Hong Kong Offshore LNG Terminal

Project Profile

May 2016

Environmental Resources Management
16/F, Berkshire House
25 Westlands Road
Quarry Bay, Hong Kong
Telephone 2271 3000
Facsimile 2723 5660

www.erm.com

Hong Kong Offshore LNG Terminal

Project Profile

ERM Document Code: *0299958_FSRU Project Profile_v0.docx*

Environmental Resources Management

16/F, Berkshire House
25 Westlands Road
Quarry Bay
Hong Kong
Telephone: (852) 2271 3000
Facsimile: (852) 2723 5660
E-mail: post.hk@erm.com
http://www.erm.com

Client: CLP Power Hong Kong Limited		Project No: 0299958			
Summary: This document presents the Project Profile for Application for an EIAO Study Brief for the Hong Kong Offshore LNG Terminal.		Date: May 2016 Approved by: *Dr Robin Kennish* *Director*			
0	Formal Submission	Var	JN	RK	05/16
Revision	Description	By	Checked	Approved	Date

Distribution

☒ Government

☒ Public

☐ Confidential

CONTENTS

1 INTRODUCTION

1.1 BACKGROUND

CLP Power Hong Kong Limited (CLP) is responsible for providing a safe, highly reliable and clean supply of electricity to over 80% of Hong Kong's population at reasonable cost. Within Hong Kong, CLP operates three power stations, namely Castle Peak Power Station (CPPS), Black Point Power Station (BPPS) and Penny's Bay Power Station (PBPS) owned by Castle Peak Power Company Limited (CAPCO), a joint venture between CLP and China Southern Power Grid Company Limited, of which CLP holds a 70% interest.

CLP and CAPCO support the Hong Kong Special Administrative Region (HKSAR) Government's objective of improving air quality and environmental performance in Hong Kong. Consistent with the HKSAR Government's medium-term strategy of increasing the use of natural gas for local power generation, and reducing the carbon intensity, provision for additional local gas-fired power generation capacity is considered by CLP and CAPCO to be the preferred choice.

Hong Kong has no indigenous energy resources and all energy for Hong Kong needs to be imported. Dependable fuel sources are critical to maintaining reliable power supply for our customers while providing environmental benefits. In the early 2000's, CAPCO began planning for future gas supplies in light of dwindling reserves in CAPCO's sole supply source at that time, the Yacheng 13-1 gas field in the South China Sea. After considering various options, CAPCO proposed the development of a land-based Liquefied Natural Gas (LNG) Receiving Terminal and its Associated Facilities (HKLNG Terminal) located in the HKSAR. Subsequent meetings and discussions with the HKSAR Government and other stakeholders commenced in 2004. The Environmental Impact Assessment (EIA) Report (Register No.: AEIAR-106/2007) for the HKLNG Terminal project to be located on the South Soko Island was approved with conditions, and an Environmental Permit EP (No. EP-257/2007) was granted on 3 April 2007. This project was then put on hold after the HKSAR Government signed a Memorandum of Understanding on Energy Co-operation with the Mainland Chinese Government, facilitating the supply of natural gas from Turkmenistan transported through Mainland China through the Second West-to-East Pipeline.

Therefore, to date, CLP and CAPCO rely on these two sources of imported gas supply to the BBPS from the Yacheng 13-1 gas field and Turkmenistan via the Second West-to-East Pipeline, both from pipelines in Mainland China.

In 2014, the Environment Bureau (EnB) of the HKSAR Government completed its consultations and discussions on the Future Fuel Mix for Electricity Generation for Hong Kong.

According to the consultation document issued by EnB, two fuel mix options were proposed:

- **Option 1:** Importing more electricity through purchase from the Mainland power grid; and

- **Option 2:** Using more natural gas for local generation.

On 31 March 2015, the HKSAR Government launched the three-month Public Consultation on the Future Development of the Electricity Market. With regard to the above two fuel mix options, the HKSAR Government plans to increase the percentage of natural gas used for power generation to around 50 per cent by 2020.

To support this increased use of natural gas in Hong Kong from 2020 onwards, CLP has identified that the development of an offshore LNG receiving terminal in Hong Kong based on Floating Storage and Regasification Unit (FSRU) technology presents a viable additional gas supply option that provides long-term energy security for Hong Kong as well as access to competitive gas supplies from world markets.

Further, FSRU technology is also considered to be more economical and has a reduced environmental footprint compared with the originally proposed land-based HKLNG Terminal and its construction duration is much shorter.

Having an offshore LNG receiving terminal in Hong Kong would increase the optionality regarding the sourcing of future gas supplies for Hong Kong, and provide flexibility to directly access competitively priced gas from the LNG market worldwide, including its associated spot market, therefore improving the future Hong Kong LNG buyers' overall negotiating position, and diversity of gas supply sources. The additional gas supply source also provides enhanced security of power supply in Hong Kong.

In this connection, The Hongkong Electric Co., Ltd. (HK Electric), the provider of electricity to the population on Hong Kong and Lamma Islands, is also interested in the prospect of sourcing future LNG supplies to augment its current single source of imported pipeline gas from the Guangdong Dapeng LNG receiving terminal in Shenzhen.

Therefore, CLP and HK Electric have agreed to jointly explore the feasibility of siting an FSRU based LNG import terminal in Hong Kong waters to serve as a potential gas supply option to meet Hong Kong's future fuel supply needs (hereinafter referred to as the '**Hong Kong Offshore LNG Terminal**' or the '**Project**').

The Project is planned to be a 'shared-use' import facility that has the capability to receive and store LNG and then deliver regasified LNG (natural gas) by subsea pipeline to the CLP/CAPCO BPPS and the HK Electric Lamma Power Station (LPS). It can also potentially supply The Hong Kong & China Gas Company Limited (Towngas) who is using natural gas as its feedstock.

The purpose of the current proposal is to consider the development, construction and future operation of the Project, including its associated subsea pipelines / gas receiving facilities to connect the end-users at CLP's BPPS and HK Electric's LPS. CLP will lead the development of the Project acting for and on behalf of HK Electric, and hence will be the Project Proponent for this ***Project Profile***.

However, any formal decision by CLP and HK Electric to proceed with the Project requires further analysis as such an investment decision is dependent upon a host of factors including but not limited to the rate of demand growth for natural gas consumption, environmental requirements, technical feasibility, the economic merits, and HKSAR Government approval. Accordingly, the submission of, and content described in this ***Project Profile*** does not constitute a commitment by or on behalf of CLP or HK Electric to proceed with the Project.

As previously mentioned CLP and CAPCO had prepared an EIA Report for the HKLNG Terminal project and have in place Environmental Permit (No. EP-257/2007). It is the intention of CLP to make use of the information presented in the said EIA Report where such information is still valid e.g. the proposed subsea pipeline route to BPPS, and where further analysis shows that such information does not require to be updated in order to support the EIA Study for the Project.

1.2 PURPOSE OF THIS PROJECT PROFILE

CLP has commenced discussions with various Government Bureaux and Departments and is now in a position to prepare and submit this ***Project Profile*** for the Project to obtain an ***EIA Study Brief*** under the *Environmental Impact Assessment Ordinance (EIAO) (Cap. 499)*. The purpose of this Project Profile is to facilitate the Director of Environmental Protection to determine the scope of environmental issues to be addressed in the EIA study and hence to issue the EIA Study Brief.

This document includes a description of the potential environmental impacts associated with the construction and operation of the Project, should CLP and HK Electric decide, and are able to obtain the HKSAR Government's approval to proceed. The description of the Project presented herein has been based on the best available information compiled by CLP, acting on behalf of HK Electric, and describes relevant construction activities, and provides operational details and baseline information relating to the conditions at the selected location for the Project, and its surrounding environment.

2 BASIC INFORMATION

2.1 PROJECT TITLE

Hong Kong Offshore LNG Terminal (based on Floating Storage and Regasification Unit (FSRU) technology)

2.2 NAME OF PROJECT PROPONENT

CLP Power Hong Kong Limited.

2.3 PURPOSE & NATURE OF PROJECT

The Project will involve the construction and operation of an offshore LNG terminal, as further described below, that is to be located in the southern waters of Hong Kong, to the east of the Soko Islands. An FSRU vessel, which will be moored at a double berth jetty, will provide facilities that enable LNG carriers (LNGCs) to deliver cargoes of LNG which are transferred and then stored in the FSRU vessel's storage tanks, and then regasified such that natural gas can be supplied to the gas receiving stations (GRS) at the BPPS and the LPS via two subsea pipelines.

2.4 LAND- VS MARINE-BASED LNG IMPORT TERMINALS

At the time of planning the earlier HKLNG Terminal, the EIA Report included an FSRU facility as one of the technology options for receiving imported LNG. However, the technology was considered nascent at that time. Since then, FSRU technology has advanced quickly and the use of an FSRU facility with an FSRU vessel is now considered a mature technology, with many worldwide applications. As of 1st March 2016, there are 22 FSRU LNG import projects in operation, and 7 projects are in various stages of development.

The requirements of the land-based HKLNG Terminal meant that it occupied a footprint of approximately 37 hectares (ha) of land which is needed to locate the necessary infrastructure including the inter-connections with the marine jetty, the LNG storage tanks (2), the compression, vaporization and gas send-out process areas, including flare and utilities areas, the control room, and the maintenance workshop, administration building and guard house. In addition a marine jetty area of 4 ha is also required, increasing the total footprint to 41 ha.

By comparison, the FSRU facility itself occupies a footprint of approximately 8 ha, yet it is comprised of the similar facilities and provides the same LNG import operations, albeit on a smaller scale. All of the LNG unloading, storage, regasification and send out facilities are located on the FSRU vessel,

and the double berth jetty head, both of which are located offshore, with no land footprint.

