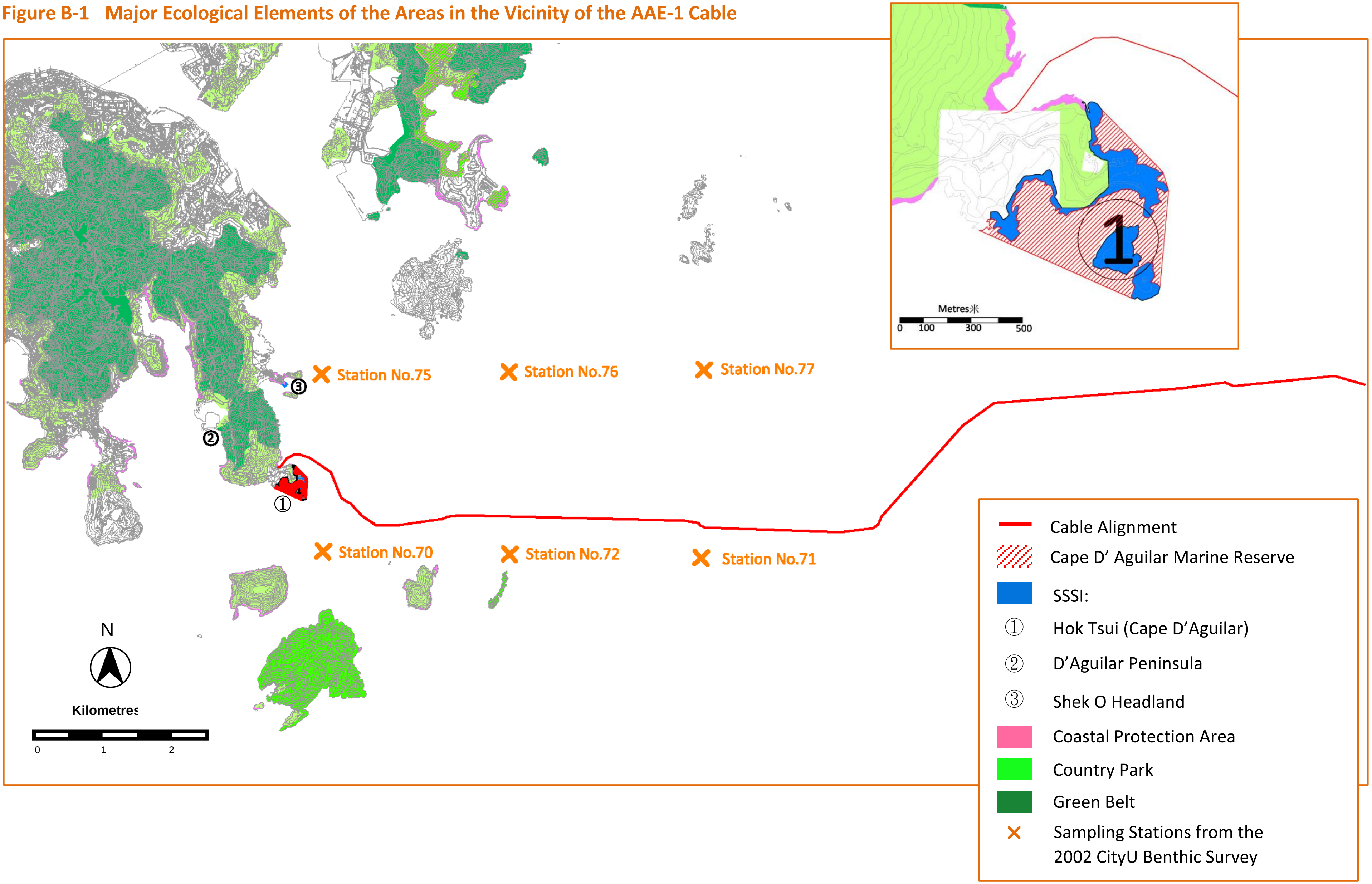


Figure B-2 Location of the Survey Transects and Sampling Points

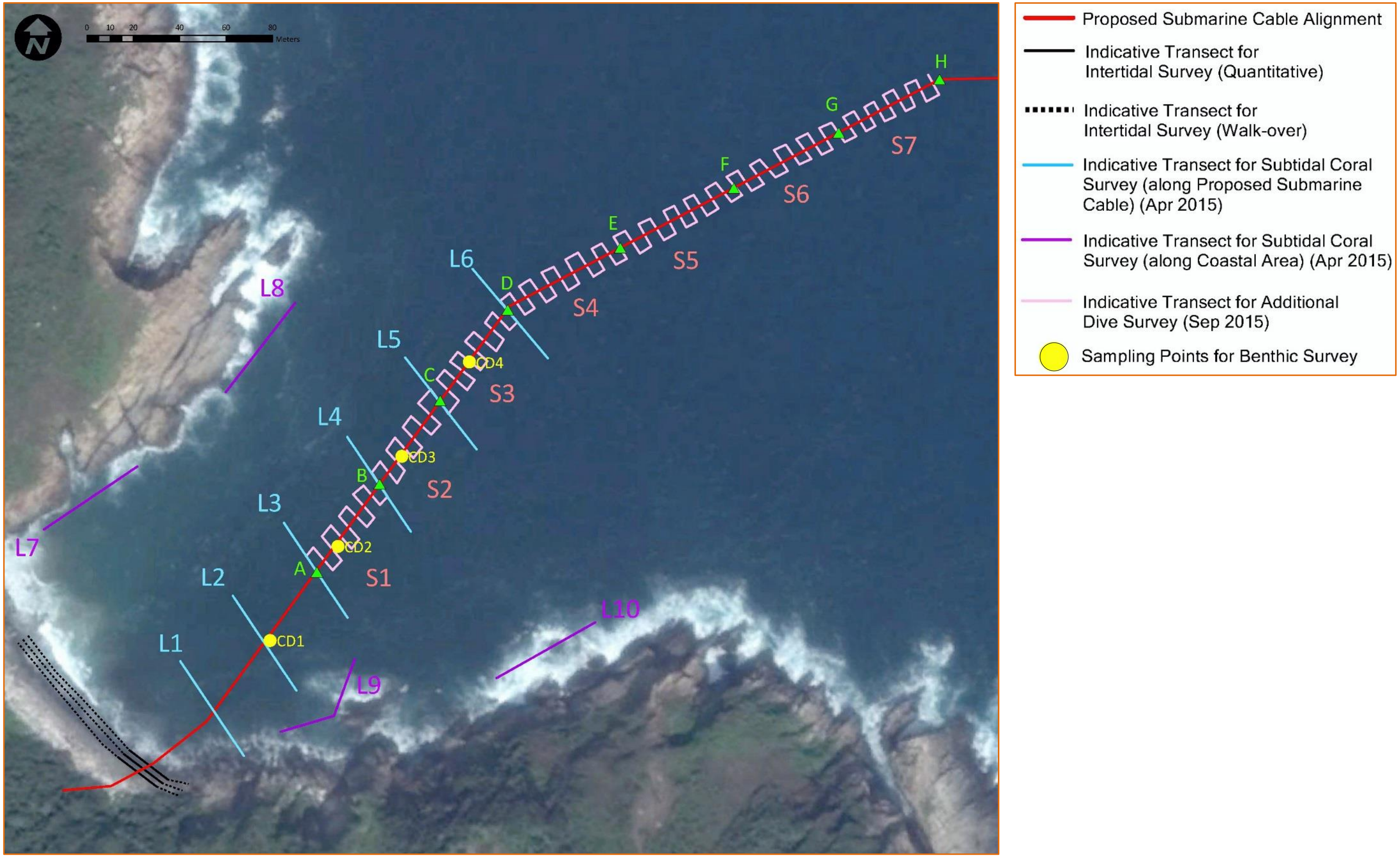


Figure B-3 Location of Corals Within Lap Sap Wan and Along the AAE-1 Cable Alignment

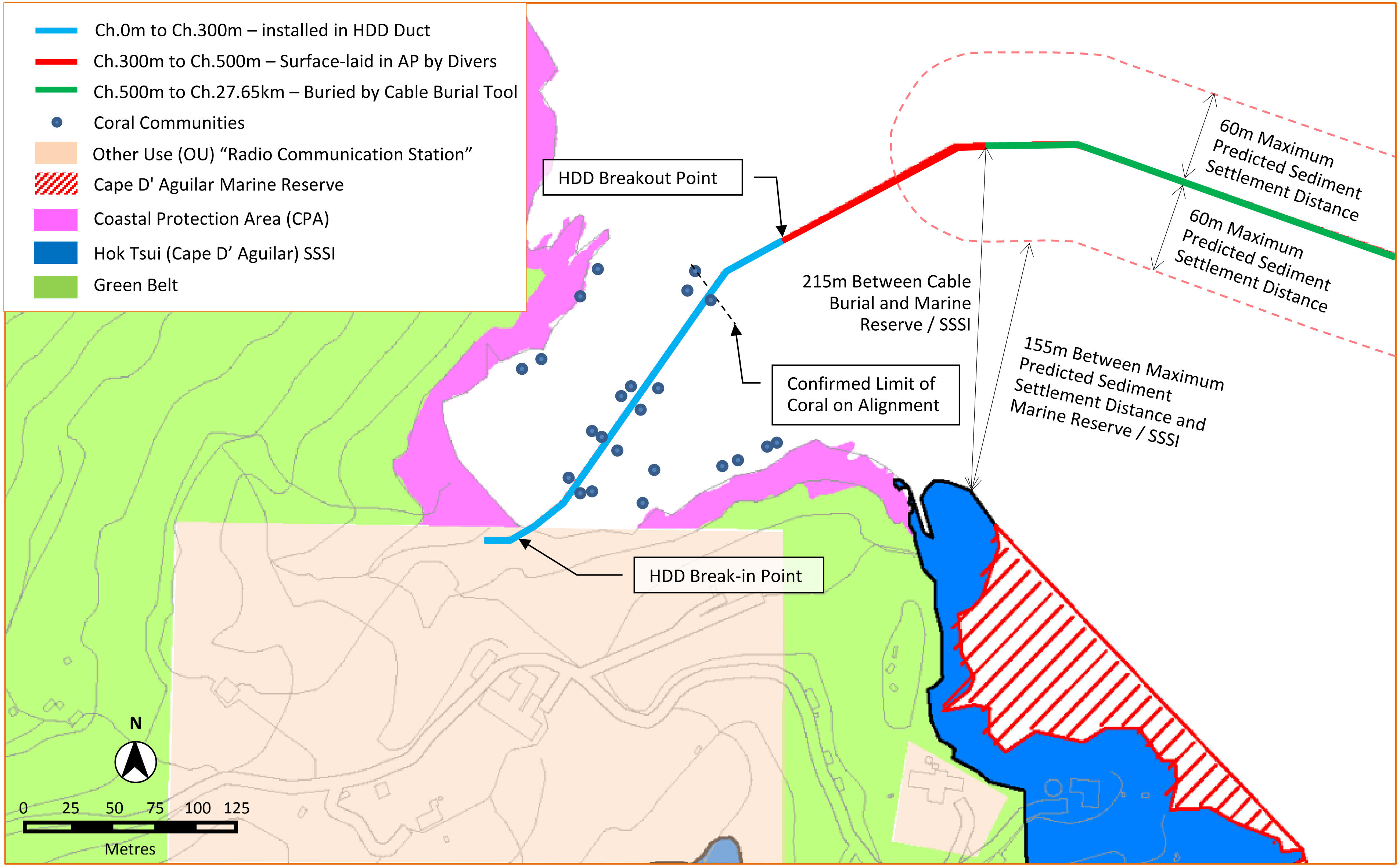
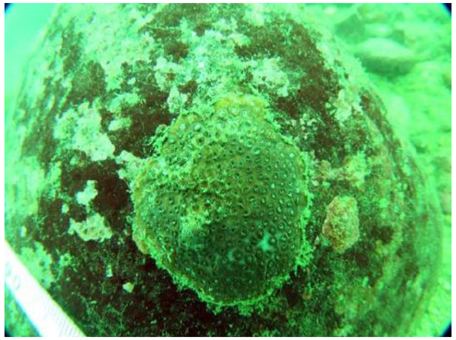


Figure B-4 Photographs of Corals in Lap Sap Wan Along Transects (April 2015)

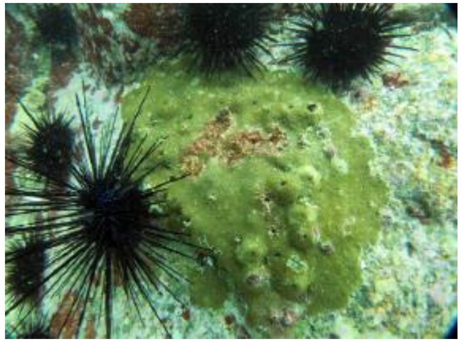
L1 Hard Coral (*Goniopora stutchburyi*)

L2 Hard Coral (*Plesiastrea versipora*)

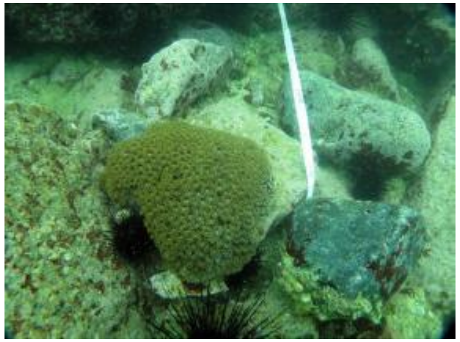


L3 Hard Coral *(Psammocora sp.)*

L7 Hard Coral *(Porites sp.)*

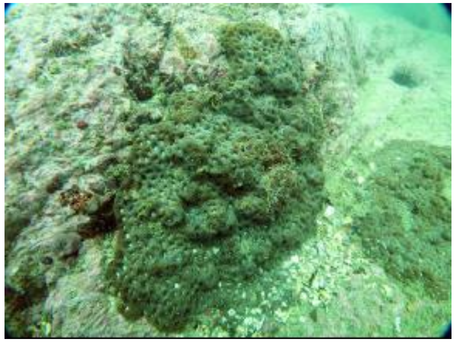


L7 Hard Coral *(Turbinaria peltata)*

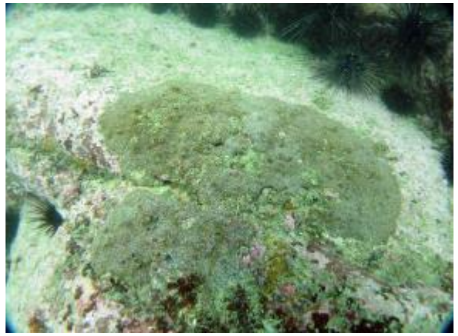


L8 Hard Coral *(Favia rotumana)*

L8 Hard Coral *(Favites pentagona)*

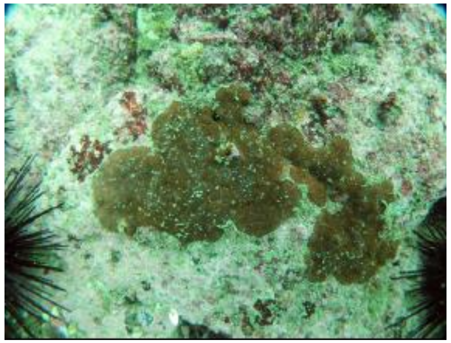


L8 Hard Coral (*Leptastrea pruinosa)*



L8 Hard Coral *(Pavona decussata)*

L8 Hard Coral *(Psammocora superficialis)*



L10 Hard Coral *(Cyphastrea serailia)*

L10 Soft Coral *(Dendronephthya sp.)*

Figure B-5 Photographs of Corals in Lap Sap Wan Along AAE-1 Cable Alignment from L3 Onwards (September 2015)

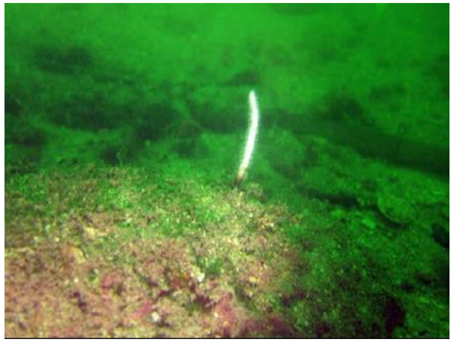
S1 Hard Coral (*Plesiastrea versipora*)