As stated above, an FSRU vessel can be a 'new-build' or a conversion of an existing LNGC. Consequently, the development of an FSRU-based facility requires a significantly shorter construction period and can be completed at a lower capital cost, compared to a land-based LNG receiving terminal of similar capacity (1).

With Hong Kong's rising demand for land availability being a significant development constraint, coupled with the advantages of a remote offshore location in Hong Kong waters, this leads to the conclusion that the Hong Kong Offshore LNG Terminal based on FSRU technology, together with its quicker construction time, lower capital cost and reduced environmental impact is, therefore, the preferred choice over a land-based LNG import terminal.

2.5 FLOATING STORAGE REGASIFICATION UNIT TECHNOLOGY

2.5.1 Introduction to the LNG Supply Chain with an FSRU Facility

To bring the supply of natural gas produced from around the world to the major gas markets, which are usually located a long distance away, natural gas is either transported to market by a long distance pipeline or converted into LNG and then transported to market by a special purpose LNGC. The LNGC receives its LNG cargo at an LNG liquefaction plant in an exporting country and then delivers this LNG to the importing country, and the LNG is unloaded at an offshore LNG receiving terminal, and a typical FSRU facility is illustrated in *Figure 2.1*.

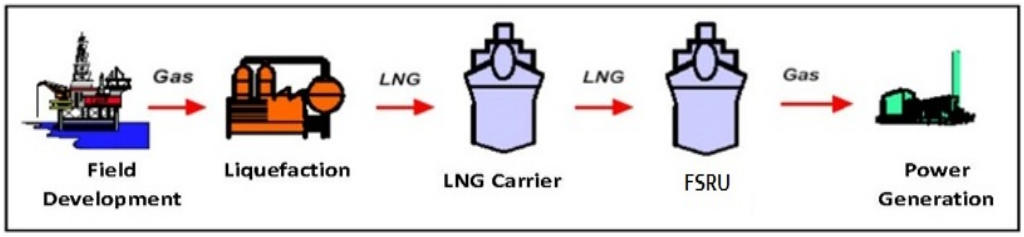
Figure 2.1 Typical Offshore LNG Receiving Terminal

(1) Franklin *et al.*, (2010). Converting Existing LNG Carriers for Floating LNG Applications (FLNG, FSRU, FSO). Offshore Technology Conference, 3-6 May 2010, Houston, Texas, USA. https://www.onepetro.org/conference-paper/OTC-20683-MS [Accessed 10-08-2015].

FSRU technology has developed and matured over the recent years, and has been chosen as a viable and cost effective design where constraints exist concerning large land-based LNG receiving facilities.

The full LNG Supply Chain with an FSRU facility used for LNG importation is illustrated in *Figure 2.2*. At the gas producing country, the process of LNG production involves the transport of the natural gas from the production fields via pipeline to a liquefaction plant. Prior to liquefaction, the gas is treated to remove contaminants, such as carbon dioxide, water and sulphur to avoid them freezing and damaging equipment when the gas is cooled to -162°C where it enters its liquid state. The LNG produced from the liquefaction process is piped into LNG storage tanks. Both the pipes and LNG storage tanks are insulated to maintain the low temperature. LNG storage tanks are designed and constructed using special materials to contain the cryogenic liquid. LNG is then pumped from the LNG storage tanks, and loaded onto the specially equipped LNGCs and transported to the LNG importing countries. When the LNGCs arrive at the place of import, LNG is unloaded onto the FSRU facility where it is stored on board the FSRU vessel in its LNG storage tanks. Then, to meet local gas demand, the LNG is re-gasified and piped to end-users, such as power plants and major industries.

Figure 2.2 LNG Supply Chain including Offshore LNG Receiving Terminal



2.5.2 Offshore LNG Receiving Terminal Key Components and Process

An offshore LNG receiving terminal is located towards the end of the gas supply chain where the LNG delivered by the LNGCs is stored, and then regasified on-board the FSRU vessel for send out to its end-users, such as power stations and major industries, via a subsea pipeline. An FSRU facility operates in the same manner as a conventional land-based LNG receiving terminal.

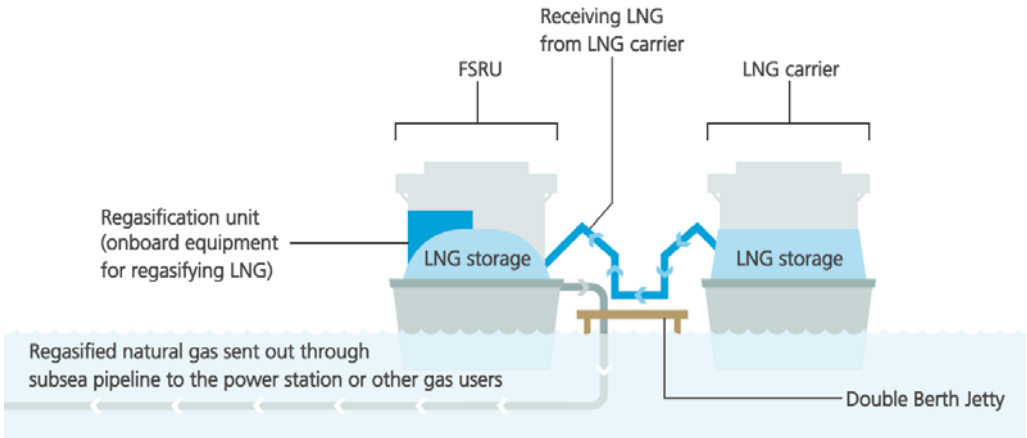
Typical key features of an FSRU facility are:

- FSRU vessel with the following on-board facilities;
  - LNG storage tanks – *Membrane* (the LNG storage tank matches the configuration of the hull of the vessel) or *MOSS* (spherical LNG storage tank) containment;
  - LNG regasification units – e.g. LNG booster pumps, LNG vaporizers, etc.

- Double berth jetty for mooring both the FSRU vessel and the LNGCs that deliver the LNG;
- LNG and high pressure gas unloading equipment located on the double berth jetty head–e.g. LNG unloading arms; and
- Subsea pipeline connecting the double berth jetty to onshore gas end-users, such as power plants and major industries.

The key components and process overview of an FSRU vessel and LNGC loading/unloading jetty are depicted in *Figure 2.3*.

Figure 2.3 ***Offshore LNG Receiving Terminal Key Components and Process Overview***



The FSRU vessel design and operations will be under internationally accepted merchant shipping standards such as the International Maritime Organization (IMO) International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC code) and ship classification society regulations. FSRU vessels are required to comply with the same strict international regulations and industry guidelines for LNGCs that have been in place since the start of the LNG industry over 50 years ago, an industry that has since grown substantially worldwide and has an outstanding safety record.

The typical safeguards that are present in LNGC / FSRU vessel design and operations are as follows:

- Design is in accordance with International Gas Carrier regulations and ship classification society requirements;
- Double hull and double bottom construction;
- Forward collision bulkhead;
- Independent, separated LNG cargo storage areas;
- Fire protection system;

- Speed limitation according to regulations and practices;
- Pilots on board during berthing /un-berthing;
- Tug assistance to control berthing /un-berthing operations; and,
- Quick release mechanisms for fast separation of either FSRU vessel or LNGC.

2.5.3 International FSRU Projects

Over recent years, offshore LNG import projects using FSRU technology have been chosen over land-based projects, and this trend is set to continue as FSRU based LNG import projects are proving to be a viable and cost-effective design overcoming many of the permitting and environmental constraints that are typically faced by large, land-based infrastructure developments. As of 1st March 2016, there are 22 FSRU LNG import projects in operation, and 7 projects are in various stages of development around the world.

2.6 HONG KONG OFFSHORE LNG TERMINAL

The Project will involve the construction of an FSRU double berth jetty in open Hong Kong waters and two subsea pipelines connecting the FSRU facility to the BPPS and the LPS. To facilitate potential gas supply to Towngas, provisions such as 'T-piece' connections will be installed in the subsea pipeline to the BPPS at strategic locations.

The key infrastructure components of the proposed Project will, therefore, comprise of:

- *FSRU Vessel*: a standard LNGC equipped with LNG storage tanks and regasification equipment;
- *Double Berth Jetty*, with its LNG unloading equipment and piping, together with mooring facilities for the FSRU vessel and LNGCs;
- *Subsea Natural Gas Pipeline including GRS* connecting the FSRU facility to the BPPS; and
- *Subsea Natural Gas Pipeline including GRS* connecting the FSRU facility to the LPS.

Delivery of LNG to the FSRU facility will be carried out by LNGCs which will access the double berth jetty through the agreed marine approach channel.

2.6.1 FSRU Vessel and LNGCs

Both the FSRU vessel and the LNGCs have insulated LNG storage tanks that are of double-hull design and construction to provide optimum protection for

the integrity of the LNG cargo containment system (Membrane or MOSS) in the event of any incident, collision or grounding.

To facilitate the import of LNG by LNGCs through both long-term contracts and the spot market, the location of the FSRU facility in Hong Kong waters should maximise accessibility from international waters, with consideration for the ease of the LNGCs marine access / transit routing.

2.6.2 Double Berth Jetty

The double berth jetty is to be designed for simultaneous mooring of both the FSRU vessel and the LNGC. A typical double berth jetty is a marine structure that includes mooring / fender facilities that are used to moor the FSRU vessel and the LNGC. On the double berth jetty head, two sets of LNG loading arms are installed together with cryogenic piping for the transfer of LNG from the LNGC to the FSRU vessel, and high pressure connecting pipework is provided that is used for the send out of natural gas from the FSRU facility into both of the subsea pipelines to the BPPS and LPS.