S1 Hard Coral (*Psammocora superficialis*)

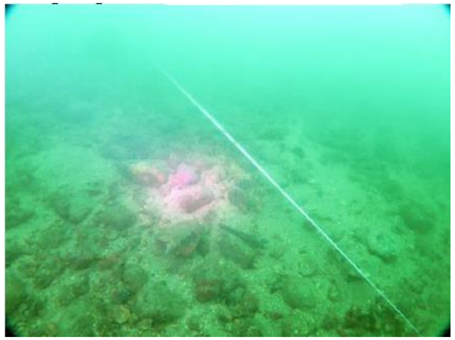
S1 to S4 Sponges

S3 Soft Coral *(Dendronephthya sp.)*

S3 Soft Coral *(Euplexaura sp.)*



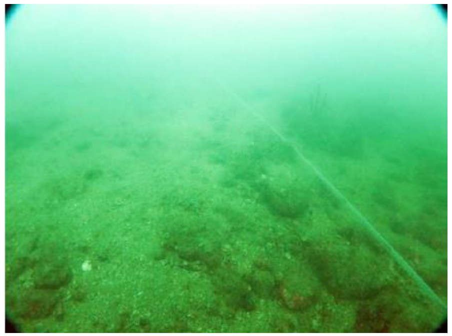
S1 Rubbles and Sandy bottom



S2 Rubbles and Sandy bottom

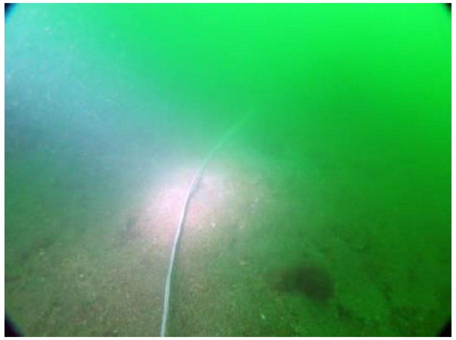
S3 Rubbles and Sandy bottom

S4 Rubbles and Sandy bottom



S5 Rubbles and Sandy bottom

S6 Rubbles and Sandy bottom



S7 Rubbles and Sandy bottom

ANNEX C

Potential Impacts to Fisheries

CONTENTS

FIGURES

FIGURES

C POTENTIAL IMPACTS TO FISHERIES

C.1 Introduction

C.1.1 This Annex provides an assessment of impacts to the existing fisheries resources and fishing operations within and adjacent to the proposed AAE-1 Cable alignment and evaluates the potential impacts to these resources.

C.1.2 The Cable will traverse waters, including spawning grounds, where fishing is permitted.

C.1.3 In Hong Kong, the marine fishing industry refers to "Capture Fisheries" only. Information and data can be obtained from the Agriculture, Fisheries and Conservation Department (AFCD) to access the potential impacts on the fishing industry that could occur along the cable alignment.

C.1.4 Baseline information has been obtained from the AFCD website[Ref.1] and from recent and relevant studies in the vicinity of the AAE-1 Cable alignment to determine whether the waters surrounding the AAE-1 Cable are important spawning grounds or nursery areas for commercial fisheries – the most up-to-date Port Survey from 2006[Ref.2] has been referenced, together with other relevant studies[Ref.3]. Mariculture information was obtained from the latest AFCD annual report[Ref.4].

C.1.5 There are no gazetted Fish Culture Zones (FCZs) within 500m of the cable alignment – the nearest are Po Toi FCZ, located some 4.9km from the cable and Tung Lung Chau FCZ, located more than 5.5km from the cable, both of which are too far away to be affected by cable installation works. The cable does not pass through any nursery grounds, although it does pass through spawning grounds.

C.1.6 The western part of the AAE-1 Cable lies within Southern Water Control Zone (WCZ) and the eastern part lies within Mirs Bay WCZ. Special attention has been given to the fishing activities and spawning grounds along the alignment, and to Po Toi FCZ and Tung Lung Chau FCZ, which is located further away.

C.2 Relevant Legislation

C.2.1 The *Technical Memorandum of the Environmental Impact Assessment Ordinance* (EIAO-TM) of Annex 9 and 17 specify the criteria and evaluating fisheries impact and provide guidelines for carrying out a fisheries impact assessment. Other regulations also apply to fisheries resources, namely:

- Fisheries Protection Ordinance (Cap 171).
- Marine Fish Culture Ordinance (Cap 353).
- Water Pollution Control Ordinance (Cap 358).
- Marine Parks Ordinance (Cap 476).
- Environmental Impact Assessment Ordinance (Cap 499).

1. https://www.afcd.gov.hk/english/fisheries/fish_aqu/fish_aqu_mpo/fish_aqu_mpo.html
2. *Port Survey 2006*, AFCD (2007).
3. ERM - Hong Kong, Ltd (1998) *Fisheries Resources and Operations in Hong Kong Water*. Final Report for the AFCD.
4. *AFCD Report 2013-2014.*

C.2.2 These regulations and guidelines are applicable in assessing fish impacts and regulate fishing practices.

C.3 Existing Situation

Fishing Background

C.3.1 Commercial fishing provides an important contribution to Hong Kong in maintaining a steady supply of fresh marine fish to local consumers. In 2014, Hong Kong fishermen provided an estimated 160,789 tonnes of fisheries produce valued at about HKD 2,530M. According to the AFCD website, the industry now consists of some 4,500 fishing vessels and some 9,400 local fishermen working aboard and provides employment in ancillary sectors servicing the fishing industry.

C.3.2 The fisheries industry in Hong Kong comprises capture and culture fisheries. The combined production of these for mariculture sectors accounted for about 28% of all seafood consumed in Hong Kong (*AFCD Report 2013-2014*).

C.3.3 The latest comprehensive survey of fisheries was undertaken as part of the Port Survey 2006, which provided a grid analysis of fishing operations covering Hong Kong waters, with each grid cell representing 720ha. The study compiled information on fisheries production and fishing operations in Hong Kong and has been useful in setting out fisheries management strategies and assessing potential environmental impacts of marine development projects on fisheries.

C.3.4 The following assessment has been based on the Port Survey 2006, other relevant and more recent studies, and from a review of information from AFCD's Annual Reports.

Capture Fisheries

C.3.5 Capture fishing activities for Hong Kong are mainly conducted in the waters adjacent to the continental shelf in the South China Sea. The majority of fishing vessels are family-operated businesses with the main fishing methods being trawling, long-lining, gill-netting and purse-seining, with the majority of the total catch obtained through trawling.

Fisheries Operations

C.3.6 The southern waters of Hong Kong have been identified as important spawning grounds and nursery areas for both fish and crustaceans.

C.3.7 The AAE-1 Cable traverses 12 Port Survey Grids, in which three grids showed <50 vessels, four grids showed 50 to 100 vessels, four grids showed 100 to 400 vessels and one grid showed 400 to 700 vessels, as shown on ***Figure C-1***. The distribution of Fishing Operations with vessels not exceeding 15m in length is shown on ***Figure C-2***, where six grids showed <10 vessels, one grid showed 10 to 50 vessels, and four grids showed 100 to 400 vessels. The distribution of fishing operations with vessels exceeding 15m in length is shown on ***Figure C-3***, where two grids showed <10 vessels, three grids showed 10 to 50 vessels, four grids showed 50 to 100 vessels and three grids showed 100 to 400 vessels.

Fisheries Production

C.3.8 The latest Port Survey[Ref.2] shows that fisheries production from the grids traversed by the AAE-1 Cable range from >0 to 50kg/ha to 400 to 600kg/ha, in which the majority of the grids show less than 200kg/ha, as shown on ***Figure C-4***.

C.3.9 A similar pattern arises from the grid analysis of fisheries production in terms of value of adult fish and fish fry per hectare, as shown on ***Figure C-5***. Fisheries production of adult fish and fish fry was highest (at HKD 2,000 to HKD 10,000/ha) in the western half of the cable alignment and lowest (at >HKD 0 to HKD 2,000/ha) in the eastern half.

Fish Fry Production / Spawning Grounds

C.3.10 The southeastern and eastern waters have been recognised[Ref.3] as spawning grounds for high value commercial species. The key species recorded spawning in the southern waters include *Cynoglossus macrolepidotus* (Largescale Tonguesole) and *Pseudosciaena crocea* (Yellow Croaker). Species recorded spawning in the eastern waters include *Apogon quadrifasciatus* (Twostripe Cardinal), *Parapristipoma trilineatum* (Chicjen Grunt), *Sebastiscus marmratus* (Common Rockfish), *Trichiurus lepturus* (Hairtail), *Upeneus sulphurous* (Sulphur Goatfish) and *Upeneus tragula* (Freckled Goatfish).

C.3.11 The latest Port Survey[Ref.2] shows that fish fry production from the area traversed by the AAE-1 Cable is low, with three grids showing production of >0 to 50 tails per hectare, as shown on ***Figure C-6***. This area was determined as important spawning grounds for commercial fisheries resources[Ref.3]. Generally, the seasonal abundance of fry in Hong Kong is at its highest between March and September for most commercial fish species with a peak between June and August; the majority of spawning of these species is concentrated between June and September. Commercially important crustaceans spawn between April and December.

C.3.12 ***Figure C-7*** shows the location of the Spawning Grounds and the AAE-1 Cable Alignment.

Nursery Areas

C.3.13 Nursey areas in Hong Kong waters are important habitat area for a number of commercial juvenile fish and crustacean species, which have been previously identified across southern waters from Lantau Island to Lamma Island.

C.3.14 There are no nursery grounds in the vicinity of the AAE-1 Cable alignment, as shown on ***Figure C-7***.

Artificial Reef Deployment

C.3.15 An Artificial Reef Deployment programme has been in effect since 1998 to enhance existing marine habitats and fisheries resources through the siting, construction and deployment of Artificial Reefs. Artificial Reefs provide hard bottom, high profile habitat in areas without natural cover and may potentially act as fish enhancement devices. AFCD deployed a total of 103,270m^3 of Artificial Reefs on the seabed of the outer Port Shelter WCZ to prevent trawling and enhance habitat quality and marine resources.

C.3.16 There are no Artificial Reefs in the vicinity of the AAE-1 Cable alignment, as shown on ***Figure C-7***.

Culture Fisheries

C.3.17 Mariculture fisheries involve rearing marine fish in cages suspended by floating rafts in sheltered coastal areas. According to the AFCD website[Ref.1] in 2014, there were 968 licensed operators in the 26 FCZs designated under the Marine Fish Culture Ordinance. These occupied a sea area of 209ha with an estimated production in 2014 of 1,225 tonnes, or about 6% of all locally consumed live marine fish.

C.3.18 The nearest FCZs to the AAE-1 Cable are Po Toi FCZ, located some 4.9km from the cable and Tung Lung Chau FCZ, located more than 5.5km from the cable, as shown on ***Figure C-7***. Given this distance, no impact from cable burial works is expected at either FCZ.

Fisheries Importance

C.3.19 The fishing operations and fisheries resources in the vicinity of the AAE-1 Cable are of moderate commercial value. Apart from the moderate commercial value, the size of the fishing areas that will be temporarily occupied by the cable installation vessel as it traverses through Hong Kong waters is considered to be small. On this basis, the Project would be considered to be of low importance to the Hong Kong fishing industry.

Sensitive Receivers

C.3.20 The following the sensitive receivers listed in ***Table C-1*** have been identified.

Table C-1 Closest Distances of Fisheries Sensitive Receivers to the Cable Alignment

Category	ID	Sensitive Receiver Description	Closest Distance to AAE-1 Cable
Fish Culture Zone	F1	Tung Lung Chau FCZ	5.5km
	F2	Po Toi FCZ	4.9km
Nursery Grounds	--	To the north of the cable alignment	>12km
Spawning Grounds	--	The cable alignment passes through	0
Artificial Reefs	--	Artificial Reefs in Port Shelter WCZ	>8km

C.4 Impact Assessment

Direct Impacts

C.4.1 As indicated in ***Table C-1***, above, due to distance separation, installation of the AAE-1 Cable will not have any direct impacts on FCZs, Nursery Grounds or Artificial Reefs. The only potential impacts may be on Spawning Grounds through which the cable passes.

C.4.2 Lap Sap Wan, which is the landing point of the AAE-1 cable, is some 450m north of the recognised Spawning Ground in the Southern Waters WCZ and so installation of the cable in Lap Sap Wan should not have any significant impact on the Spawning Ground to the south and east.

C.4.3 The length of the AAE-1 cable within Hong Kong is 27.65km, of which the first 500m (from the Beach Manhole at Lap Sap Wan) is either within a duct drilled below the seabed or is affixed to the rock surface of the seabed within Lap Sap Wan. The remaining 27.15km of cable will be, except for the crossing of the HKE gas pipeline, buried up to 5m below the seabed in marine sediments.

C.4.4 As the cable laying vessel traverses across Hong Kong waters it will occupy part of the sea surface, which is thus unavailable for use by other marine vessels, including fishing vessels. However, this "temporary loss" of fishing grounds will be limited to 70m x 25m at any one time (i.e. the "footprint" of the vessel) and impacts from the presence of the cable laying vessel are no different to those from any other marine vessel passing through Hong Kong waters. Other than area occupied by the cable laying vessel, there is no other temporary loss of fishing grounds.

C.4.5 The majority of the AAE-1 Cable alignment is located within areas identified in ***paragraph C.3.10*** as Spawning Grounds of generally "low" fish fry production rate.

C.4.6 Although this might be considered as an interruption to any fishing operations that may have been occurring, it is no different than any other marine vessel – from sampans to container ships – traversing Hong Kong waters.

C.4.7 The cable burial machine – typically 6m x 1m – will occupy the seabed as it buries the cable that is fed down from the cable laying barge above.

C.4.8 The EIAO-TM states that Spawning Grounds can be regarded as an important habitat type as they are critical to the regeneration and long-term survival of many organisms and their populations. After the cable burial machine has buried the cable, the seabed will be reinstated naturally by resettlement of disturbed sediments, following which there will be immediate recolonization by benthic fauna that provide food for fish. Thus, there is only short-term and a minor disturbance to the seabed within the Spawning Grounds and this should not cause any significant impact to fisheries production.

C.4.9 These impacts would be of relatively short duration:

- Offshore Cable Installation (Ch.500m to Ch.27.65km) 28 days
- Cable Protection Work < 7 days

C.4.10 Overall, no long-term direct impacts to fisheries resources or fishing operations are expected to occur that would affect either fisheries resources or fishing operations, i.e. the direct impacts are not considered to be significant.

Indirect Impacts

C.4.11 As indicated in ***Table C-1***, above, due to distance separation, installation of the AAE-1 Cable will not have any indirect impacts on FCZs, Nursery Grounds or Artificial Reefs. The only potential indirect impacts may be on Spawning Grounds through which the cable passes.

C.4.12 Indirect impacts may occur through elevation in suspended solids resulting from the disturbance of the seabed during the burial of the cable. However, this disturbance will be localised, temporary and of short duration.

C.4.13 To account for site-specific current velocities in the waters surrounding the Cape D'Aguilar Peninsula, current data has been obtained from Marine Department (MD) for stations close to the Cape D'Aguilar Peninsula. Calculations (in ***Annex A***) indicate that any sediments disturbed during cable burial works from Ch.300m until the AAE-1 Cable enters the east-west cable corridor (approx. Ch.2.5km) will settle onto the seabed within 60m of the cable alignment in less than 3.5 minutes.

C.4.14 From approx. Ch.2.5km (where the AAE-1 Cable enters the established east-west cable corridor) to Ch.27.65km, current velocities have been adopted from approved Project Profiles for other cables that were also buried in the established east-west cable corridor. Calculations (in ***Annex A***) indicate that any sediments disturbed during cable burial works from approx. Ch.2.5km to Ch.27.65km will settle onto the seabed within 180m of the cable alignment in less than 3.5 minutes.

C.4.15 Burial of the AAE-1 Cable is therefore not expected to result in unacceptable impacts to water quality, particularly in terms of suspended sediments. As such, cable burial is not expected to result in any significant indirect impacts to fisheries.

Fisheries Impact Evaluation

C.4.16 An evaluation of the impact to fisheries is presented in ***Table C-2*** in accordance with EIAO-TM Annex 9:

Table C-2 Evaluation of Fisheries Impact

Aspect	Evaluation of Impact
Nature of Impact	The submarine cable will be installed over a 27.65km distance from Lap Sap Wan to the eastern boundary of Hong Kong. From Ch.500m out from the shore of Lap Sap Wan, the cable will be directly laid and buried using a cable burial machine, below the seabed. Direct impacts to the immediate seabed will result from cable laying and indirect impacts may result from elevation in suspended solids in the water column as a result of the burial process.
Size of Affected Area	The total length of the cable in Hong Kong waters is approximately 27.65km, of which the first 300m will be installed in a cable duct drilled below the seabed. The temporary loss of fishing grounds, will be limited to the area occupied by the cable laying vessel, i.e. approximately 70m x 25m at any one time, along 27.35km, which will take just 3 to 4 weeks for the entire cable alignment.
Loss of Fisheries Resources and Production	Fisheries production in the affected area ranges from >0 to 50 kg/ha to 400 to 600 kg/ha in terms of catch weight of adult fish, in which the majority of the grids show >0 to 200kg/ha. Fisheries production of adult fish and fish fry was highest (at HKD 5,000 to HKD 10,000/ha) in the western half of the cable alignment and lowest (at >HKD 0 to HKD 5,000/ha) in the eastern half. As explained above, due to the small area occupied by the cable laying barge and short duration required for the cable installation in any one location (just 3 to 4 weeks for the entire cable alignment), potential impacts on fishing vessel transit and fishing activities along the cable alignment will not be significant.
Destruction and Disturbance of Spawning and Nursery Grounds	The cable does not pass through any recognised Nursery Grounds. The southeastern and eastern waters through which the cable will be laid have been recognised as spawning grounds for high value commercial species. After the cable burial machine has buried the cable, the seabed will be reinstated naturally by resettlement of disturbed sediments, following which there will be immediate recolonization by benthic fauna that provide food for fish. In terms of indirect impacts, the maximum predicted extent of suspended solids is expected to be 60m from the cable alignment and would settle back onto the seabed within 3.5 minutes, based on worst case assumptions. Given the above, there is only short-term and a minor disturbance to the seabed within the Spawning Grounds.

Aspect	Evaluation of Impact
Impact on Fishing Activities	Fishing activities along the cable alignment are of moderate commercial value and the size of the fishing areas that will be temporarily occupied by the cable installation vessel as it traverses through Hong Kong waters is considered to be small. On this basis, the Project would be considered to be of low importance to the fishing industry and impacts will be minimal.
Impact on Aquaculture Activity	The nearest FCZs are Po Toi FCZ, located at some 4.9km from the cable and Tung Lung Chau FCZ, at more than 5.5km from the cable. Given this distance, no impact from cable burial works is expected at either FCZ.

C.5 Cumulative Impacts

C.5.1 As described in Section 2.3 of the Project Profile, there is only one planned project near the AAE-1 Cable – the Offshore Wind Farm in Southeastern Waters. However, this project is not expected to be in construction at the same time as the installation of the AAE-1 Cable and, therefore, there will be no cumulative impacts.

C.6 Mitigation Measures

C.6.1 As no adverse impacts to fisheries resources are expected to occur, no specific mitigation measures to fisheries are required.

C.7 Residual Impact

C.7.1 The residual impacts to fisheries resources, habitats and fishing operations during construction phase are considered to be within acceptable level and no specific fisheries monitoring programme is found to be necessary.

C.7.2 Overall, it is concluded that the installation of AAE-1 Submarine Cable will comply fully with Annex 9 of the EIAO-TM.

C.8 Conclusion

C.8.1 A review of existing information on the fisheries resources and fishing operations along the alignment of the AAE-1 Cable has found the majority of the area supports fisheries resources with moderate fisheries production. There are no Nursery Grounds, FCZs or Artificial Reefs in the area that would be affected by the Project. There is, however, a recognized Spawning Ground at southeastern and eastern waters through which the AAE-1 Cable passes.

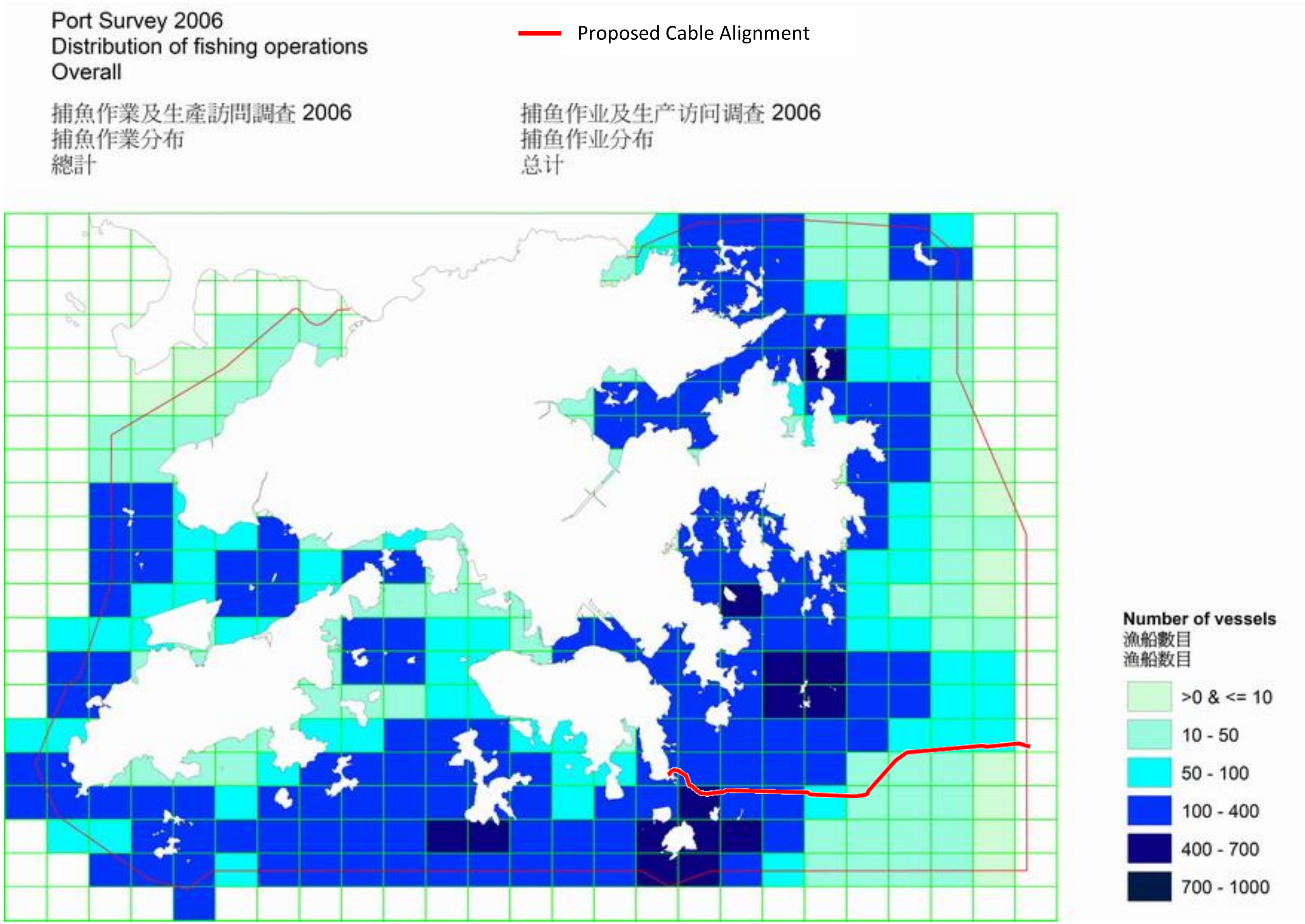
C.8.2 Fisheries production in the affected area ranges from >0 to 50 kg/ha to 400 to600 kg/ha in terms of catch weight of adult fish, in which the majority of the grids show >0 to 200kg/ha. Fisheries production of adult fish and fish fry was highest (at HKD 5,000 to HKD 10,000/ha) in the western half of the cable alignment and lowest (at >HKD 0 to HKD 5,000/ha) in the eastern half.

C.8.3 Due to the small area occupied by the cable laying barge and short duration required for the cable installation in any one location, potential impacts on fishing vessel transit and fishing activities along the cable alignment will not be significant.

C.8.4 In terms of indirect impacts, the maximum predicted extent of suspended solids is expected to be 60m from the cable alignment in proximity to Cape D'Aguilar Peninsula and 180m within the established east-west cable corridor, and would settle back onto the seabed within 3.5 minutes, based on worst case assumptions

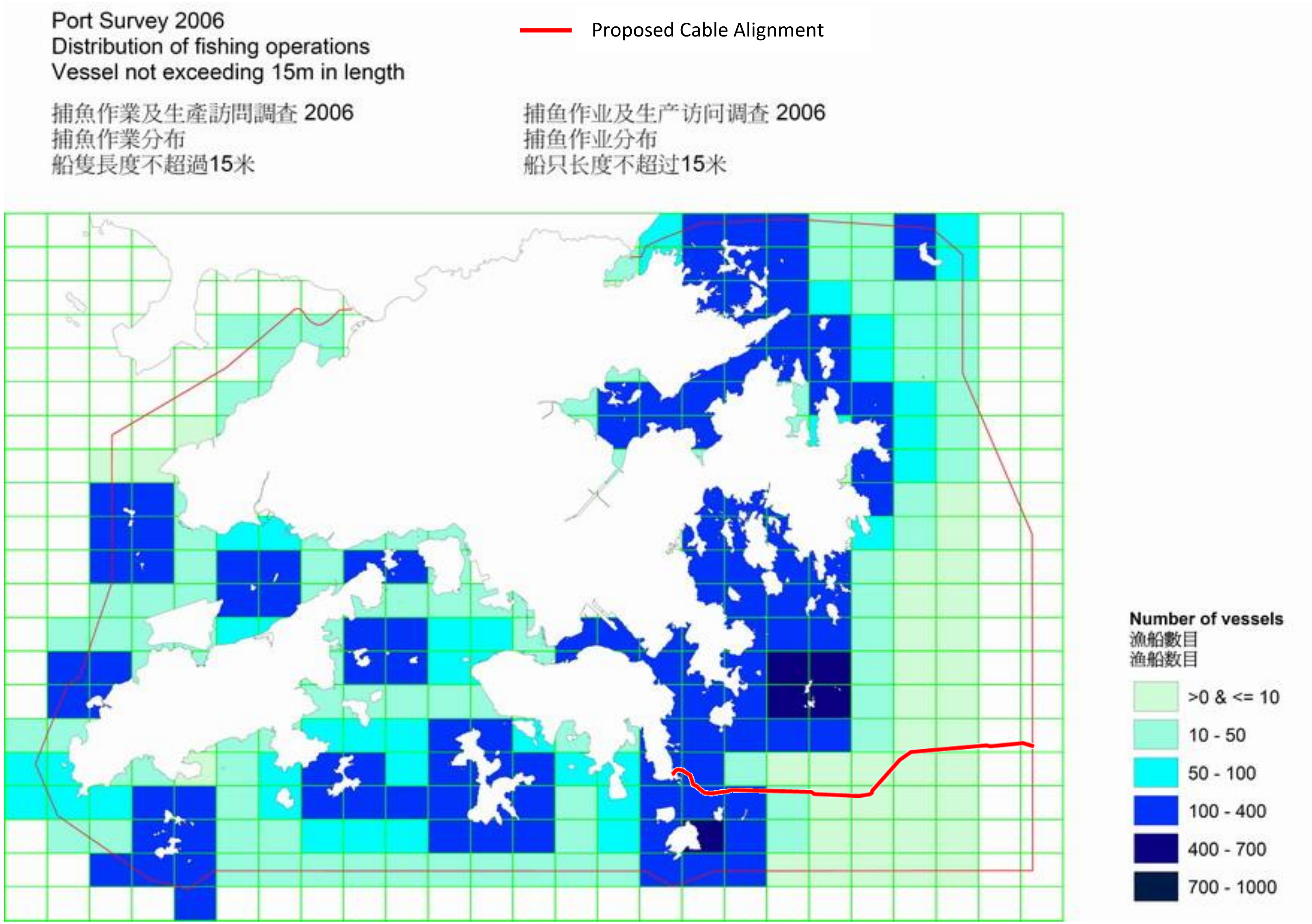
C.8.5 Given the above, adverse impacts are not expected to arise from the cable laying works. Overall, no unacceptable impacts are predicted to occur to fisheries resources or fishing operations as a result of this Project.

Figure C-1 Distribution of Fishing Operations in Hong Kong Waters and Location of the AAE-1 Cable



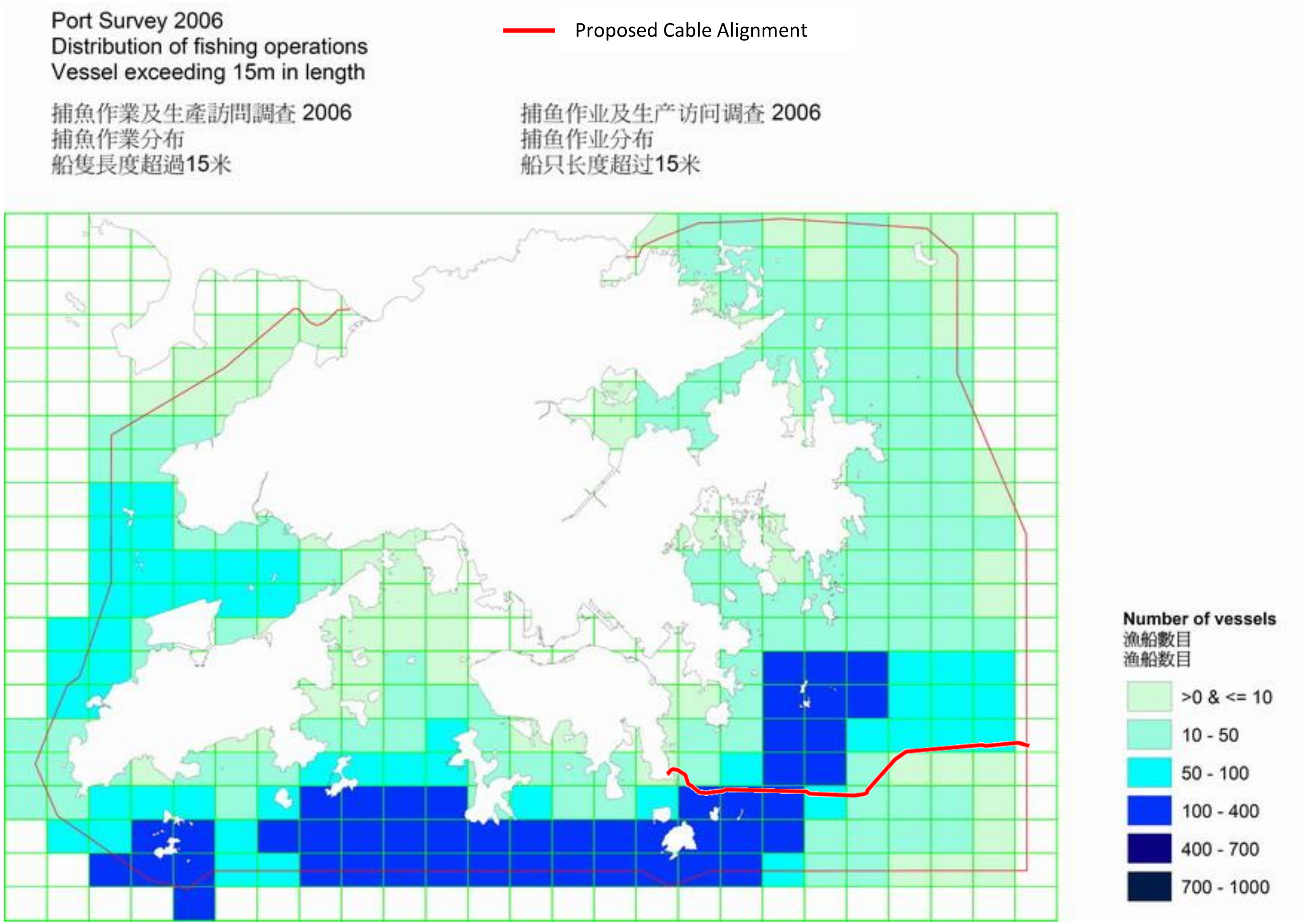
Source: Port Survey 2006, AFCD.