2.6.3 Subsea Natural Gas Pipelines

A subsea pipeline of approximately 30 inch (~760mm) diameter (size to be confirmed during the development stage of the Project) will be installed in order to supply natural gas from the FSRU facility to the GRS at the BPPS. The route of this pipeline will follow that approved in the HKLNG Terminal EIA Report as closely as possible. The pipeline route is located in proximity to the Lantau Channel Traffic Separation Scheme (TSS) in south-west Hong Kong Boundary and the relevant authorities responsible for the implementation of the TSS will be consulted during the EIA Study for the Project.

A subsea pipeline of approximately 20 inch (~500mm) diameter (size to be confirmed during the design stage of the Project) will be installed in order to supply natural gas from the FSRU facility to the GRS at the LPS. A section of the pipeline route to the south of Shek Kwu Chau would traverse the South of Cheung Chau high speed craft recommended route. The Marine Department will be consulted during the EIA Study for the Project.

2.6.4 Gas Receiving Station

The subsea pipeline from the FSRU facility to the BPPS will terminate at a new GRS to be installed at the BPPS. Facilities associated with the GRS are not complex and the site area requirements are relatively small. It is planned that the GRS can be located within the BPPS site, and this will be confirmed during the EIA Study and the development stage of the Project.

The subsea pipeline from the FSRU facility to the LPS will terminate at a new GRS to be installed at the LPS. It is planned that the GRS can be located within the LPS site, and this will be confirmed during the EIA Study and the development stage of the Project.

2.6.5 *Key Engineering Requirements of the Proposed Offshore LNG Receiving Terminal*

CLP is currently exploring the best engineering design options for the Project. For the purpose of this ***Project Profile***, the project design parameters have been set to accommodate an FSRU vessel and LNGCs whose maximum capacity is 267,335 m^3. This is to ensure that the double berth jetty is able to berth the widest range of LNG vessels.

It is important to note that the decision on the design and sizing of the actual FSRU vessel will be made in future, and this will depend on the gas demand required in the Hong Kong electricity market in 2020 and onwards, and the market availability of 'new-build' or 'conversion' capacity at shipyards at the time that this decision is made during the development phase of the Project.

Key dimensions of a typical large FSRU vessel and LNGC are listed in *Table 2.1* and *Table 2.2*.

Table 2.1 Typical Dimension of a Large FSRU Vessel

Typical Dimensions	Specification
Vessel Length Overall (LOA)	345 m
Vessel Fully Loaded / Design Draft	~12.5 m
Beam	54 m
Vessel Basis	'New-Build' or 'Conversion'
Total Storage Capacity	267,335 m^3

Table 2.2 Typical Design Parameters for Large LNGC

Typical Dimensions	Specification
Vessel Length Overall (LOA)	345 m
Vessel Fully Loaded / Design Draft	~12.5 m
Beam	54 m
Vessel Basis	Existing LNGC chartered / owned by LNG supplier
LNG Unloading	At the double berth jetty via LNG loading arms (16" dia) and inter-connecting cryogenic piping
Maximum Unloading Rate	12,000 m^3/hr

The FSRU vessel and the LNGCs will be moored at the double berth jetty, which will sit within a berth pocket. For the purpose of this ***Project Profile***, the key requirements for the marine access and berthing requirements will be based on the FSRU vessel and LNGC design parameters as shown in *Table 2.3*.

Table 2.3 Marine Access & Berthing Requirements for Large FSRU Vessel / LNGCs

Marine Access and Berthing Requirements	Value
Water depth for marine access and berthing	-15 m CD
Length of Double Berth Jetty for FSRU Vessel / LNGC	450 m (including mooring dolphins)
Width of Double Berth Jetty for FSRU Vessel / LNGC	50 m
Berthing pocket & manoeuvring area - Length - Width	 500 m 475m
Diameter of marine access area for FSRU Vessel / LNGC	690-700 m
Width of marine access channel - Length will depend on site	250-260 m

* All estimates are based on proposed location of the FSRU Facility in south-west Hong Kong waters; actual parameter / size may vary depending on the bathymetry of the final selected location of the FSRU Facility.

For the pre-Front End Engineering Design phase of the Project, CLP has identified typical FSRU vessel / LNGCs operational limits based on other FSRU projects and available metocean data on wind, wave and current speed requirements for the navigation, berthing and safe mooring of the FSRU vessel and LNGCs alongside the double berth jetty, followed by safe LNG unloading operations, and regasification for natural gas send out. These operational limits proposed are presented in *Table 2.4*.

Please note that the typical operational limits are based on LNG industry practice and information available during the preparation of this *Project Profile*. 'Project-specific' operational limits relating to metocean conditions will be reconfirmed during the EIA Study and the development phase of the Project.

Table 2.4 Typical Operational Limits for FSRU Vessel and LNGCs Operations

	Limiting Wind Speed (m/s)*	Limiting Wave Height (m)	Limiting Current Speed (m/s)
Navigation	26.0	3.5	1.54
Berthing	12.0	2.0	0.6
LNG Unloading Operations	19.0	2.0	0.6
Dolphin / Double Berth Jetty Mooring	26.0	2.25	0.8

* Note that the table shows assumed sets of limits for wind, wave and current which in reality are interactive, i.e. lowering the wind speed could potentially increase the tolerance of wave height and current speed. Specific metocean limits will be further determined during the EIA Study and the design phase of the Project.

The water depth requirement is estimated to be around -15m CD. The operational limits are to be checked and verified by the detailed bathymetry survey and navigation study during the EIA Study and the development stage of the Project.

2.7 *ALTERNATIVE SITE ANALYSIS PROCESS*

In early 2015 CLP commenced work on the identification of potential locations within Hong Kong that could accommodate the site (Site) for the FSRU facility and its associated infrastructure. The following sections of this ***Project Profile*** detail the processes by which a suitable location was identified for more detailed analysis as part of the EIA Study in order to determine the actual Site for the FSRU facility.

The approach to selecting suitable locations for the FSRU facility Site has been based on other site search studies conducted in Hong Kong [(1) (2) (3) (4) (5)]. The approach was organised into two main phases, the first focussed mainly on excluding incompatible areas and the second in narrowing down to a most preferred /suitable location. In order to guide the site selection procedure the key engineering requirements referenced in *Section 2.6.5* were referred to, in particular, marine access and berthing requirements (*Table 2.3*) and metocean conditions (*Table 2.4*).

2.7.1 *Absolute Constraints*

These factors are seen to pose an 'absolute' obstacle to the development of the Project justified by the presence of highly significant issues. These are used for the preliminary elimination of all unsuitable locations to facilitate the establishment of 'No Go Areas', including statutory protected locations at which an FSRU facility would not be allowed to be constructed and are, therefore, avoided from the outset. These Absolute Constraints, which were grouped into Marine Safety and Environmental categories, were applied as the first screen to eliminate unsuitable locations so as to identify potential locations for the FSRU facility Site that were available within Hong Kong waters.

(1) ERM-Hong Kong, Ltd (2005) Detailed Site Selection Study for a Proposed Contaminated Mud Disposal Facility within the Airport East/East of Sha Chau Area. *Final Report*. For the Civil Engineering Department, Hong Kong SAR Government.

(2) ERM - Hong Kong, Ltd (2000) Strategic Assessment and Site Selection Study for Contaminated Mud Disposal. *Strategy Selection Report*. For the Civil Engineering Department, HKSARG.

(3) Castle Peak Power Company Limited (2006). Liquefied Natural Gas (LNG) Receiving Terminal and Associated Facilities. EIA Report (Register No. EIA-125/2006)

(4) The Hongkong Electric Co., Ltd. (2009) Development of a 100MW Offshore Wind farm in Hong Kong. EIA Report (Register No. EIA-177/2009).

(5) Engineering Investigation and Environmental Studies for Integrated Waste Management Facilities Phase 1- Feasibility Study (2011). EIA Report (Register No. Agreement No. CE 29/2008).

Marine Safety Constraints

The FSRU facility when operating will involve the transfer and storage of LNG, as well as the regasification of the LNG and send out of natural gas at high pressure in subsea pipelines. Consequently, it is critical from a safety perspective that the FSRU facility Site selected is away from areas of heavy marine traffic and nearby populations, and is not overly exposed to adverse weather or metocean conditions. With that in mind areas of Hong Kong waters that are designed for marine traffic purposes were excluded from further consideration and these included:

- Marine Vessel Fairways;
- Access Channels and Traffic Separation Schemes;
- Restricted Areas (high/low/unrestricted traffic volume);
- Existing Anchorages (dangerous goods, immigration and others); and
- Gazetted Typhoon Shelters and Marina.

Stability of the moored FSRU vessel and the LNGC is important during LNG unloading and transfer and gas send out to avoid accidental spills of the cryogenic liquid. Consequently, areas in Hong Kong waters that experience extreme wave heights or high current speeds were excluded from further consideration.

The limiting extreme wave height for navigation is assumed to be at 3.5 m as referenced in *Table 2.4*. Given the interactive nature of wind, wave and current, wind speed alone is not necessary a limiting factor to FSRU vessel and LNGC operations, but its compound effect on wave height could affect their operations. Peak current speeds tolerance for berthing during wet and dry seasons in ebb and flow were modelled and applied. The limiting current speed for berthing, LNG unloading and regasification and send-out operations were assumed to be 0.6 m/s as referenced in *Table 2.4*.

Environmental & Conservation Constraints

Areas that have been designated for environmental conservation were also been excluded from further consideration and these included:

- Designated Marine Parks and Marine Reserves;
- Sites of Special Scientific Interest (SSSI);
- Coastal Protection Areas;
- Country Parks and Special Areas;
- Mai Po Nature Reserve Area;

- Restricted Areas gazetted under *Wild Animal Protection Ordinance*;
- Fish Culture Zones;
- Gazetted Artificial Reefs; and
- Gazetted Beaches.

All of the above constraints have some form of development control which would either render the FSRU facility incompatible or to gain approval to develop the FSRU facility in these areas would involve significant permitting challenges that would add prohibitive cost and time.

2.7.2 Potential Constraints

These factors may render potential locations undesirable due to an established or proposed use, environmental value and / or technical challenges amongst other reasons. Although considered not to prevent locating the FSRU facility, these constraints pose significant issues or cost implications that may potentially present an obstacle to the development of the Project, and risk its safe and timely delivery. The potential constraints covered four main categories:

1. **Marine: (a)** ease of navigation of LNGCs transit route; **(b)** dredging requirements for FSRU facility and LNGCs transit route; **(c)** presence of subsea utilities; and, **(d)** presence of designated mud disposal/sand dredging areas.

2. **Environmental Conservation: (a)** proposed and potential areas of conservation interest, including marine parks and geoparks; **(b)** marine mammal habitats; **(c)** fisheries resources, spawning and nursery areas; and **(d)** coastal ecological resources such as corals, mangroves etc.

3. **Planning: (a)** proposed and potential land developments; **(b)** proximity to BPPS; and, **(c)** proximity to LPS.

4. **Social**: **(a)** marine recreation areas including secondary contact zone; and, **(b)** size and distance of nearest population.

The areas excluded by the Absolute Constraints were mapped out and the remaining areas examined with reference to the Potential Constraints. This process helped identify locations that could be considered as suitable for siting the FSRU facility.

It is apparent from this process that the majority of marine areas in western and north-western waters were excluded as part of the constraint mapping exercise. This includes the area around BPPS, an end-user of natural gas from the FSRU facility. The rationale for this is that the majority of these areas have relatively high current speeds and are very shallow and, therefore, would require substantial dredging to be able to accommodate the FSRU

facility. The areas of deeper water that have the required depth of 15m CD are typically shipping lanes or fairways and hence are not suitable for siting the FSRU facility. In addition the transit routes for the LNGCs in these areas are not considered suitable due to the presence of heavy marine traffic.

The constraint mapping exercise also excluded the majority of marine areas in central waters north of Lamma Island. This is because these areas have a number of maritime and port operations that represent safety constraints to the FSRU facility as well as LNGC transit. The majority of these areas also have relatively high current speeds and are shallow and, therefore, would require substantial dredging to be able to accommodate the FSRU facility. The areas to the southwest of Lamma Island also experience extreme wave heights (> 3.5m navigation operational limit, *Table 2.4*) and hence are not suitable for siting the FSRU facility.

2.7.3 Identification of the Preferred Site

The unconstrained areas that were considered to be of sufficient size for the FSRU facility Site and broadly accessible by an LNGC were identified and examined. The result of this process was that three locations were examined in more detail against the Potential Constraints criteria presented above.

The three locations were as follows:

1. West Lamma

2. South of Cheung Chau & Shek Kwu Chau

3. South-West Hong Kong Water Boundary

Location 3 was identified as being the preferred location for the FSRU facility Site for the following reasons.

The location is remote from populated areas and secondary recreational zones, with the closest small population located in Sha Tsui on Lantau Island at a distance of more than 5 km. The preferred location is also located well away from designated marine vessel fairways and high-speed passenger ferry routes between Hong Kong and the Pearl River Delta. It has sufficient water depth of -10 to -16 m CD with no or minimum dredging requirements for the FSRU facility or the LNGC transit route, compared to other potential locations. The preferred location is in relatively calm waters, sheltered from typhoon conditions, thereby considered as favourable to FSRU facility operations. The preferred location is ~43 km from the BPPS and ~20 km from the LPS, hence this determines the distances of the subsea pipeline connections from the FSRU facility to the BPPS and the LPS, and overall, ~63 km of new subsea pipelines will be installed.

The relative shortcomings of the preferred location for the FSRU facility include its location within known habitats of species of conservation interest

i.e. Finless Porpoise and Chinese White Dolphin, to the west, and the South Cheung Chau mud disposal site to the east.

There is also uncertainty regarding the size and boundary limits of the proposed marine park of at least 700 ha for the Integrated Waste Management Facilities (IWMF), which is to be established somewhere between Soko Islands and Shek Kwu Chau within the preferred location of the FSRU facility. It was agreed in a meeting with the Environmental Protection Department (EPD) responsible for the IWMF Project that CLP would observe its proposed boundary to determine the site for the FSRU facility, the actual details to be agreed in future. It should be noted that the preferred location for the FSRU facility is located away from the Soko Islands Marine Park (SIMP).

Further analysis will be carried out during the EIA Study and the development phase of the Project in order to confirm the optimal Site for the FSRU facility. This analysis will also fully consider all of the comments and feedback that was received from the relevant government departments and this will include the IWMF marine park and other environmental, risk, social, and technical factors.

Therefore, for the purposes of this ***Project Profile***, CLP intends to take Site 3 – South-West Hong Kong Water Boundary forward and carry out engineering, constructability, marine, quantitative risk assessment (QRA), subsurface, metocean, marine traffic studies, including the EIA Study itself, and engage with stakeholders e.g. subsea cable owners, marine park owners etc., and consult with the various HKSAR Government Departments in order to select the actual Site for the FSRU facility.

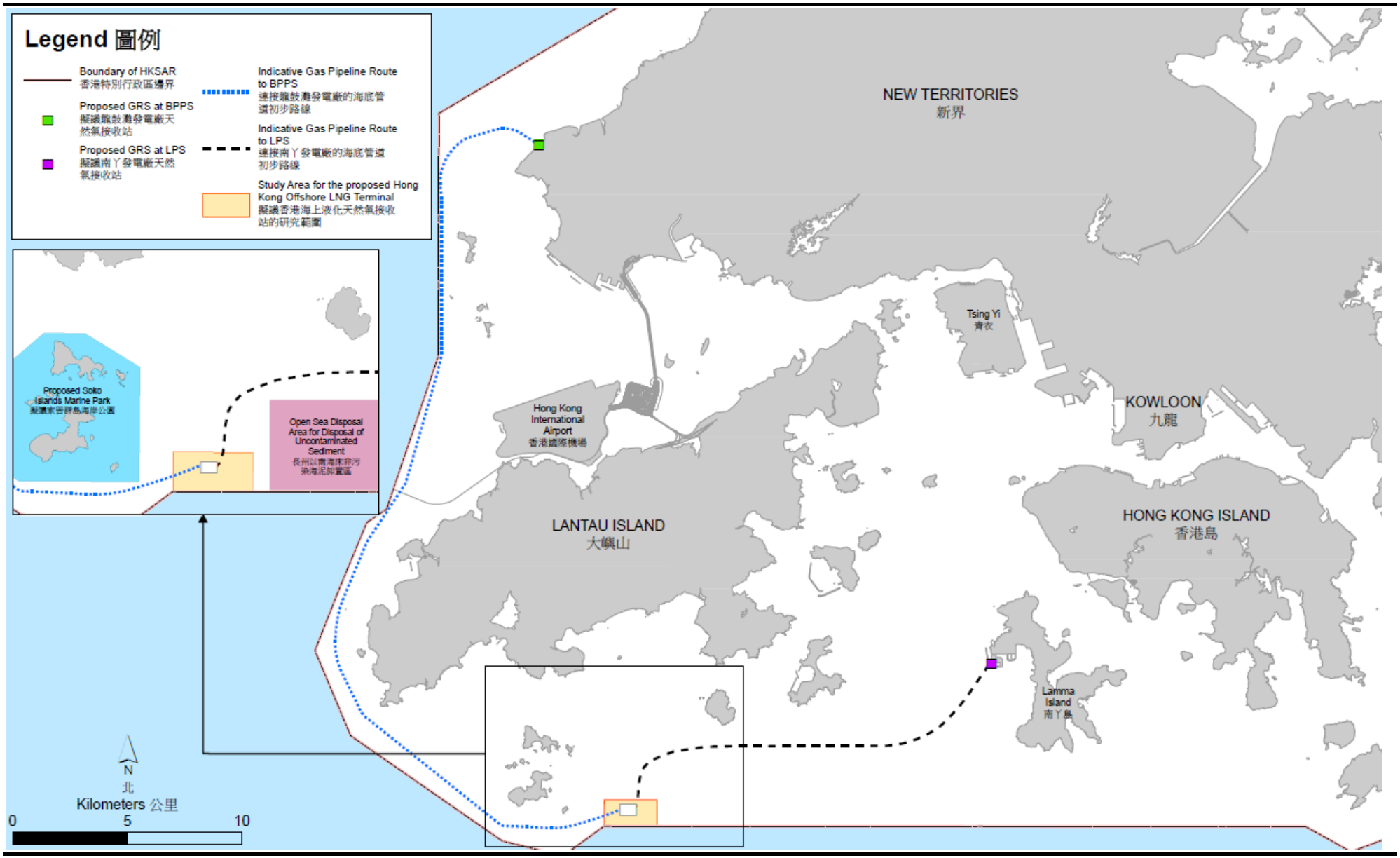
2.8 LOCATION & SCALE OF THE PROJECT

The location that CLP intend to analyse further during the EIA Study is an area of open Hong Kong waters as shown on *Figure 2.4*. The location is optimal based on suitable metocean and wave conditions, and its distance from populated areas. The FSRU facility will be a 100% marine based without any onshore land requirements. The final Site for the FSRU facility will be within this location.