Figure C-2 Distribution of Fishing Operations (Vessel not exceeding 15m in length) and Location of the AAE-1 Cable



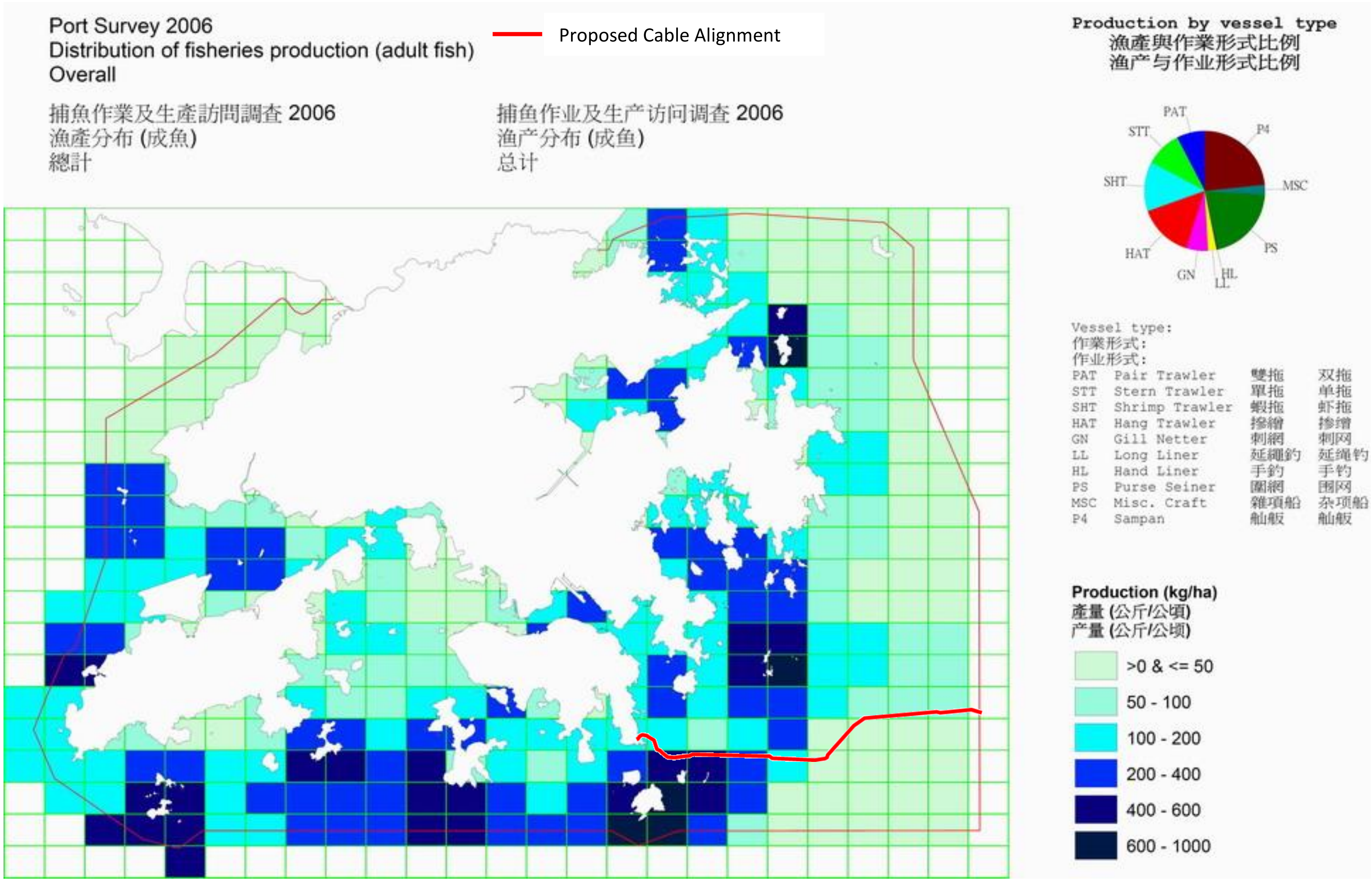
Source: Port Survey 2006, AFCD.

Figure C-3 Distribution of Fishing Operations (Vessel exceeding 15m in length) and Location of the AAE-1 Cable



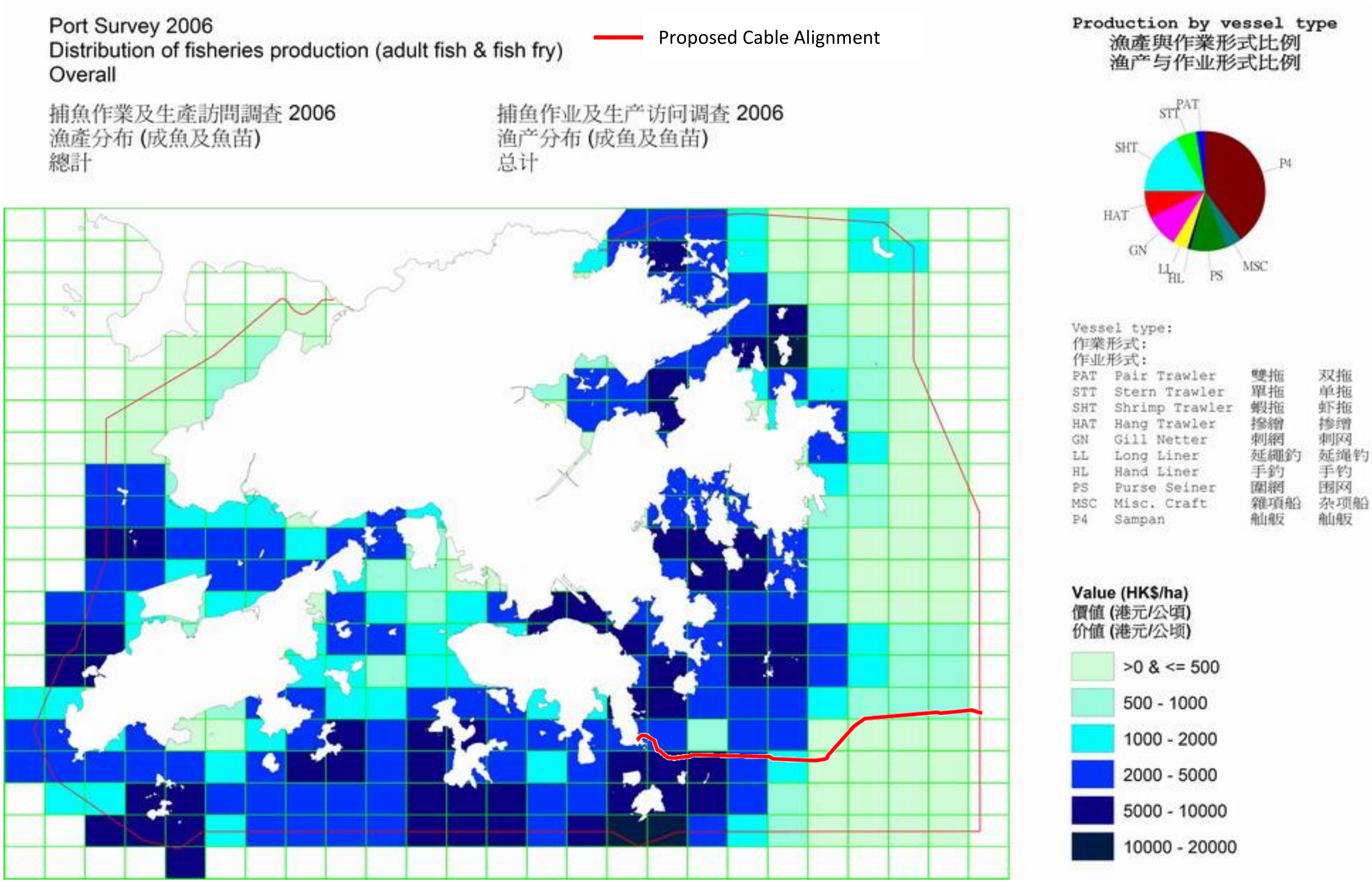
Source: Port Survey 2006, AFCD.

Figure C-4 Distribution of Fisheries Production (Adult Fish) and Location of the AAE-1 Cable



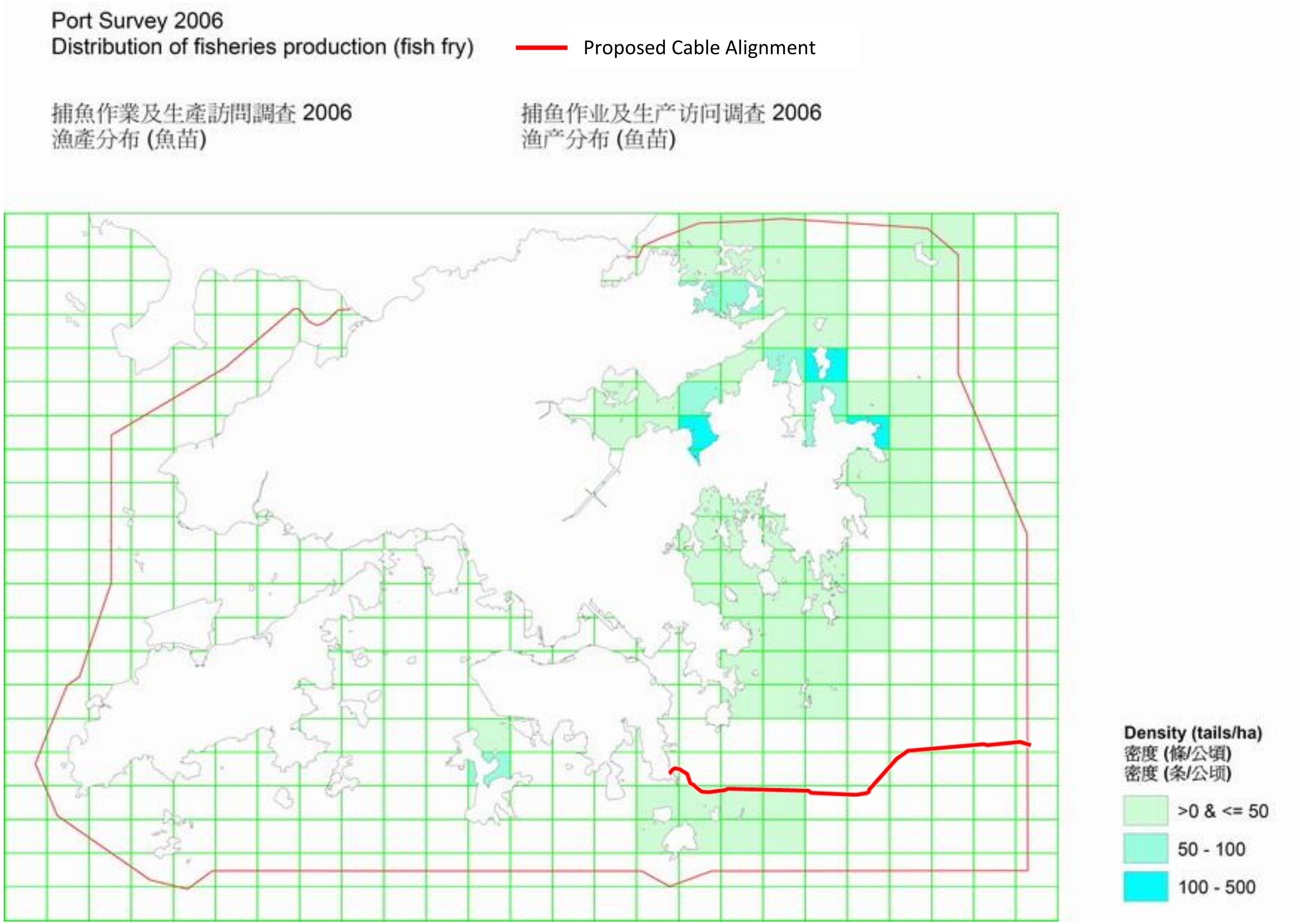
Source: Port Survey 2006, AFCD.

Figure C-5 Distribution of Fisheries Production (Adult Fish & Fish Fry) and Location of the AAE-1 Cable



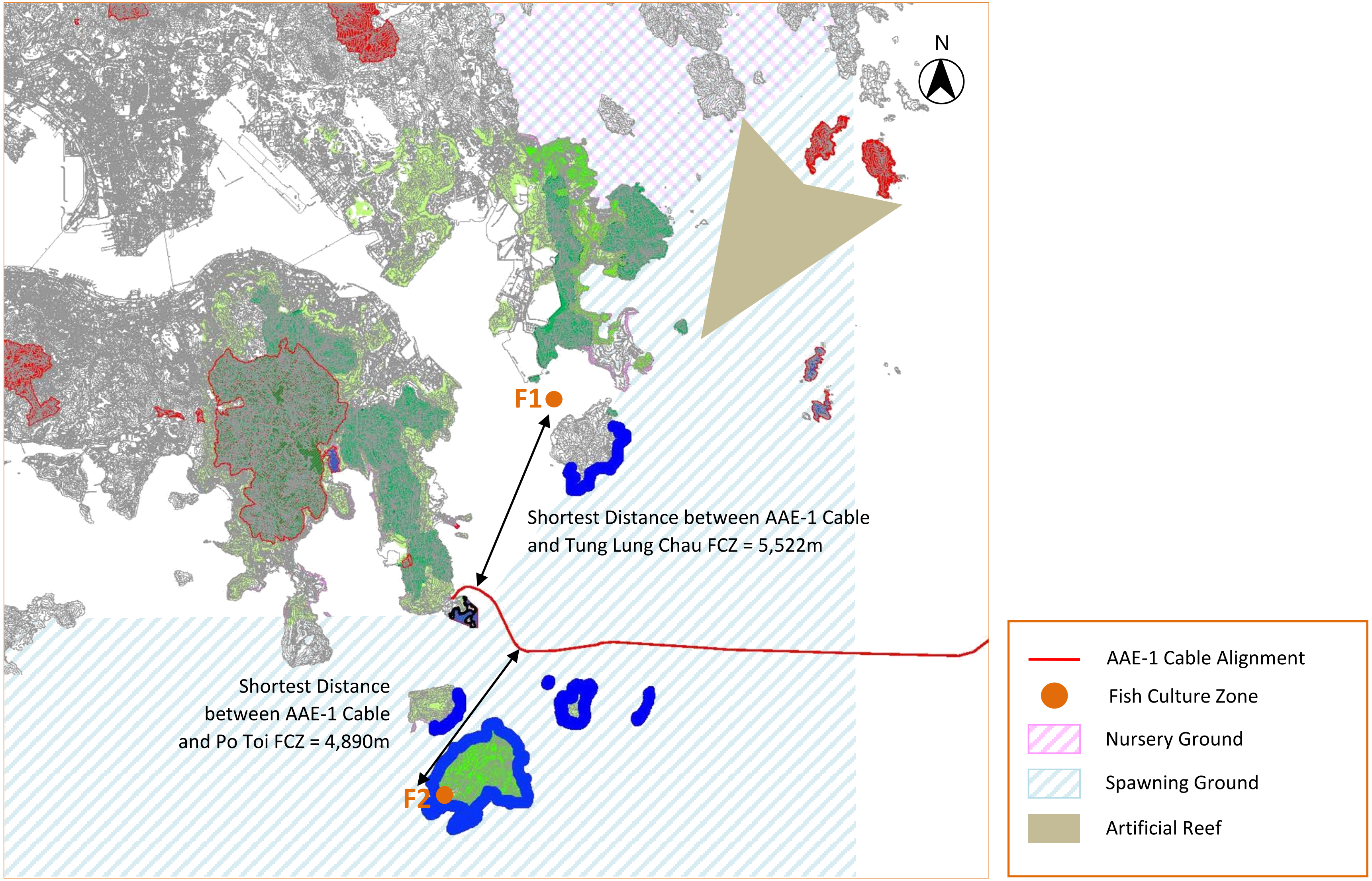
Source: Port Survey 2006, AFCD.