In order to deliver the regasified LNG (natural gas) from the FSRU facility to the BPPS, a ~43 km subsea pipeline will be constructed. Similarly, in order to deliver the regasified LNG (natural gas) from the FSRU facility to the LPS, a ~20 km subsea pipeline will be constructed. The provisional route for both subsea pipelines is as shown in *Figure 2.4.* The exact route of both subsea pipelines will be determined during the EIA Study and the development phase of the Project.

Land will be required for the GRS at the BPPS, and this will be within the BPPS site. Similarly, land will be required for the GRS at the LPS, and this will be within the LPS site.

Figure 2.4 Key Elements of the Hong Kong Offshore LNG Terminal



2.9 CONSTRUCTION PHASE

2.9.1 FSRU Vessel and LNGCs

The FSRU vessel will either be a converted LNGC with vaporizers added, or a 'new-build'. The FSRU vessel, both in appearance, design and operations, remains a marine vessel and will be moored in place for the lifetime of the Project, except for departure under emergency conditions such as a tropical typhoon, or for dry dock maintenance. To enhance the physical protection of the LNG storage area, an FSRU vessel is double-hulled on all sides in a manner similar to LNGCs.

To allow safe transit of the FSRU vessel and LNGCs to and from the double berth jetty, dredging may need to be undertaken depending on the selected Site's water depth. As discussed above, the selection of the Site will favour locations with minimal estimated dredging volumes, whilst the exact dredging volume will be determined during the EIA Study and design phase of the Project. It is understood that the management and disposal of any dredged material will follow the procedures and requirements specified in *PNAP ADV-21 – Management Framework for Disposal of Dredged/ Excavated Sediment*, and a Marine Dumping Permit will be obtained under the *Dumping at Sea Ordinance* (Cap. 466).

2.9.2 Double Berth Jetty

The double berth jetty is typically constructed using steel piles installed at the selected FSRU facility Site.

2.9.3 Subsea Pipelines

The subsea pipelines will be installed using a combination of techniques including pre-trenching (e.g. dredging) and post-trenching (e.g. jetting), subject to agreement by the relevant authorities. The design and construction of the subsea pipelines will be optimised to minimise impacts to water quality and marine ecology and fisheries. Due to the relatively short construction time and proven installation methods, the impacts to marine traffic along the proposed subsea pipeline routes are expected to be minimal.

2.9.4 Gas Receiving Stations

The construction works for the GRS facilities at the BPPS and the LPS would be conventional, land-based techniques, and would inter-connect with the incoming subsea pipelines through an open trench followed by direct burial. The onshore pipeline sections would both have a protective coating, and will be provided with cathodic protection.

2.10 OPERATION PHASE

2.10.1 LNGC Transit, Receiving Facilities and LNG Storage on FSRU Vessel

The LNGCs will require a water depth of -15m CD depending on the static and dynamic allowances to be determined for the port approaches, harbour transit and arrival at the double berth jetty.

In transit to the receiving FSRU facility, the LNGCs will proceed through the designated fairways, turn into the approach channel towards the double berth jetty, and then be manoeuvred alongside with the assistance of tugs.

At the double berth jetty, once a LNGC has been safely moored, LNG unloading can commence and the LNGC will be connected with the FSRU vessel through the unloading arms and cryogenic piping on the jetty head.

The LNG in the LNGC will be delivered to the FSRU vessel's LNG storage tanks using the LNGC's discharge pumps. The unloading process from a typical sized LNGC with a capacity between 150,000 m^3 and 180,000 m^3 will take approximately 12 to 18 hours. It is envisaged, based on the estimated FSRU facility throughput, that the frequency of LNG delivery on average will be one LNGC arriving every five to eight days.

The FSRU facility will operate on a 24-hour, 365 days a year basis, to send out a consistent and reliable supply of natural gas to the BPPS and the LPS. A typical FSRU facility with capacity of 170,000 m^3 can store up to 77,000 tonnes of LNG. CLP has yet to determine the size and capacity of the FSRU vessel to be used for the Project and, as outlined previously, this will be based on the projected future Hong Kong gas demand for 2020 and onwards.

2.10.2 Regasification Process

On board the FSRU vessel, the LNG is re-gasified by a simple heat exchange process. Common types of vaporizers for an FSRU vessel include generic Intermediate Fluid Vaporizer (IFV) and Shell & Tube Vaporisers (STV) which are both compatible with wave motions experienced by the FSRU vessel. The re-gasified LNG (natural gas) is then sent out through the subsea pipelines to the GRS at the BPPS and the GRS at the LPS for use in power generation.

During regasification operations the seawater that is used for warming the LNG in the vaporizers is discharged back into the sea, at about 7-10^{o}C cooler than its intake ambient temperature, and this includes small quantities of anti-foulants such as sodium hypochlorite. Potential impacts to water quality against applicable standards will be further assessed in the EIA Study and the development stage of the Project.

In the history of LNG shipping (1964-2016), LNGCs demonstrate an outstanding industry safety record and have rarely been involved in collisions and groundings; none of these leading to a breach of an LNG storage tank.

Since the first FSRU project was commissioned, up to the present time (2016), there have been no accidents (1). This excellent operational safety record has been maintained through the application of rigorous safety policies, stringent design codes and operational practices implemented by the LNG industry.

2.11 NUMBER AND TYPE OF DESIGNATED PROJECT TO BE COVERED BY THE PROJECT PROFILE

The following elements of the Project addressed in this ***Project Profile*** are classified as Designated Projects under the *EIAO.*

- Construction of a storage and transfer facility of liquefied natural gas with a storage capacity of more than 200 tonnes (item *L.2* of *Part I* of *Schedule 2 of EIAO*);
- Dredging operation for the navigation channel, berthing area and subsea pipelines that exceeds 500,000 m^3 (item *C.12* of *Part I* of *Schedule 2* of *EIAO*); and
- Installation of two subsea pipelines connecting the proposed FSRU facility with the BPPS and the LPS (item *H.2* of *Part I* of *Schedule 2* of *EIAO*).

2.12 NAME AND TELEPHONE NUMBERS OF CONTACT PERSON

Name, Position & Title	**Telephone Number**
Graham Holland *Director – Project Development* *CLP Power Hong Kong Limited*	2678-4968

(1) CLP/DNV GL Research as presented on 1 March 2016.

3 OUTLINE OF PLANNING AND IMPLEMENTATION PROGRAMME

3.1 PROJECT PLANNING & IMPLEMENTATION

The ***Project Proponent*** is CLP Power Hong Kong Limited (CLP). Please note that, as stated in *Section 1.1*, CLP will be acting for and on behalf of HK Electric.

CLP will take the lead in the planning, design and development of the Project. The parties that will be responsible for the construction, operation and maintenance of the Project will be determined during the EIA Study and the development phase of the Project.

The ***Project Proponent*** will engage Environmental Consultants to conduct an EIA Study and Engineering Consultants to undertake the engineering design work. It is planned that the Project will be constructed by suitably experienced and qualified Contractor(s) to be appointed by the ***Project Proponent*** at a future stage in the development of the Project.

3.2 INDICATIVE PROJECT PROGRAMME

The development stage of the Project, including the EIA Study, is anticipated to be completed within 18 to 24 months. Subject to obtaining HKSAR Government approval of the Project and a final investment decision on the Project being taken, it is anticipated that the construction of the Project would commence in 2019, with commercial operations of the Project anticipated by the end of 2020.

3.3 INTERACTIONS WITH OTHER SURROUNDING PROJECTS

The Project will be constructed in five areas:

(i) FSRU facility that will be installed in the southern waters of Hong Kong, where it will operate, and the transit route for LNGCs is expected to be from the southern boundary of Hong Kong waters to the FSRU facility;

(ii) Subsea pipeline that will connect the FSRU facility with the BPPS and hence will traverse the south-western, western and north-western waters of Hong Kong;

(iii) GRS that will be constructed and operated at the BPPS, within the existing power station footprint;

(iv) Subsea pipeline that will connect the FSRU facility with the LPS and hence will traverse the southern waters of Hong Kong; and

(v) GRS that will be constructed and operated at the LPS, within the existing power station footprint.

Potential interactions with existing, committed or planned projects in these areas have been highlighted below. The information presented will be re-examined and confirmed during the EIA Study and the development stage of the Project.

3.3.1 FSRU Facility Location & LNGCs Transit Route

The intended Site for the FSRU facility where the FSRU vessel and LNGCs will be moored at the double berth jetty is in the southern waters of Hong Kong in relatively open waters. There are some developments nearby that may have the potential to interact with the construction works and future operations:

- *Development of the Integrated Waste Management Facilities Phase 1 (Register No.: AEIAR-163/2012):* Although the marine works for this Project may not overlap with those of CLP, a key requirement from the EIA was the development of at least 700 ha compensatory marine park. EPD is at present conducting a study on the siting and management of the compensatory marine park. As stated *in Section 2.7.3*, it was agreed that CLP would observe its proposed boundary to determine the site for the FSRU facility, the actual details to be agreed in future.

- *Designation of Southwest Lantau Marine Park and Soko Islands Marine Park:* Agriculture, Fisheries and Conservation Department (AFCD) is proceeding with the statutory approvals required to gazette these two Marine Parks during 2016. The proposed boundaries do not overlap with the proposed location for the FSRU facility or the subsea pipeline route to BPPS.

- *Potential Spa and Resort Development at Soko Islands*: Civil Engineering and Development Department (CEDD) is undertaking a feasibility study on developing a spa and resort on South Soko. Whilst the development itself is on land and hence does not overlap with this Project, marine traffic associated with the construction and operation of the spa and resort may interact with that of this Project. Details of its implementation programme are uncertain at this stage.

3.3.2 Subsea Pipeline Route to the BPPS

The developments that may have the potential to interact with the construction works of the subsea pipeline to the BPPS include:

- *Expansion of Hong Kong International Airport into a Three-Runway System (Register No.: AEIAR-185/2014):* This project includes various marine activities that could interact with the installation of the subsea pipeline to the BPPS. This includes the diversion of existing subsea utilities and land formation works. Information from the EIA indicates that marine construction works would cover late 2015 through 2021. A compensatory marine park has also been proposed in the EIA though

designation is expected to be after the subsea pipeline to the BPPS has been installed.

- *Tonggu Waterway:* Information from the Shenzhen Port Tonggu Channel Developing Office indicates that maintenance dredging may take place annually. The EIA Study will review any updated information to determine if there is any interaction between this maintenance dredging and the construction of the Project.

- *Hong Kong - Zhuhai - Macao Bridge Hong Kong Link Road (Register No.: AEIAR-144/2009):* This project provides the necessary linkage in the form of viaducts/bridgework between the Hong Kong-Zhuhai-Macao Bridge Main Bridge and the Hong Kong boundary crossing facilities (HKBCF). Located to the north of Lantau Island over the Airport Channel, it is currently under construction and its programme is being reviewed.

- *Sha Chau and Lung Kwu Chau Marine Park:* The provisional route of the subsea pipeline to the BPPS is outside of this Marine Park. Environmental acceptability of pipeline construction adjacent to this Marine Park has been demonstrated in the EIA study of the HKLNG Terminal project and this will be confirmed in this EIA Study.

3.3.3 Subsea Pipeline Route to the LPS

The developments that may have the potential to interact with the construction works of the subsea pipeline to the LPS include:

- *Improvement Dredging for Lamma Power Station Navigation Channel (EPD Study Brief ESB-282/2014)*: This Project involves improvement dredging of the Lamma Power Station Navigation Channel adjacent to the LPS to meet the requirements for continued safe passage and berthing of associated vessels. The EIA Study will review any updated information to determine if there is any interaction between this improvement dredging and the construction of the Project.

- *Development of a 100MW Offshore Wind Farm in Hong Kong (Register No.: AEIAR-152/2010):* HK Electric propose to develop an offshore wind farm in the waters between Lamma Island and Cheung Chau lying adjacent to the Southwest Lamma Channel, at approximately 4 km southwest of the LPS. The subsea pipeline to the LPS may not overlap with the infrastructure of the wind farm. Details of its implementation programme are uncertain at this stage, and this will be included in the EIA Study.

3.3.4 Gas Receiving Station at BPPS

The GRS will be located within the existing BPPS site. The developments that may have the potential to interact with the construction and operation of the GRS at the BPPS include:

- *Engineering Feasibility Study for Industrial Estate at Tuen Mun Area 38* (*EPD Study Brief ESB-277/2014*): this project includes the development of an Industrial Estate with temporary loading and storage of petrochemical feedstock site and other road modification works in Tuen Mun Area 38 and is currently under EIA stage. This potential concurrent project is more than 3 km away from the BPPS, and its construction period is tentatively scheduled from 2019 to 2023;

- *West New Territories (WENT) Landfill Extensions* (*Register No.: AEIAR-147/2009*): this landfill extension is approximately 2 km away from the BPPS, and is likely to commence in the near future, but the programme remains uncertain;

- *Potential Reclamation Site at Lung Kwu Tan*: this site is located along the coastal waters of Lung Kwu Tan and Lung Kwu Sheung Tan. With an area of about 200 – 300 ha, this proposed site would potentially be used for residential development (1). Details of its implementation programme are uncertain at this stage;

- *Decommissioning of West Portion of the Middle Ash Lagoon at Tsang Tsui, Tuen Mun* (*Register No.: AEIAR-186/2015*): This project involves the decommissioning of the pulverized fuel ash (PFA) lagoon at the west portion of the Middle Ash Lagoon at Tsang Tsui, Tuen Mun, which was operated by CAPCO for the placement of water and PFA. The decommissioning will provide buildable land for future developments by the HKSAR Government. A columbarium has been proposed to be built at the site. The tentative decommissioning period would be from September 2015 to March 2016. The project site is about 1 km away from the BPPS site.

- *Additional Gas-fired Generation Units Project (EPD Study Brief ESB-286/2015):* The scope of this project involves the construction and operation of up to two 600 MW class additional gas-fired generation units at BPPS. Subject to obtaining HKSAR Government approval of the Project and a final investment decision on the Project being taken by CLP/CAPCO, it is anticipated that the construction of the Project would be implemented in stages commencing from the second half of 2016, with commercial operation of the first unit anticipated by the end of 2019.

3.3.5 Gas Receiving Station at LPS

The GRS will be located within the existing LPS site. The developments that may have the potential to interact with the construction and operation of the GRS at the LPS include:

(1) Agreement No. CE 14/2013 (CE) Cumulative Environmental Impact Assessment Study for the Three Potential Nearshore Reclamation Sites in the Western Waters of Hong Kong - Investigation - Executive Summary (Final) (2013). Retrieved October 6, 2015 from Civil Engineering and Development Department, Web site: http://www.cedd.gov.hk/eng/landsupply/doc/Executive%20Summary%20on%20Final%20Report(S2)b.pdf

- *Planning and Engineering Study on Future Land Use at Ex-Lamma Quarry Area at Sok Kwu Wan, Lamma Island* (*EPD Study Brief ESB-270/2014*): The Project comprises tourist and recreational facilities and housing developments accompanied by supporting infrastructure at the Ex-Lamma Quarry Area at Sok Kwu Wan, Lamma Island, which is about 3 km from the LPS. Details of its implementation programme are uncertain at this stage.

4 MAJOR ELEMENTS OF THE SURROUNDING ENVIRONMENT

Major environmental elements surrounding the Project are summarised below and are presented in *Figure 4.1*. Potential impacts of the Project on these elements and sensitive receivers will be studied in the EIA Study.

4.1 PLANNING & DEVELOPMENT CONTEXT

The proposed FSRU facility is located in marine waters which are not covered by any statutory planning tools such as the *Outline Zoning Plan* (OZP). The proposed GRS at the BPPS will be implemented within the boundary of the existing BPPS which is not covered by an OZP. The proposed GRS at the LPS will be implemented within the boundary of the LPS which is zoned as "*Other Specified Uses (Power Station)*" under the approved *Lamma Island Outline Zoning Plan* (*No. OZP S/I-LI/11*).

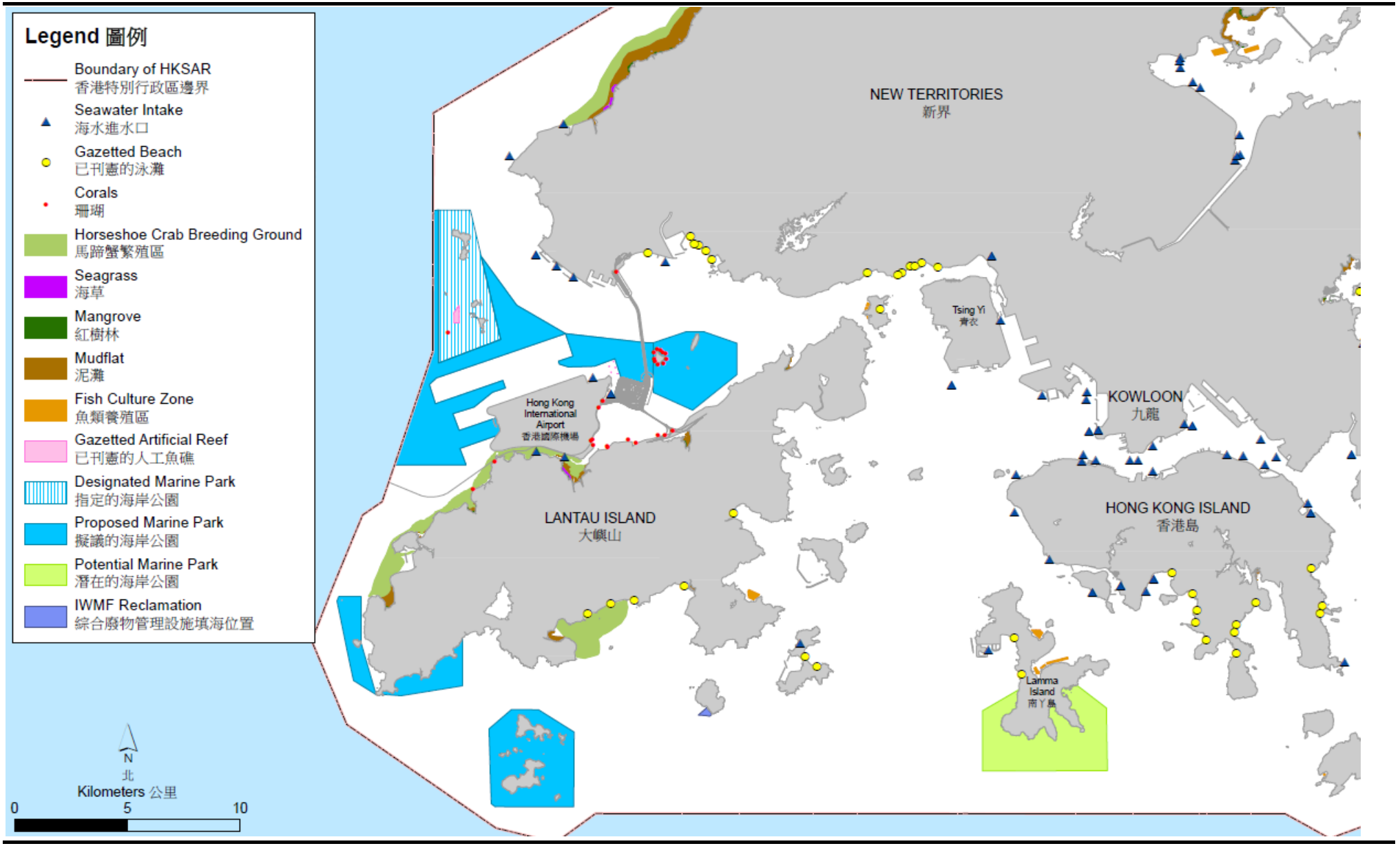
4.2 INDUSTRIAL, COMMERCIAL & RESIDENTIAL DEVELOPMENTS

Existing, committed and planned industrial, commercial and residential developments are regarded as potential environmentally sensitive receivers for air quality, noise impacts and hazards to life. These sensitive receivers are presented in *Table 4.1*.