Figure C-6 Distribution of Fisheries Production (Fish Fry) and Location of the AAE-1 Cable



Source: Port Survey 2006, AFCD.

Figure C-7 Fisheries Sensitive Receivers



ANNEX D

Potential Impacts to Cultural Heritage

CONTENTS

TABLES

FIGURES

D POTENTIAL IMPACTS TO CULTURAL HERITAGE

D.1 Introduction

D.1.1 There are known cultural heritage resources on the Cape D'Aguilar Peninsula. While the AAE-1 Cable is a submarine cable, it does come ashore and connects into an existing Beach Manhole (BMH) at Lap Sap Wan. There is, therefore, potential for the works at the BMH to affect cultural heritage resources on the Cape D'Aguilar Peninsula. A brief cultural heritage assessment has therefore been carried out in ***Section D.3***.

D.1.2 As described in the Project Profile, and shown on ***Figure 1-2***, the submarine section of the AAE-1 Cable follows an existing east-west cable corridor that is used by other cables, such as the ASE SEG-4, EAC-C2C-SEG-1/2A/C/D, SMW3-SEG-1.11, VSNL-1A-SEG-9, etc. Southeast of Cape D'Aguilar, it joins an existing northeast-southwest cable corridor, used by cables such as ASE SEG-4, EAC-C2C-SEG-1/C/D, etc. East of Lap Sap Wan, the AAE-1 Cable follows a westerly alignment to the BMH at Lap Sap Wan.

D.1.3 The existing east-west cable corridor and northeast-southwest cable corridor have been used by numerous submarine cables and after numerous Marine Archaeological Investigations (MAI) there are no marine archaeological resources that will be affected by the AAE-1 Cable. However, Lap Sap Wan has not been subject to MAI and there may be marine archaeological resources that could be impacted by the Project. For this reason, a MAI has been conducted along the entire AAE-1 Cable, including Lap Sap Wan, as described in ***Section D.4***.

D.2 Relevant Legislation and Assessment Criteria

D.2.1 The following legislation and guidelines are applicable to the assessment of sites of cultural heritage (both terrestrial and marine) in Hong Kong:

- Environmental Impact Assessment Ordinance (Cap 499) and the associated Technical Memorandum on the EIAO Process (EIAO-TM), Annexes 10 and 19.
- Antiquities and Monuments Ordinance (Cap. 53).
- Hong Kong Planning Standards and Guidelines (HKPSG).
- Guidelines for Marine Archaeological Investigation, prepared by the Antiquities and Monuments Office (AMO).

EIAO-TM Annex 10 and 19

D.2.2 The EIAO-TM outlines the criteria for assessment of impact on sites of cultural heritage.

D.2.3 Annex 10 provides the criteria for evaluating impact on sites of cultural heritage and also notes the general presumption in favour of the protection and conservation of sites of cultural heritage and that adverse impacts on sites of cultural heritage shall be kept to the absolute minimum.

D.2.4 Annex 19 notes that preservation is the preferred solution and if full preservation is not feasible, due to site constraints and other factors, this must be fully justified with alternative proposals or layout designs, which confirm the impracticability of total preservation.

Antiquities and Monuments Ordinance, Cap 53

D.2.5 The Antiquities and Monuments Ordinance (Cap. 53) provides statutory protection against the threat of development on declared and proposed Monuments, to enable their preservation for posterity. The Ordinance also establishes statutory procedures to be followed in making such a declaration.

Hong Kong Planning Standards and Guidelines

D.2.6 The Chapter 10, Conservation, of the HKPSG provides general guidelines and measures for the conservation of historic buildings, sites of archaeological interest and other antiquities.

Guidelines for Marine Archaeological Investigation

D.2.7 The *Guidelines for Marine Archaeological Investigation* (MAI) set out the standard methodology to effectively complete a MAI. The *Guidelines* set out five work stages as set out below:

1. Baseline review to establish existing data about the study area.
2. Geophysical Survey to obtain accurate seabed data.
3. Assessment of Archaeological Potential to establish existence of underwater cultural heritage on the seabed.
4. Remote Operated Vehicle/Visual Diver Survey. If Stage 3 has located seabed features with archaeological potential a visual survey is required to establish archaeological value.
5. Design a mitigation strategy in consultation with the AMO, if required.

D.3 Assessment of Terrestrial Cultural Heritage

D.3.1 According to the list of *Declared Monuments in Hong Kong*, maintained by AMO there is one declared Monument located within 500m from the Project, namely Cape D'Aguilar Lighthouse. Furthermore, there are also two Grade 2 historic buildings located within 500m of the Project, namely D'Aguilar Battery and Bokhara Battery. ***Figure D-1*** shows the location of these cultural heritage resources and the BMH at Lap Sap Wan, where the AAE-1 Cable lands and where the HDD equipment will be located.

Cape D'Aguilar Lighthouse

D.3.2 Cape D'Aguilar Lighthouse, the first of its kind built in Hong Kong, was put into service on 16 April 1875. The existing structure is a round stone tower, 9.7m high and white in colour. The tower base, the arched doorway and the circular staircase are of fine masonry. The door is made of iron with geometric decoration on top. Cape D'Aguilar Lighthouse once played an important role in the maritime history of Hong Kong and was declared Monument on 3 March 2006. The lighthouse is currently operational and under the management of the Marine Department, but for security and operational reasons it is not open to the public.

D.3.3 Cape D'Aguilar Lighthouse is located on the cliff about 25m above sea level and is some 450m southeast of the BMH at Lap Sap Wan. Given this distance separation, both vertically and horizontally, the HDD works to be carried out around the BMH are unlikely to have any direct or indirect impacts on Cape D'Aguilar Lighthouse, such as vibration.

The submarine cable installation on the seabed will obviously not have any direct or indirect impacts on Cape D'Aguilar Lighthouse.

Cape D'Aguilar Battery

D.3.4 Cape D'Aguilar Battery was constructed as an Emergency Battery, completed in July 1939. It originally contained 2 x 4" BL Naval guns, which were destroyed by the gun crew prior to abandoning the battery on 19 December 1941 after the Japanese invasion of Hong Kong during World War II. No guns now remain and the battery is in ruins, heavily overgrown by vegetation.

D.3.5 Cape D'Aguilar Battery is located in the middle of the Cape D'Aguilar Peninsula at about 150m above sea level and is 480m east of the BMH at Lap Sap Wan. Given this distance separation, both vertically and horizontally, the HDD works to be carried out around the BMH are unlikely to have any direct or indirect impacts on Cape D'Aguilar Battery, such as vibration. The submarine cable installation on the seabed will obviously not have any direct or indirect impacts on Cape D'Aguilar Battery.

Bokhara Battery

D.3.6 Bokhara Battery was constructed in November 1941. Originally to be named Fort Grasett, Bokhara Battery takes its name from a group of offshore rocks. These submerged shoals, in turn, were named after the SS Bokhara, a P&O liner that struck the rocks in 1873. Bokhara Battery originally contained 2 x 9.2" BL Mk X guns, which were removed from Pottinger Battery at Devils Peak, and 1 x 3" Anti-aircraft gun. All guns were destroyed by the gun crew prior to abandoning the battery on 19 December 1941, after only one month in operation. No guns now remain and the site is now contains buildings and antennae that for part of a modern telecommunication station.

D.3.7 Bokhara Battery is located on the cliff about 40m above sea level and is 315m southeast of the BMH at Lap Sap Wan. Given this distance separation, both vertically and horizontally, the HDD works to be carried out around the BMH are unlikely to have any direct or indirect impacts on Bokhara Battery, such as vibration. The submarine cable installation on the seabed will obviously not have any direct or indirect impacts on Bokhara Battery.

Conclusions

D.3.8 Based on the above assessments, the HDD works to be carried out at the BMH at Lap Sap Wan are unlikely to have any direct or indirect impacts on the cultural heritage resources identified. This is due to the distance separation, both vertically and horizontally, between the works area at the BMH and the cultural heritage resources.

D.3.9 There is no Site of Archaeological Interest (SAI) found within the boundary of the Project and there are no potential impacts on terrestrial archaeological resources arising from the Project.

D.4 Objective and Methodology for MAI

D.4.1 The objectives of the MAI are to include a phased review/investigation of a Survey Area in accordance with the *Guidelines for Marine Archaeological Investigation* issued by AMO. This should include, but not limited to the following:

D.4.2 During a Phase I Assessment, the following shall be undertaken:

- Desktop review of the Survey Area.
- Review of Geophysical Survey data.
- Establish marine archaeological potential.
- Conduct marine archaeological impact assessment.

D.4.3 Based on the results of the first stage MAI, further investigation may or may not be required as follows:

D.4.4 Should a Phase II Assessment be required, the following shall be undertaken:

- Remote Operated Vehicle/Visual Diver Survey/Watching Brief if potential sites are identified during Phase I work.
- Provide a Report on these aspects.

D.5 Marine Archaeological Investigation Assessment Methodology

D.5.1 The MAI follows the methodology set out EIAO-TM Annexes 10 and 19 and the *Guidelines for Marine Archaeological Investigation* issued by AMO.

Desktop Review

D.5.2 A Desktop Review was undertaken to compile a comprehensive inventory of cultural heritage resources of the Study Area. It included:

- Publications on local historical, architectural, anthropological, archaeological and other cultural studies;
- Unpublished papers, records, archival and historical documents held in local libraries and other government departments;
- Marine charts records held in the Hong Kong Maritime Museum and the National Maritime Museum Library in London.

D.5.3 The Study Area for the MAI is shown in ***Figure D-2***.

Marine Geophysical Survey

D.5.4 A detailed geophysical survey was required to provide data to plan the route alignment. The specifications for the site investigation were the same required by the MAI and this mean that the same data could be used for the MAI. It was therefore possible to re-interpret the data without the need for additional data collection. Only data relevant to the MAI is presented. The survey was completed by survey company EGS.

D.5.5 The survey within Hong Kong waters was divided into two stages. During the first stage from KP0 to KP5 (KP is a kilometre marker point, with KP0 being the BMH at Lap Sap Wan and beginning of the land section of the cable). The first stage was carried out on 5 and 6 January 2015 and covered a 1km wide survey corridor, as shown on ***Figure D-6***.

D.5.6 The second stage of marine survey operations from KP5 to the Hong Kong boundary at KP27.8 was carried out from 16 to 27 April 2015 and covered a 500m wide survey corridor, also as shown on ***Figure D-6***.

D.5.7 Gravity coring was conducted on 20 April 2015 and cable crossing/alignment surveys within this section were undertaken on 27 April 2015. Full details of the survey methodology are presented in the EGS report[Ref #1].

D.5.8 ***Table D-1*** presents the types of geophysical survey methods together with the survey objectives:

Table D-1 Geophysical Survey Methods and Objectives

Survey Methods	Survey Objectives
Single Beam Echo Sounder	To measure seabed depth
Swath Bathymetry	To measure detailed seabed topography
Side Scan Sonar	To locate anomalous seabed features and map sediment types
Seismic Sub-Bottom Profiling	To identify sub-bottom features and stratigraphy

Horizontal Positioning Fixing

D.5.9 The survey vessel was located with a Globally Corrected Global Positioning System (GcGPS) unit called the C-Nav, in which no shore based transmitter is required. The system provides corrected positions to an accuracy of ±0.3m.The EGS computerized navigation system was added to the CcGPS positioning system to control the steering of the boat along the traverses specified, and to log all horizontal and vertical control data.

D.6 Results of Desktop Review and Geophysical Survey Data

Desktop Review

D.6.1 A review was completed of historical charts covering the study area. These are helpful to establish what may be located in the general marine area and if any shipwrecks are present. Charts from 1888 and 1966 are presented as ***Figure D-3*** and ***Figure D-4***, respectively. No evidence of specific shipwrecks was found.

D.6.2 The history of Bokhara Battery[Ref #2], although on land, has relevance to what may be on the seabed. It was constructed shortly before the Japanese invasion. At 10:00hrs on the 8th December 1941, two hours after the Japanese attack on Kai Tak Airfield, the Bokhara Battery saw its first action. It engaged a Japanese patrol vessel at extreme range. Due to the swift advance of the Japanese forces on Hong Kong Island, the gunners at both D'Aguilar and Bokhara Batteries were ordered to destroy their emplacements and retire from their positions. It has been recorded that the two guns were tipped down the cliff and the battery destroyed. After the demolition was successfully accomplished all members withdrew to Stanley and continued to fight from there. Significant building structures remain and are now used as part of a modern telecommunication station.

1. EGS, 2015. Cape D'Aguilar, Hong Kong Landfall Report for Cable Route Design and Engineering for AAE-1 Cable System. Segment 1H.1.
2. Wordie, J., Ko, T., 1996. Ruins of War. A Guide to Hong Kong's Battlefields and Wartime Sites. Joint Publishing (HK) Co. Ltd

D.6.3 A 1990 publication[Ref #3] lists Cape D'Aguilar as an excellent dive location and refers to the possibility of seeing cannon on the seabed. It is possible that these are the same cannon that were originally thrown from the Bokhara battery.

D.6.4 In the 1992 a team of divers from the Swire Institute of Marine Science, based on Cape D'Aguilar raised one of the canons and kept it at the Institute. Contact has been made with the Institute, who have confirmed that they only raised one canon and that one was left on the seabed.

Geophysical Survey

D.6.5 A total of 17 sonar contacts, SC001 to SC017, were located in the side scan sonar data, and are identified on ***Figure D-2***. Only one of these, SC008, was located less than 50m from the cable centreline, which is the standard buffer distance used for cable installation.

D.6.6 ***Table D-2***, below, presents the total number of Sonar Contacts located along the proposed cable route. The side scan sonar trace for SC008 is shown on ***Figure D-5***.

D.7 Establishing Archaeological Potential

D.7.1 In accordance with Section 4 of the *Guidelines for Marine Archaeological Investigation* the sonar contact SC008 requires inspection and evaluation by divers as it is less than 50m from the proposed cable route. This will provide an indication of its archaeological significance.

D.7.2 The unique historical information about the Bokhara cannons indicates that a rapid area search in Lap Sap Wan Bay is prudent as there is one cannon on the seabed at this location (refer to ***paragraph D.6.4***).

D.8 Visual Diver Survey

Procedural Requirements

D.8.1 The diver survey could not start until a Licence to Excavate and Search for Antiquities was granted by AMO. Licence No. 395 was granted on 24th August 2015 to Ms Sarah HEAVER of SDA Marine Ltd.

Methodology For Diver Survey

D.8.2 The location of SC008 and the search for the cannon along the alignment is shown on ***Figure D-6***.

D.8.3 A GPS was used to locate the survey target SC008 and all survey locations. A metal sinker was placed on the seabed at the target location and a 50m circular search completed.

3. Moody, M., 1991. Diving in Hong Kong and the Far East. Private publication.

Table D-2 Side Scan Sonar Contact List

Contact Number	Latitude Longitude	Easting Northing	Water Depth (m)	KP RPL Offset	Dimensions (m)	Description
AAE1-A1H.1-CDA-**SC001**	22° 12.966'N 114° 15.750'E	2666867.4E 5411860.4N	25	0.817 390m N	2.2x1.3x<0.5	Debris/Boulder
AAE1-A1H.1-CDA-**SC002**	22° 12.529'N 114° 16.072'E	2667439.2E 5411027.2N	29	1.606 90m E	3.1x1.5 x<0.5	Debris
AAE1-A1H.1-CDA-**SC003**	22° 11.947'N 114° 16.132'E	2667545.2E 5409919.1N	29	2.553 469m SW	5.9x2.0 x<0.5	Debris/Boulder
AAE1-A1H.1-CDA-**SC003**	22° 11.918'N 114° 16.421'E	2668059.1E 5409863.7N	28	2.885 160m SW	1.7x1.1xnmh	Debris
AAE1-A1H.1-CDA-**SC005**	22° 12.168'N 114° 17.082'E	2669230.6E 5410339.3N	27	4.051 480m N	3.2x3.0xnmh	Debris
AAE1-A1H.1-CDA-**SC006**	22° 11.617'N 114° 17.125'E	2669308.3E 5409289.4N	26	3.985 570m S	1.9x1.2 x<0.5	Debris
AAE1-A1H.1-CDA-**SC007**	22° 12.137'N 114° 17.982'E	2760828.5E 5410280.6N	29	5.541 255m N	2.1x1.0 x<0.5	Debris
AAE1-A1H.1-CDA-SC008	**22° 11.892'N 114° 21.244'E**	**2676617.3E 5409814.4N**	**31**	**11.160 26m N**	**5.5x3.9 x<0.5**	**Debris**
AAE1-A1H.1-CDA-**SC009**	22° 11.963'N 114° 21.318'E	2676749.9E 5409949.3N	31	11.283 167m N	3.6x3.2 xnmh	Debris
AAE1-A1H.1-CDA-**SC010**	22° 12.334'N 114° 23.852'E	2681246.8E 5410656.0N	30	16.095 62m NW	2.6x<1 x<0.5	Debris
AAE1-A1H.1-CDA-**SC011**	22° 13.392'N 114° 24.977'E	2683243.4E 5412672.5N	29	18.838 97m NW	4.4x1.0xnmh	Debris
AAE1-A1H.1-CDA-**SC012**	22° 13.549'N 114° 25.222'E	2683677.3E 5412972.7N	29	19.246 296m N	7.3x3.5 x<0.5	Unknown Object
AAE1-A1H.1-CDA-**SC013**	22° 13.565'N 114° 25.240'E	2683709.7E 5413002.1N	NA	19.279 313m N	5.5x1.5xnmh	Debris
AAE1-A1H.1-CDA-**SC014**	22° 13.375'N 114° 25.850'E	2684792.9E 5412641.0N	29	20.301 123m S	3.1x1.4x0.5	Debris
AAE1-A1H.1-CDA-**SC015**	22° 13.395'N 114° 26.610'E	2686140.6E 5412678.6N	29	21.605 180m S	5.5x1.5xnmh	Debris
AAE1-A1H.1-CDA-**SC016**	22° 13.582'N 114° 26.931'E	2686711.2E 5413035.8N	29	22.180 137m N	3.1x1.4x0.5	Debris
AAE1-A1H.1-CDA-**SC017**	22° 13.531'N 114° 28.835'E	2690090.8E 5412937.1N	29	25.460 164m S	6.0x<1xnmh	Debris

Note: Red indicates sonar contact SC008 is within 50m of the cable centreline – see ***Figures D-5 and D-6***. Locations of all sonar contacts are shown on ***Figure D-2***.

D.8.4 The seabed survey at Lap Sap Wan covered 50m either side of the cable from KP0.75 to KP1.5. The extent of the diver survey is shown on ***Figure D-6***.

D.8.5 The diver wore a helmet mounted video camera to record the whole dive to obtain maximum information. Through water communications from the surface provided proper direction for the diver at all times. ***Figure D-7*** shows the diver wearing a helmet with video and communications systems.

Survey Team

D.8.6 The Licence to Search for and Excavate for Antiquities granted by the AMO requires that the Licence holder is present on site supervising the survey work at all times.

D.8.7 There was a team of four divers plus Sarah HEAVER on site every day as Project Supervisor. The dive team rotated the jobs of in-water diver, dive tender, standby diver/CCTV technician and dive supervisor. Each diver carried out 25% of the survey and Sarah HEAVER completed 100% of the project supervision. The boat had a skipper and one crew member.

D.8.8 All diving operations followed the *Code of Practice – Safety and Health at Work for Industrial Diving* (1998) published by the Occupational Safety and Health Branch of the Hong Kong Labour Department. All diving operations also met the requirements of the UK Health and Safety Executive *Diving at Work Regulations* (1997) and the *Commercial Diving Projects Inland/Inshore: Diving at Work Regulations* (1997), Approved Code of Practice. All divers hold up-to-date HSE diver qualifications and current medical certificates

D.9 Conclusion of MAI

D.9.1 The GPS was used to locate the dive boat at the correct positions to locate sonar contact SC008, which is shown on ***Figure D-6***. It was quickly and easily identified as modern dumped material, as shown in ***Figure D-8***. There was no indication of archaeological significance.

D.9.2 A total of 16 dives were completed along the AAE-1 Cable alignment near to Lap Sap Wan between KM0.75 and KM1.50, as shown on ***Figure D-6***, to look for the historically recorded cannon. It was not located. Only some small items of modern debris were found. There was no indication of marine archaeological resources.

D.9.3 ***Figure D-9*** provides photo records and brief description for each of the 16 no. dive targets.

D.10 Mitigation

D.10.1 The MAI did not locate any underwater cultural heritage which might be impacted by the cable installation. Therefore no mitigation or further action is required.

Figure D-1 Location of Terrestrial Built Heritage in the Vicinity of the BMH at Lap Sap Wan

Source: Google Earth

Figure D-2 MAI Study Area and Sonar Contacts

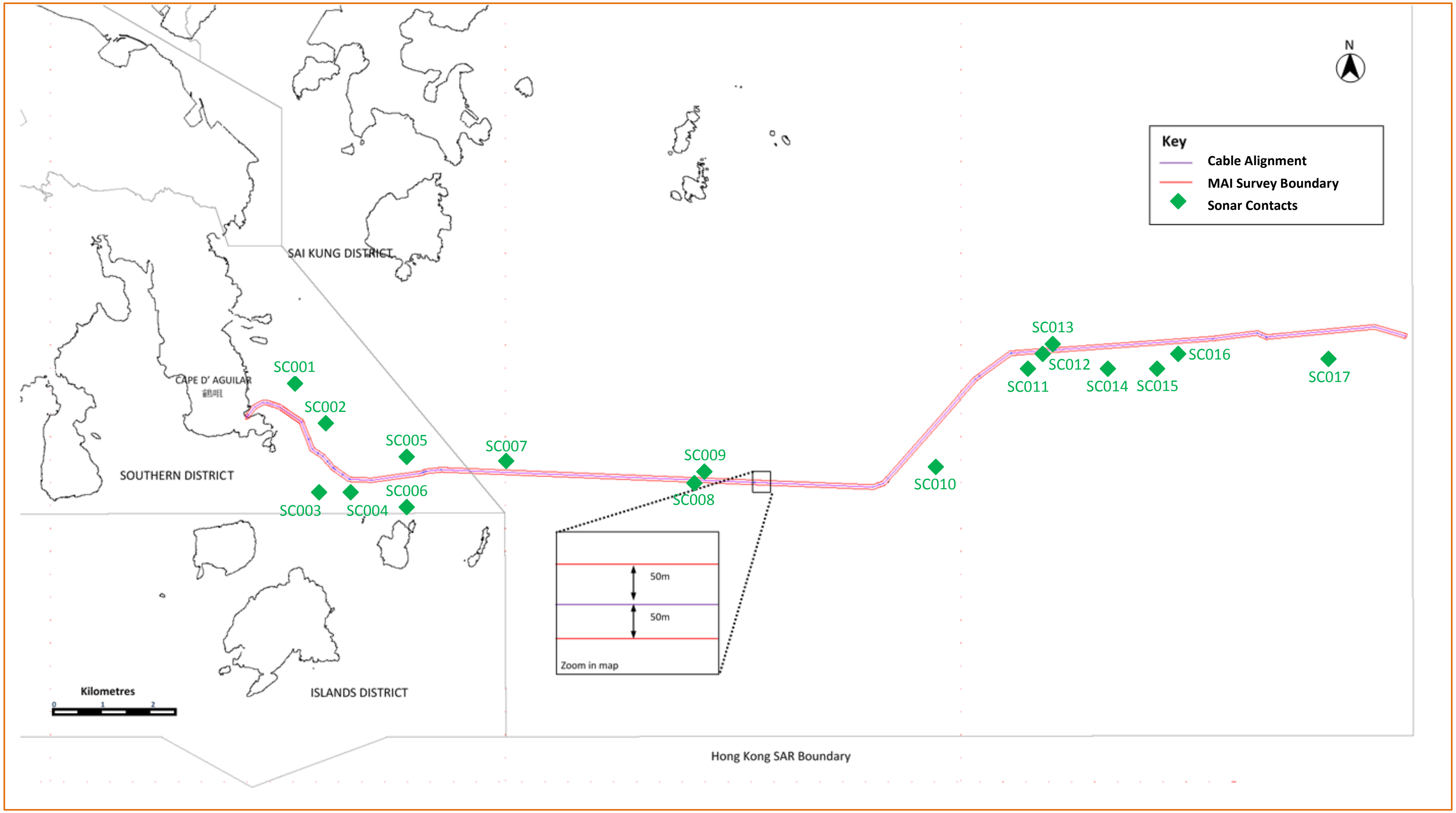
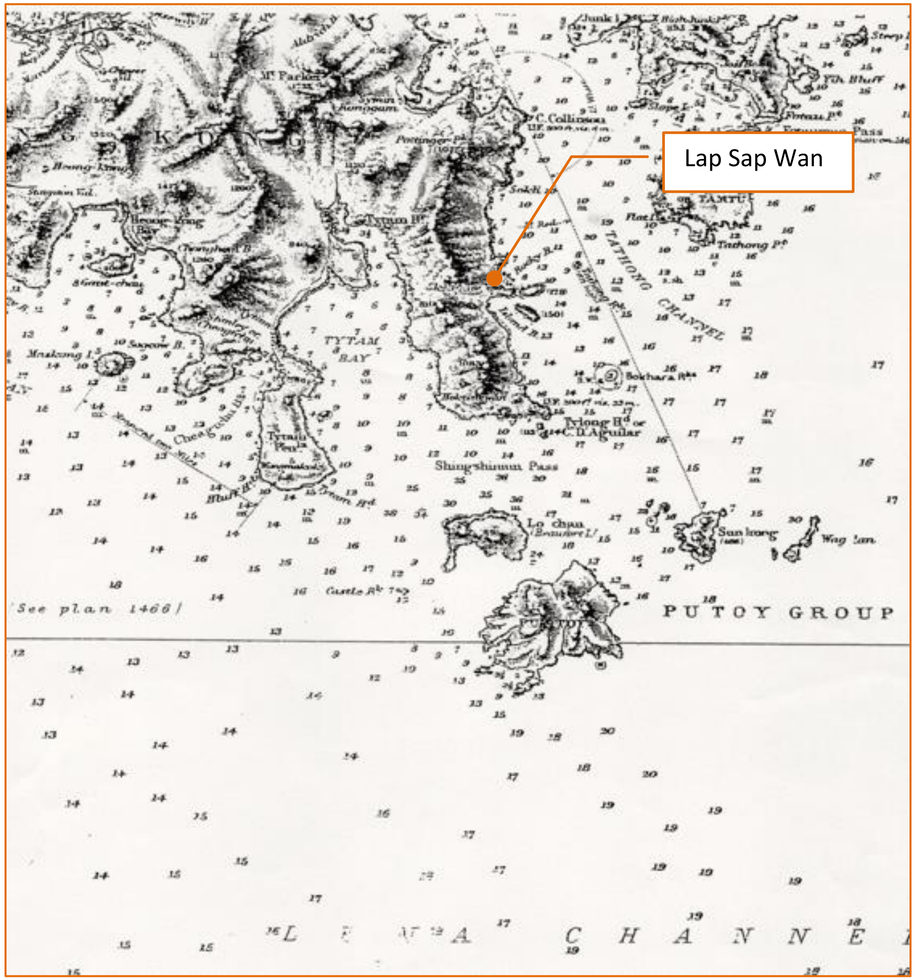
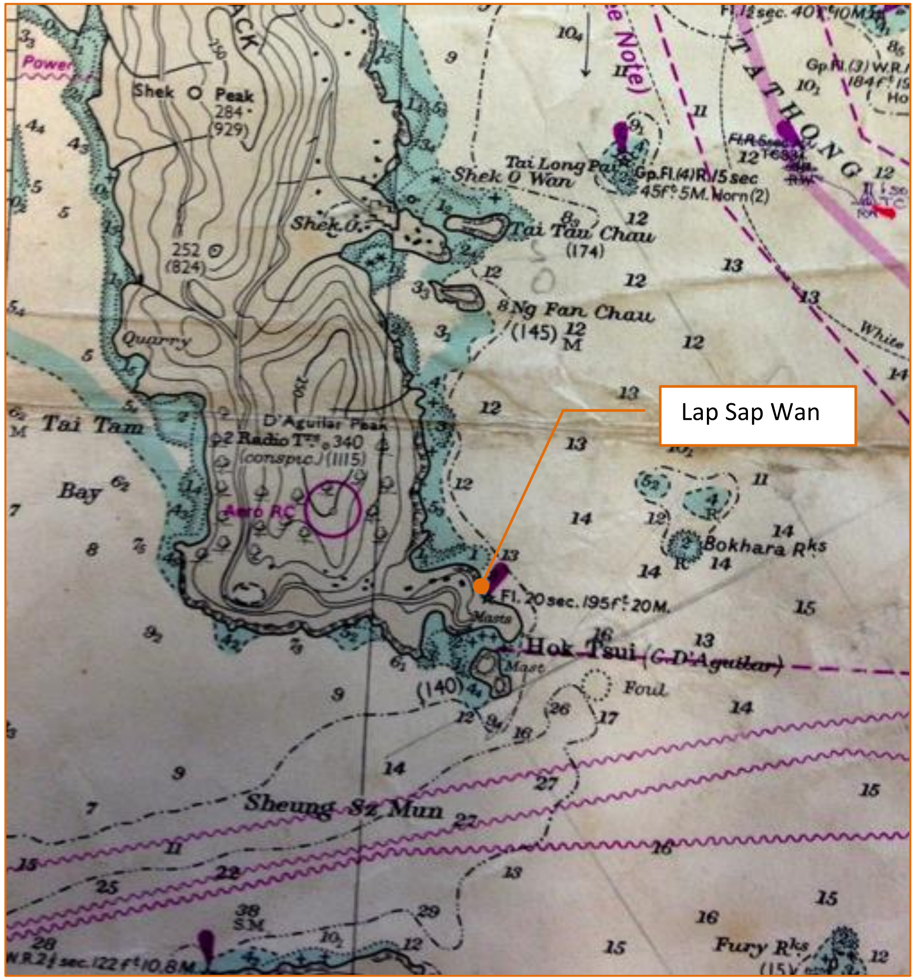