Table 4.1 Potential Existing and Planned Environmental Sensitive Receivers in the Vicinity of the Project

Sensitive Receivers	Type of Use
Residents at Ha Pak Nai	Residential
Residents at Sheung Pak Nai	Residential
Residents at Lung Kwu Sheung Tan	Residential
Residents at Sha Po Kong	Residential
Proposed development in Lung Kwu Tan reclamation area (planned)	Residential
Site offices of Industrial/commercial plants (e.g. Green Island Cement, Eco Park, Shiu Wing Steel Mill)	Industrial/ Commercial
Site office of BPPS	Industrial
Site office of CPPS	Industrial
Site office of LPS	Industrial
Site office of WENT landfill	Industrial
Site office of Sludge Treatment Facility	Industrial
Residents at Yung Shue Wan	Residential
Residents at Hung Sing Yeh	Residential
Proposed development in Ex-Lamma Quarry Area at Sok Kwu Wan (planned)	Residential

Figure 4.1 Sensitive Receivers in the Surrounding Environment



4.3 *SHIPPING FAIRWAYS*

It is expected that the proposed route corridor for the subsea pipeline to BPPS will unavoidably cross the Urmston Road shipping channel, which is at present not a designated channel. The Urmston Road is a major vessel fairway that connects the Pearl River Estuary, the west and northwestern Hong Kong waters and the waters between Chek Lap Kok and Tuen Mun. To the southwest of Lantau the pipeline corridor also is expected to cross the traffic separation scheme of the Lantau Channel.

The West Lamma Channel, which is frequently used as access routes by various large shipping vessels, is located about 2 km to the northwest of the proposed route corridor for the subsea pipeline to LPS. The majority of this pipeline route would avoid the South of Cheung Chau high speed craft recommended route, while a section of pipeline route to the south of Shek Kwu Chau would traverse this recommended fairway.

The FSRU facility preferred location is outside of the marine shipping lanes, including the Adamasta Channel which is to the north and the West Lamma Channel which is to the east. The LNGCs arrivals are expected to be via the southern approaches to Hong Kong waters.

4.4 *SUBSEA UTILITIES & FACILITIES, INCLUDING CABLES, PIPELINES, OUTFALLS & SEDIMENT DISPOSAL SITE*

The Black Point to Shekou Subsea Cable System lands approximately 50 m to the north of the GRS site at BPPS. The closest outfall is the outfall for BPPS itself.

There are also two subsea pipelines connecting the two gas export facilities from the Chinese Mainland to the BPPS at the northern end of the BPPS site, however the Project's subsea pipeline to the BPPS does not have to cross either of these export subsea pipelines.

The existing subsea pipeline connecting the LPS and the Guangdong LNG Terminal in Dapeng Bay in Shenzhen is located to the east of the route of the subsea pipeline to LPS. Whilst the proposed pipeline will share a similar landing point of the existing pipeline at LPS, no pipeline crossing is anticipated.

In southern waters there are numerous subsea telecommunications that come into Hong Kong waters and land along the coast of South Lantau that the route of the subsea pipelines from the FSRU facility to the BPPS and LPS will have to cross. There is an electric cable planned for the proposed offshore wind farm for connection to LPS and the proposed subsea pipeline to LPS may not overlap with this.

The South of Cheung Chau Open Sea Mud Disposal Area is over 500 m from the FSRU facility. The provisional route of the subsea pipeline to the LPS would avoid any overlap with this CEDD area.

4.5 GAZETTED BATHING BEACHES

There are no gazetted beaches within 5 km of the GRS location at BPPS. For non-gazetted beaches, the Lung Kwu Sheung Tan (Upper and Lower) is at least 2 km from BPPS. Along the southern coast of Lantau there are gazetted beaches at Tong Fuk, Cheung Sha (Upper and Lower) and Pui O, , which are over 8 km from the FSRU facility and over 6.5 km from the subsea pipeline route to the LPS.

Two gazetted bathing beaches, Hung Shing Yeh and Lo So Shing, are located on the west coast of Lamma Island at least 2 km away from the GRS location at the LPS and the subsea pipeline route to the LPS. Beaches at Cheung Chau are about 2.5 km from the subsea pipeline route to the LPS.

4.6 SEAWATER INTAKE

Nearby seawater (cooling water) intake includes that of the BPPS. Other seawater intakes include the CPPS intake, Permanent Aviation Fuel facility (PAFF) intake, Shiu Wing Steel Mill intake and Tuen Mun Flushing Water intake located more than 4 km away from BPPS.

Seawater (cooling water) intakes for the LPS and LPS Extension are located about 500 to 800 m to the northeast of landing point of the subsea pipeline route to the LPS. Seawater intake for the Water Supplies Department's (WSD) Flushing Water at Cheung Chau is more than 4 km from the subsea pipeline route to the LPS.

4.7 AREAS OF CONSERVATION VALUE

To the north of the GRS site at BPPS is the Pak Nai Site of Special Scientific Interest (SSSI), which is an intertidal mudflat/mangrove habitat about 5 km away from the proposed location of the Project.

The Sha Chau and Lung Kwu Chau Marine Park is located adjacent to the subsea pipeline route to the BPPS. A committed marine park is going through the statutory gazettal process and this is located around The Brothers. The Project is not expected to interact with this committed marine park.

In addition to the above there are proposed marine parks along or adjacent to the route of the subsea pipeline route to BPPS. These include the compensatory marine park area proposed as mitigation in the Third Runway EIA Study and the route of the subsea pipeline to BPPS passes through this area. The subsea pipeline to BPPS also passes to the west of the proposed

Southwest Lantau Marine Park and to the south of the Soko Islands Marine Park.

For the IWMF there is an EIA requirement for the siting of a compensatory marine park of at least 700 ha to be included as mitigation for the project. At present there is no publicly available boundary for this proposed marine park. The FSRU facility and the subsea pipeline to BPPS could be in the vicinity of this marine park.

The Sham Wan SSSI in southern Lamma is a nesting ground of green turtle (*Chelonia mydas*). This SSSI is more than 4 km to the east of the proposed route of the subsea pipeline to the LPS and its landing point. It is noted that the areas around this SSSI along the southern coast of Lamma Island have been proposed as a potential site for a Marine Park.

4.8 COASTAL PROTECTION AREA

Ha Pak Nai, Pak Nai and Sheung Pak Nai are designated Coastal Protection Areas (CPA) by the *Town Planning Ordinance*, *Hong Kong Town Planning Board* in the *Sheung Pak Nai and Ha Pak Nai OZP No. S/YL-PN/9*. The closest of these CPAs is more than 3 km from the GRS location at BPPS. There are other CPAs located along the coast at Tai O and along the South Lantau shoreline from Shui Hau through to Pui O.

Some areas along the western coastline of Lamma Island, including Hung Shing Yeh, Lo So Shing and Ha Mei Wan are designated also (*OZP No. S/I-LI/9)*. These CPA are more than 3 km from the proposed route of the subsea pipeline to the LPS.

4.9 ECOLOGICAL SENSITIVE RECEIVERS

As shown on *Figure 4.1* there are areas considered to be horseshoe crab breeding grounds along the Pak Nai coastline, the northwest coastline of Lantau (from Tai O to Tung Chung Bay) and Shui Hau on the southern coast of Lantau. Mangrove areas are also present around Tai O, Yi O, Tung Chung Bay and at Pak Nai.

The north-western and western waters of Lantau are regarded as important habitat for the Chinese White Dolphin (*Sousa chinensis*). In southwestern and southern Lantau waters both the Chinese White Dolphin and the Indo-Pacific Finless Porpoise (*Neophocaena phocaenoides*) can be recorded at different times of the year. The Finless Porpoise is also regularly sighted in the waters to the southwest of Lamma Island.

Along the proposed route of the subsea pipelines to the BPPS, no seabed benthos of conservation interest, such as amphioxus and corals, has been recorded from previous surveys of the LNG Terminal Project EIA. Intertidal and coral surveys were conducted in the vicinity of BPPS as part of the Black

Point Gas Supply Project EIA. Species common and widespread in Hong Kong were recorded and some isolated colonies of corals were recorded.

In the seabed in the vicinity of the proposed route of the subsea pipeline to the LPS, isolated colonies of octocorals and black coral which are common in Hong Kong were recorded from previous surveys of the Offshore Wind Farm EIA. Intertidal and coral surveys were conducted in the vicinity of LPS as part of the Offshore Windfarm EIA. Species common and widespread in Hong Kong were recorded and some isolated colonies of corals were recorded.