Figure D-3 Cape D'Aguilar – 1888 Royal Navy Hydrographic Office



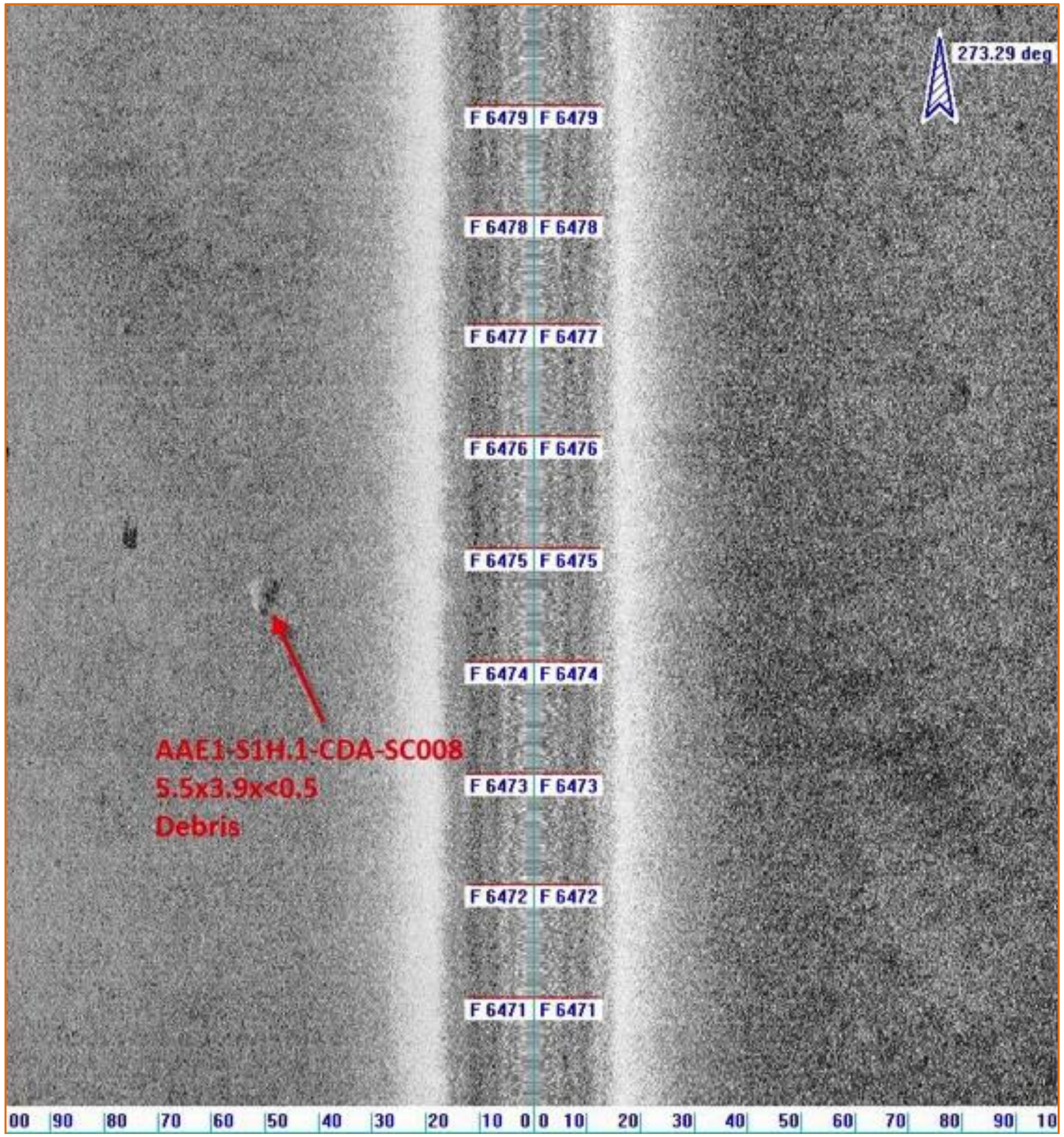
Source: SDA Marine Ltd

Figure D-4 Cape D'Aguilar – 1966 Royal Navy Hydrographic Office



Source: SDA Marine Ltd

Figure D-5 Side Scan Sonar Showing SC008



Source: EGS Report AAE 1 Segment 1H.1

Figure D-6 Location of SC008 and Alignment Search for Cannon

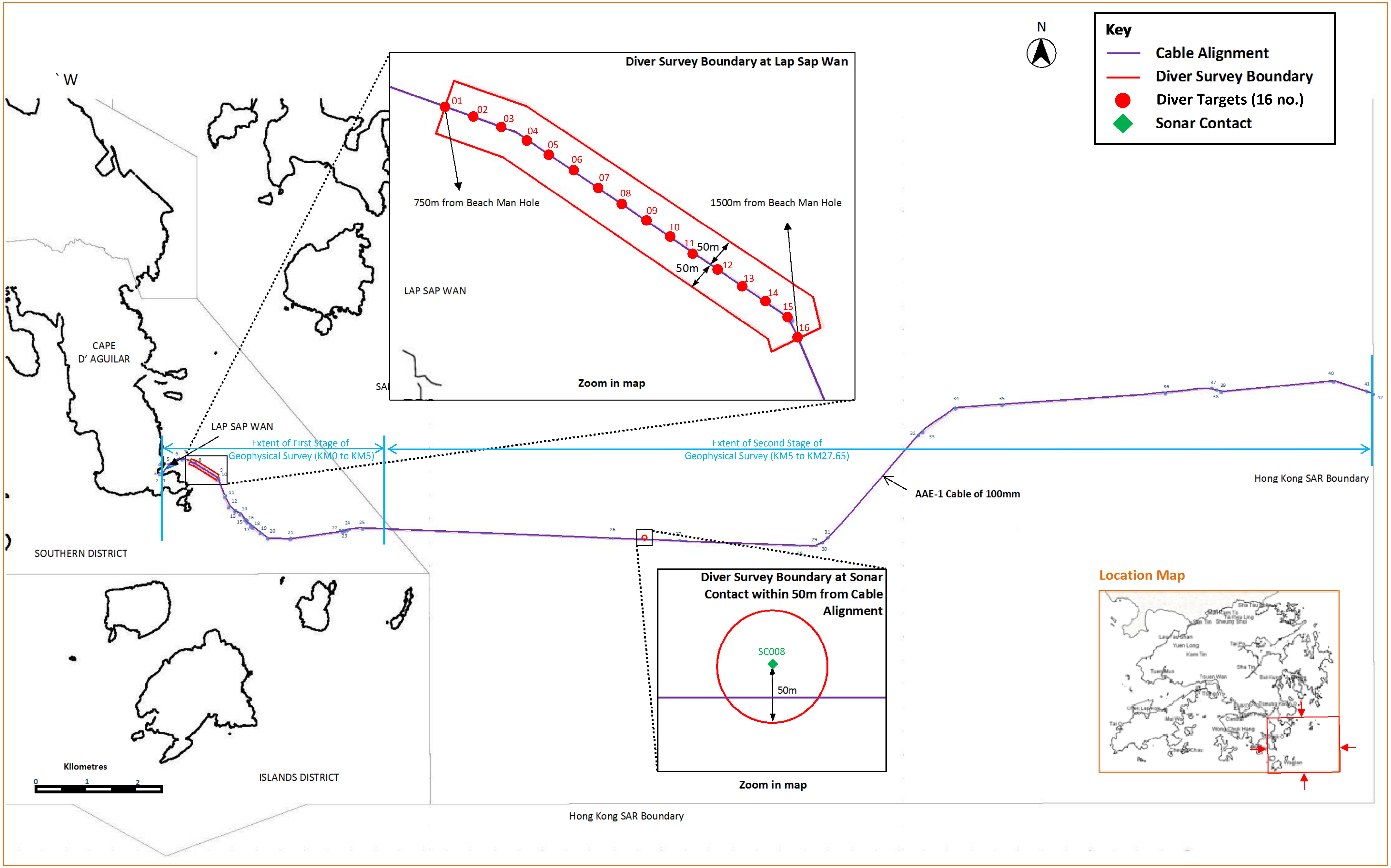


Figure D-7 Diver Wearing Helmed-mounted Video and Communications

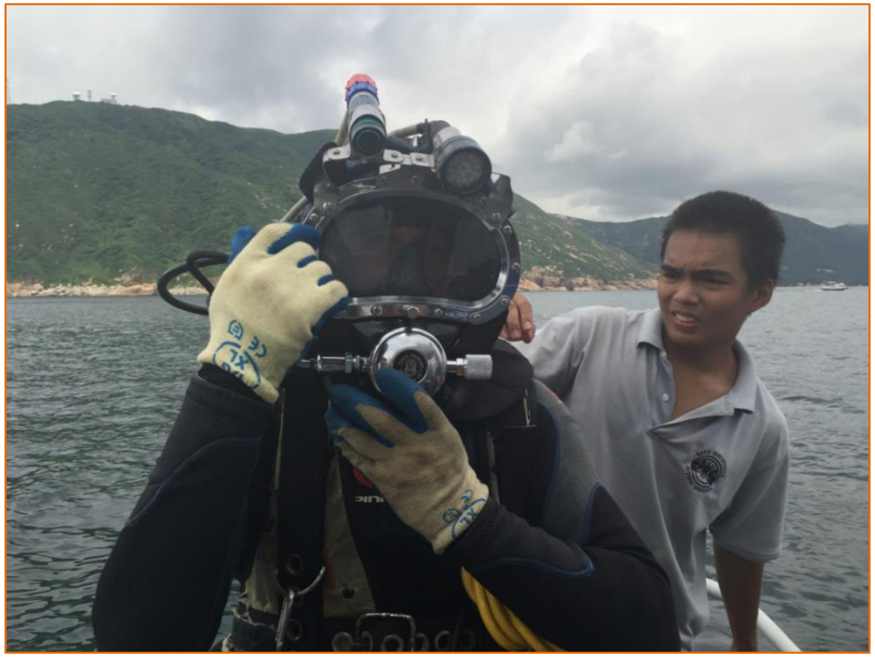


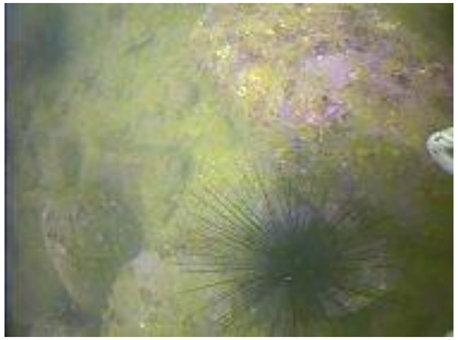
Figure D-8 Modern Dumped Material at Location SC008

Figure D-9 Photographic Record of Dive Targets Between KM0.75 and KM1.50

01 Metal Pipe

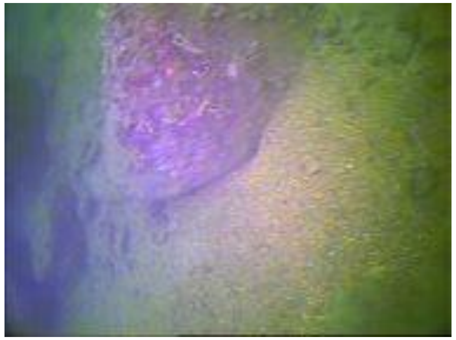
02 Rocks on Seabed

03 Rocks on Seabed



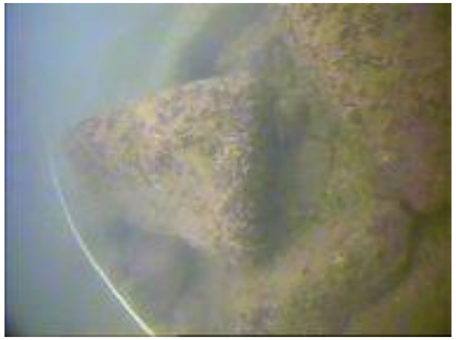
04 Rocks on Seabed

05 Rocks on Seabed



06 Modern Metal Debris

07 Rocks on Seabed



08 Rocks on Seabed

Figure D-9 Photographic Record of Dive Targets Between KM0.75 and KM1.50 (continued)

09 Modern Debris

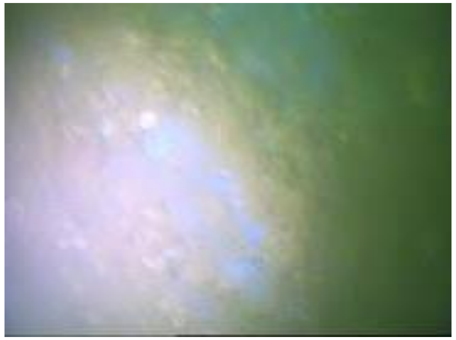
10 Rocks on Seabed

11 Rocks on Seabed

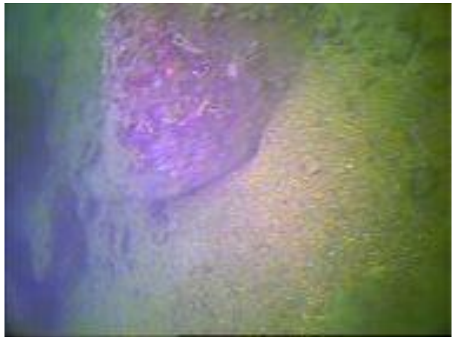
12 Modern Metal Debris

13 Rocks on Seabed

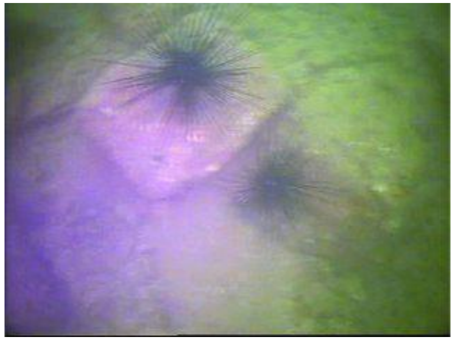
14 Rocks on Seabed



15 Rocks on Seabed



16 Rocks on Seabed



ANNEX E

Environmental Monitoring and Audit Manual

CONTENTS

TABLES

FIGURES

E ENVIRONMENTAL MONITORING AND AUDIT

E.1 Introduction

E.1.1 This Annex specifies the requirements of the Environmental Monitoring and Audit (EM&A) for the Project. Overall, the proposed EM&A programme allows for:

- Verification of the predictions in the Water Quality Assessment (***Annex A***) that the installation of the submarine cable will not result in unacceptable impacts on water quality (and thereby also on ecological resources dependent upon water quality) in the vicinity of the cable alignment at Lap Sap Wan.
- Ensure that the installation of the submarine cable is conducted in a careful manner and that appropriate action is undertaken promptly in the event that impacts are identified to sensitive receivers and are found to be caused by the cable installation works.

E.2 Environmental Team

E.2.1 The Permit Holder will engage an Environmental Team (ET) to carry out the water quality monitoring and marine mammal observation proposed in this Project Profile. The ET shall be led by an ET Leader, who has at least 7 years of experience in EM&A or environmental management, and have suitably qualified staff included in the ET.

E.2.2 The ET and ET Leader shall not be in any way an associated body of the Project Proponent or any of its contractors. The ET and ET Leader shall not be in any way an associated body of the Independent Environmental Checker (IEC).

E.2.3 The ET and ET Leader are employed to implement the EM&A programme and ensure the Project Proponent's compliance with the project's environmental performance requirements during construction. The duties are:

- Sampling, analysis and statistical evaluation of monitoring parameters as required in the Project Profile.
- Carry out marine mammal observation.
- Audit of compliance with environmental protection, and pollution prevention and control regulations.
- Monitor the implementation of environmental mitigation measures.
- Monitor compliance with Conditions in the Environmental Permit.
- Review the construction programme and comment as necessary.
- Review the construction methodology and comment as necessary.
- Prepare and update the EM&A works schedule with reference to the best available detailed construction programme.
- Investigate non-compliant events, evaluate and identify corrective measures.
- Liaise with the Independent Environmental Checker (IEC) on all environmental performance matters, and timely submission of all relevant EM&A submissions for the verification by IEC.

- Advise the Project Proponent and its contractors on environment improvement, awareness, enhancement matters, etc.
- Timely submission of the EM&A report to the Project Proponent, IEC and thereafter the EIAO Register Office.

E.3 Independent Environmental Checker

E.3.1 Prior to commencement of construction of the Temporary Working Platform, the Permit Holder shall engage an IEC to advise on environmental issues related to the Project.

E.3.2 The IEC shall have at least 7 years of experience in EM&A or environmental management. The IEC shall not be in any way an associated body of the Project Proponent or any of its contractors. The IEC shall not be in any way an associated body of the ET.

E.3.3 The IEC shall audit the overall EM&A programme including the implementation of all environmental mitigation measures, submissions relating to EM&A, and any other submission required under this Project Profile. In addition, the IEC shall be responsible for verifying the environmental acceptability of permanent and temporary works, particularly in relation to the Horizontal Directional Drilling (HDD) works.

E.3.4 The IEC shall arrange and conduct at least fortnightly inspections at the location of the Temporary Working Platform from its construction to its dismantling. Ad hoc inspections shall also be carried out if significant environmental problems are identified.

E.3.5 The IEC shall ensure that baseline and impact monitoring is conducted by the ET according to the prescribed schedule at the correct locations.

E.3.6 The main duty of the IEC is to carry out environmental audit of the construction of the Project, including the following:

- Review and audit all aspects of the EM&A programme.
- Validate and confirm the accuracy of monitoring results, monitoring equipment, monitoring locations, monitoring procedures and locations of sensitive receivers.
- Carry out random sample check and audit on monitoring data and sampling procedures, etc.
- Audit the recommendations and requirements in Project Profile against the status of implementation of environmental protection measures on site.
- Review the effectiveness of environmental mitigation measures and Project environmental performance.
- On an as needed basis, audit the construction methodology of the Project Proponent and its contractor and agree the least impact alternative in consultation with the ET Leader.
- Check and verify details of the silt curtain before deployment.
- Investigate complaint cases and check the effectiveness of corrective measures.
- Review accuracy of environmental monitoring section of EM&A reports.
- Verify EM&A reports submitted by the ET Leader.
- Feedback audit results to ET by signing off relevant EM&A proformas.
- Prepare a monthly report (in letter format) summarising the above.

E.4 Water Quality Monitoring

Parameters Measured

Baseline Monitoring and Impact Monitoring

E.4.1 The parameters to be measured in situ are:

- Dissolved oxygen (DO) (% saturation and mg/L).
- Temperature (°C).
- Turbidity (NTU).
- Salinity (‰ or ppt).

E.4.2 The only parameter to be measured in the laboratory is:

- Suspended Solids (SS) (mg/L).

E.4.3 In addition to the water quality parameters, other relevant data shall also be measured and recorded in field logs, including the location of the sampling stations and cable burial machine at the time of sampling, water depth, time, weather conditions, sea conditions, tidal state, current direction and speed, special phenomena and work activities undertaken around the monitoring and works area that may influence the monitoring results.

Silt Curtain Monitoring

E.4.4 The parameter to be measured in situ is:

- Turbidity (NTU).

Equipment

E.4.5 The following equipment shall be supplied by the ET and shall be approved by the IEC before use:

- **Dissolved Oxygen and Temperature Measuring Equipment.** The instrument shall be a portable, weatherproof dissolved oxygen measuring instrument complete with cable, sensor, comprehensive operation manuals, and shall be operable from a DC power source. It shall be capable of measuring: dissolved oxygen levels in the range of 0 – 20 mg/L and 0-200% saturation; and a temperature of 0-45^{o}Celsius. It shall have a membrane electrode with automatic temperature compensation complete with a cable of not less than 35m in length. Sufficient stocks of spare electrodes and cable shall be available for replacement where necessary (for example, YSI model 59 meter, YSI 5739 probe, YSI 5795A submersible stirrer with reel and cable or an approved similar instrument).
- **Turbidity Measurement Equipment.** Turbidity should be measured from a split water sample from the SS sample. A turbidimeter should be used to measure the turbidity level.
- **Salinity Measurement Instrument.** A portable salinometer capable of measuring salinity in the range of 0-40ppt shall be provided for measuring salinity of the water at each monitoring location.

- **Water Depth Gauge.** No specific equipment is recommended for measuring the water depth. However, water depth gauge affixed to bottom of the water quality monitoring vessel is preferred.
- **Current Velocity and Direction.** No specific equipment is recommended for measuring the current velocity and direction.
- **Positioning Device.** A Global Positioning System (GPS) shall be used during monitoring to ensure the accurate recording of the position of the monitoring vessel before taking measurements. The use of GPS is preferred for positioning device, which should be well calibrated at appropriate checkpoint (e.g. Quarry Bay Survey Nail).
- **Water Sampling Equipment.** A water sampler, consisting of a transparent PVC or glass cylinder of not less than two litres, which can be effectively sealed with cups at both ends, shall be used (Kahlsico Water Sampler 13SWB203 or an approved similar instrument). The water sampler shall have a positive latching system to keep it open and prevent premature closure until released by a messenger when the sampler is at the selected water depth.

Sampling / Testing Protocols

E.4.6 All in situ monitoring instruments shall be checked, calibrated and certified by a laboratory accredited under HOKLAS or any other international accreditation scheme before use, and subsequently re-calibrated at-monthly intervals throughout all stages of the water quality monitoring. Responses of sensors and electrodes shall be checked with certified standard solutions before each use.

E.4.7 For the on-site calibration of field equipment, the *BS 1427: 1993, Guide to Field and On-Site Test Methods for the Analysis of Waters* shall be observed. Sufficient stocks of spare parts shall be maintained for replacements when necessary. Backup monitoring equipment shall also be made available so that monitoring can proceed uninterrupted even when equipment is under maintenance, calibration etc.

E.4.8 Water samples for SS measurements shall be collected in high density polythene bottles, packed in ice (cooled to 4^{o}C without being frozen), and delivered to a HOKLAS laboratory as soon as possible after collection. At least two replicate samples should be collected from each of the monitoring events for in situ measurement and lab analysis.

Laboratory Analysis

E.4.9 All laboratory work shall be carried out in a HOKLAS accredited laboratory. Water samples of about 1,000mL shall be collected at the monitoring and control stations for carrying out the laboratory determinations. The determination work shall start within the next working day after collection of the water samples. The laboratory measurements shall be provided within two days of the sampling event (48 hours).

E.4.10 The analyses shall follow the standard methods as described in *APHA Standard Methods for the Examination of Water and Wastewater, 19th Edition*, unless otherwise specified (APHA 2540D for SS). The submitted information should include pre-treatment procedures, instrument use, Quality Assurance/Quality Control (QA/QC) details (such as blank, spike recovery, number of duplicate samples per-batch, etc.), detection limits and accuracy. The QA/QC details shall be in accordance with requirements of HOKLAS or other internationally accredited scheme.

Monitoring Locations

Baseline Monitoring and Impact Monitoring

E.4.11 11 no. monitoring station locations were selected to identify potential impacts to water and ecological sensitive receivers, and 1 no. control station was selected to be unaffected by the installation works.

E.4.12 Water quality sampling in these locations will be conducted prior to (baseline monitoring) and during (impact monitoring) the installation of the cable in order to demonstrate that the cable installation works do not affect the sensitive areas nearby. The proposed sampling locations are as follows, and are also shown on ***Figure E-1***:

- **E1** is a monitoring station to identify the impact of cable installation works on Cape D'Aguilar Marine Reserve.
- **E2** is a monitoring station to identify the impact of cable installation works on the coral communities at the coast of Sung Kong.
- **E3** is a monitoring station to identify the impact of cable installation works on the coral communities at the coast of Waglan Island.
- **E4** is a monitoring station to identify the impact of cable installation works on the coral communities at the coast of Po Toi.
- **E5** is a monitoring station to identify the impact of cable installation works on the coral communities at the coast of Beaufort Island.
- **L1** is a monitoring station to identify the impact of cable installation works on the Shek O Headland SSSI.
- **G1** is a Gradient Station between E2 and the cable alignment.
- **G2** is a Gradient Station between E3 and the cable alignment.
- **G3** is a Gradient Station between L1, B1, B2 and B3 and the cable alignment.
- **G4** is a Gradient Station between E4 and the cable alignment.
- **G5** is a Gradient Station between E5 and the cable alignment.
- **C1** is a Control Station approximately 3 km from the proposed cable alignment.

E.4.13 The co-ordinates of these 12 no. monitoring stations are listed in ***Table E-1*** and the exact co-ordinates will be determined before commencement of Baseline Monitoring (prior to cable laying).

Table E-1 Co-ordinates of the Water Quality Monitoring Stations (HK Grid)

Station	Location	Easting	Northing
L1	Shek O Headland SSSI	844691.67	809921.83
E1	Cape D'Aguilar Marine Reserve	844731.08	807948.62
E2	Coral communities at the coast of Sung Kong	847925.81	805752.35
E3	Coral communities at the coast of Waglan Island	849676.83	805707.55
E4	Coral communities at the coast of Po Toi	844789.19	805605.10
E5	Coral communities at the coast of Beaufort Island	845644.19	804910.24
G1	Gradient Station	847792.32	806543.30

Station	Location	Easting	Northing
G2	Gradient Station	849746.51	806330.48
G3	Gradient Station	844818.65	808986.53
G4	Gradient Station	845393.10	806478.88
G5	Gradient Station	846104.33	806081.00
C1	Control Station	848517.07	803792.59

Silt Curtain Monitoring

E.4.14 Water quality monitoring "inside" and "outside" of the silt curtain will be undertaken between Ch.500m (the start of cable burial) Ch.2.5km (when the cable enters the established east-west cable corridor). The "inside" and "outside" monitoring locations are shown on ***Figure E-1***.

Frequency and Duration

Baseline Monitoring and Impact Monitoring

E.4.15 Baseline Monitoring at each of the 12 no. monitoring stations shall commence no later than six weeks before the start of cable installation works and shall be carried out for a consecutive period of four weeks.

E.4.16 Impact Monitoring at each of the 12 no. monitoring stations shall commence at the start of cable burial (around 500m from shore) and shall be completed at a point 10km from shore (ch.10,000m). Beyond 10km from the landing point at Lap Sap Wan, water quality monitoring is no longer required.

E.4.17 Three sets of Baseline Monitoring and Impact Monitoring shall be carried out each week and the interval between any two sets of monitoring shall not be less than 36 hours.

E.4.18 Within each set, each location shall be monitored twice; within a three hour window of 90 minutes before and 90 minutes after the mid-ebb tide; and within a three hour window of 90 minutes before and 90 minutes after the mid-flood tide.

E.4.19 At each tide at each location, in situ measurement and samples shall be taken at three depths; 1m below the sea surface; mid-depth; and 1m above the seabed. For stations that are less than 3m in depth, only the mid depth sample shall be taken. For stations that are less than 6m in depth, only the surface and seabed sample shall be taken.

Silt Curtain Monitoring

E.4.20 Water quality monitoring "inside" and "outside" of the silt curtain shall be carried out on an hourly basis when the cable burial tool is operating between Ch.500m and Ch.2.5km in order to provide near-real time results so that prompt action can be taken if needed.

E.4.21 One water sample shall be taken from the "inside" of the silt curtain and one from the "outside" of the silt curtain using the water sampling equipment listed in the last bullet of ***paragraph E.4.5***. Each sample shall be taken 1m above the seabed. These water samples will be analysed by the ET for turbidity (in NTU) using a turbidimeter to determine real-time suspended solids readings (in mg/L) based on the relationship established between turbidity and suspended solids in the Baseline Monitoring Report.

Action and Limit Levels / Event Action Plan

Baseline Monitoring and Impact Monitoring

E.4.22 Water quality monitoring results will be evaluated against Action and Limit levels shown in ***Table E-2***.

Table E-2 Action and Limit Levels for Water Quality

Parameter	Action Level	Limit Level
SS in mg/L (Depth-averaged)	95th percentile of baseline data, or 20% exceedance of value at any impact station compared with corresponding data from the control station.	99th percentile of baseline data, or 30% exceedance of value at any impact station compared with corresponding data from the control station

E.4.23 The Event / Action Plan is shown in ***Table E-3***. Please note that the Event / Action Plan relates only to exceedances that are directly attributable to the cable installation works, over which the installation contractor has control.

Table E-3 Event / Action Plan for Water Quality

Event	Contractor
Action Level Exceedance	1. Repeat sampling event. 2. Inform EPD and AFCD and confirm notification of the non-compliance in writing. 3. Discuss with cable installation contractor and the IEC the most appropriate method of reducing suspended solids during cable installation. 4. Repeat measurements after implementation of mitigation for confirmation of compliance. 5. If non-compliance continues, increase measures in Step 3 and repeat measurement in Step 4. If non-compliance occurs a third time, suspend cable laying operations and continue sampling until normal water quality resumes.
Limit Level Exceedance	Undertake Steps 1-4 immediately, if further non-compliance continues at the Limit Level, suspend cable laying operations until an effective solution is identified.

Silt Curtain Monitoring

E.4.24 The results of water quality monitoring "inside" and "outside" of the silt curtain in terms of suspended solids in mg/L shall be used for reference and shall be reviewed in near-real time by the ET.

E.4.25 If an increase in suspended solids is noticed "outside" the silt curtain compared to "inside" the silt curtain, then additional water quality control measures should be implemented. These will be determined by the ET as required, but may include decreasing the speed of cable installation barge, halting the burial works temporarily, increasing monitoring frequency, applying an additional layer of silt curtain, etc. until conditions return to normal.

E.4.26 Advice of the IEC shall be sought in case of any concerns.

E.5 Marine Mammal Observation

E.5.1 Noise generated by cable laying works is not likely to have significant adverse impact on marine mammals, as assessed in ***Annex B***, since the noise level generated by the jetting works would fall below the hearing ranges of most marine mammals present in Hong Kong waters. As a precautionary measure, however, a marine mammal exclusion zone will be established during the cable installation works to prevent marine mammals from being affected by the works.

E.5.2 A marine mammal exclusion zone within a radius of 250m from the cable installation barge will be set up during the cable laying works in day-time hours. It begins when the installation barge moves out of Lap Sap Wan (500m from shore), continues on a daily basis as the barge heads eastwards, and ceases 10km from Lap Sap Wan, when the water quality monitoring also ceases.

E.5.3 The observation shall be undertaken by a qualified observer, who shall be suitably trained to conduct the observation work, and whose curriculum vitae shall be provided to AFCD prior to the commencement of the observation.

E.5.4 Before the installation work starts, the qualified observer will stand on the open upper decks of the barge and scan the 250m exclusion zone for at least 30 minutes. If cetaceans are observed in the exclusion zone, cable installation works shall be halted until they have left the area. This measure guarantees that the area in vicinity of the cable route is clear of marine mammals before the installation works start and thus could reduce potential disturbance to marine mammals. Should cetacean(s) move into the exclusion zone during cable installation, it is considered that they have acclimatised to the works and therefore suspension of cable installation is not required.

E.6 Reporting

E.6.1 The schedule for Baseline Monitoring and Impact Monitoring shall be submitted by the Project Proponent to EPD and AFCD no later than one week before the scheduled date of commencement of Baseline Monitoring.

Baseline Report

E.6.2 Upon completion of Baseline Monitoring for water quality, a *Baseline Monitoring Report* shall be prepared by the ET. This shall include details of the monitoring carried out, such as location, weather conditions, parameters measured, monitoring results and discussion, etc. and any recommendations for subsequent monitoring.

E.6.3 A relationship between turbidity (in NTU) and suspended solids (in mg/L) shall be established for use during silt curtain monitoring to enable suspended solids to be estimated from turbidity readings.

E.6.4 The *Baseline Monitoring Report* shall be certified by the ET and verified by the IEC, and thereafter submitted to the EIAO Register Office at least two weeks before commencement of construction of the Project.

Monthly EM&A Report

E.6.5 During Impact Monitoring, a *Monthly EM&A Report* shall be prepared by the ET detailing the EM&A carried out during that month. This will include water quality monitoring, and marine mammal observations, as appropriate.

E.6.6 The *Monthly EM&A Report* shall include the following sections, to be agreed with the IEC:

- Basic project information.
- Environmental status.
- Summary of EM&A requirements.
- Implementation status.
- Monitoring results.
- Report on non-compliance, complaints, notifications of summons and successful prosecutions.

E.6.7 The results of the silt curtain monitoring shall be included in the *Monthly EM&A Report.*

E.6.8 The *Monthly EM&A Report* shall be certified by the ET and verified by the IEC, and thereafter submitted to the EIAO Register Office within two weeks after the end of the reporting month.

IEC's Monthly Report

E.6.9 At the same time that the ET's *Monthly EM&A Report* is submitted, the IEC shall submit each month a short report (in letter format) to the EIAO Register Office summarising the results of the IEC's fortnightly audit inspections and any other observations on the environmental performance of the Project.

Figure E-1 Proposed Water Quality Monitoring Stations