4.10 FISHERIES SENSITIVE RECEIVERS

There is no Fish Culture Zone (FCZ) located close to the BPPS. The closest AFCD designated FCZ is located at Ma Wan which is over 20 km from the Project site. The oyster production area located along the shore from Tsim Bei Tsui to Pak Nai is more than 4 km from the BPPS.

A total of 5,580 m^3 of artificial reefs were deployed in the Sha Chau and Lung Kwu Chau Marine Park. The recognised northern Lantau fisheries spawning area is located some distance away from the subsea pipeline route to the BPPS. There is also a spawning and nursery ground identified by AFCD in South Lantau waters.

There are two designated FCZ at Lo Tik Wan and Sok Kwu Wan, located at the east of Lamma Island.

Results of the AFCD Port Survey 2006 suggested that key fishing areas with high fisheries production are located around Sha Chau and Lung Kwu Chau, Tai O, Soko Islands, Cheung Chau and Lamma Island.

4.11 SITES OF CULTURAL HERITAGE

No declared/deemed monuments, graded/ recorded heritage resources or site of archaeological interest are located in the vicinity of the BPPS and the LPS.

The EIA of the Offshore Wind Farm located three shipwrecks/potential sites of marine archaeological value in the vicinity of the LPS. The wrecks are:

- Wreck no. 60016 – a "Dead" wreck (i.e. not considered to exist) near the proposed subsea pipeline route to the LPS;
- Wreck no. 69098 – a "Live" wreck at approximately 650 m to the west of the proposed subsea pipeline route to the LPS; and

- Lamma SC001 – a "Live" wreck identified in the geophysical survey of the Wind Farm Project, but not listed under United Kingdom Hydrographic Office Wrecks database, which is located at about 1 km east of the proposed subsea pipeline route to the LPS.

5 POTENTIAL IMPACTS ON THE ENVIRONMENT

5.1 OVERVIEW OF POTENTIAL ENVIRONMENTAL IMPACTS

The potential environmental impacts arising from the construction and operation of the Project have been investigated and are summarised in *Table 5.1*, and discussed in this *Section*.

Table 5.1 Potential Environmental Impacts Arising from the Project during its Construction Works and Operations

Potential Impact	Construction Works [a]	Operations [a]
• Air Quality		
- Dust	-	-
- Gaseous emissions	-	✓
- Odour	-	-
• Noise	✓	✓
• Liquid Effluents & Discharges	✓	✓
• Generation of Waste or By-products	✓	-
• Manufacturing, Storage, Use, Handling, Transport, or Disposal of Dangerous Goods	-	✓
• Hazard to Life	✓	✓
• Disposal of Spoil Material, including Potentially Contaminated Materials	✓	✓
• Disruption of Water Movement or Bottom Sediment	✓	✓
• Change in Visual Appearance	-	✓
• Cultural & Heritage	✓	-
• Terrestrial Ecology	-	-
• Marine Ecology & Fisheries	✓	✓
• Cumulative Impacts	✓	✓

Notes:
(a) ✓ = Possible '—' = Not Expected

5.2 HAZARD TO LIFE

Safety is the principal consideration in the design, construction and operation of the FSRU facility and its associated subsea pipelines and GRS installations. The FSRU facility and its associated subsea pipelines and GRS installations will likely be classified as a Notifiable Gas Installation and hence is subject to the requirements under the *Gas Safety Ordinance (Cap. 51)*.

As per Hong Kong regulatory requirements, a Quantitative Risk Assessment will be carried out during the EIA Study to ensure the potential risks of constructing and operating the FSRU facility and its associated subsea pipeline to the BPPS and the LPS and their GRS facilities, including FSRU refuelling operations and the transit of LNGCs in Hong Kong waters, are

considered and fall under the levels stipulated in the *Hong Kong Government Risk Guidelines (see Annex 4, Figure 1 of the EIAO-TM).*

5.3 *WATER QUALITY*

5.3.1 Construction

Marine construction works have the potential to affect water quality sensitive receivers. Construction phase impacts of the Project are divided into the following marine work components:

- Dredging for the navigation channel to and the berthing area at the FSRU facility; and
- Installation of subsea pipelines to the BPPS and the LPS using methods traditionally used in Hong Kong (e.g. a combination of dredging and jetting with either gravel or rock backfilling to provide pipeline protection.

Navigation Channel and Berthing Area

It is envisaged that dredging for the navigation channel to and the berthing area will be required to allow safe transit of the LNGC to and from the FSRU facility. The exact dredging volume will be determined during the EIA Study. The dredging will be undertaken using either trailing suction hopper dredgers or grab dredgers. The primary impacts of the dredging works on water quality are temporary increases in suspended sediment concentrations and potential marginal decreases in dissolved oxygen levels. Such impacts may not only affect the water body within the works area but also the sensitive receivers in the vicinity.

The impact of the dredging on water quality will be assessed in detail during the EIA Study. Mitigation measures will be proposed if found necessary.

Subsea Pipelines to BPPS and LPS

The subsea pipelines will be installed using a combination of techniques including pre-trenching (e.g. dredging) and post-trenching (e.g. jetting) subject to agreement by the relevant authorities. The design and construction of the subsea pipelines will be optimised to minimise impacts to water quality and marine ecology and fisheries. Jetting operations will cause sediment to be suspended into the water column during the burial of the subsea pipelines, but this sediment is expected to rapidly settle onto the seabed. This indicates that sediment would not be transported beyond the immediate vicinity of the jetting machine and, as such, it is considered unlikely that there would be any adverse impacts to sensitive receivers. For dredging, the exact dredging volume will be determined during the EIA Study and it is expected that silt curtains will be used, where needed, to control the dispersion of sediment during dredging operations.

It is recommended that computer modelling of sediment plume dispersion and water quality be carried out as part of the EIA Study to simulate the impacts from jetting and trench dredging operations. Such modelling would determine the fate of sediments entering suspension during dredging and the resultant suspended sediment concentrations in the receiving waters and at sensitive receivers. It is expected that there will be no unacceptable impacts to water quality caused by the construction of both of the subsea pipelines based on past experience in Hong Kong.

5.3.2 Operation

During the operation of the FSRU facility it is expected that discharges will include cooled water, as seawater will be used for warming the LNG in the regasification facilities. Compliance with the Water Quality Objectives (WQO) ($\Delta \pm 2^0$C from ambient) must be achieved at sensitive receivers. For operational reasons, the discharges will likely contain antifoulants and consequently their concentration in the effluent must comply with the *Water Pollution Control Ordinance Technical Memorandum on Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters*.

Modelling at the EIA Study will be carried out to determine the potential impact and recommend the position of the discharge point so as to minimise any potential adverse impacts. Options for further mitigation will be considered in the EIA Study if found to be necessary.

Operation of the FSRU facility will be supported by dual fuel power generators and emergency diesel generators. Refuelling operations will be carefully controlled by standard operating procedures to reduce the potential of accidental fuel spillage

During operations, surveys will be carried out in the vicinity of the FSRU facility to check for any natural siltation that may impact on marine operations such as the LNGC approach and mooring. Should natural siltation occur, then maintenance dredging will be carried out.

5.4 MARINE ECOLOGY

5.4.1 Construction

Impacts to ecological resources during construction works have the potential to consist of the following:

- Indirect impacts to marine ecological resources around the marine construction works areas as a result of perturbations to water quality due to the activities described in *Section 2.9*. Soft-bottom subtidal organisms that will be disturbed during the laying of the subsea pipelines, navigation channel and berthing area dredging are commonly recorded elsewhere in Hong Kong waters. Desktop information on the seabed conditions within the proposed route corridors for both subsea pipelines, the navigation

channel and the berthing area indicates that the seabed is composed mainly of soft muds with no organisms of high ecological value recorded. Sediment plume modelling, recommended to be conducted as part of the EIA Study, is necessary for an assessment of the impacts to water quality which is, in turn, essential for a thorough evaluation of indirect impacts to marine ecological resources.

- Underwater sound impacts to marine mammals as a result of piling works for the construction of the double berth jetty. Mitigation measures exist for controlling the propagation of sound underwater and these have been applied effectively in Hong Kong and include the use of bubble jackets and bubble curtains. The EIA Study will examine this matter through conducting an underwater sound assessment.

5.4.2 Operation

The operation of the FSRU facility will involve the intake of seawater into regasification equipment and the subsequent discharge of cooled water. The cooled water and associated antifoulants such as sodium hypochlorite in the effluent have the potential to impact sensitive marine habitats. The design studies to be conducted during the EIA Study will have as one of the key issues an examination of measures to minimise the effect of the discharges on marine sensitive receivers.

Indirect impacts to marine ecological resources as a result of perturbations to water quality due to any maintenance dredging that may be required and accidental fuel spillage will be assessed in the EIA Study.

5.5 FISHERIES

5.5.1 Construction

Reviews of existing information on commercial fisheries resources and fishing operations in the waters adjacent to the proposed location for the FSRU facility and along both of the proposed subsea pipeline routes have been undertaken. Information from a study on fishing operations in Hong Kong and the AFCD Port Survey 2006 indicate that fisheries production values in the vicinity of the assessment area vary from low to high. There are no licensed fish culture activities present within 10 km of the project works.

Potential impacts to fisheries resources and fishing operations may arise from disturbances to benthic habitats on which the fisheries resources depend for food, or through changes to key water quality parameters, as a result of the dredging works and installation of the subsea pipelines. As impacts arising from the proposed dredging or jetting works are expected to be largely confined to the specific works areas and be of short duration, the expected elevations of suspended sediment due to the Project are not expected to exceed environmental standards, and they are not expected to cause adverse impacts to water quality, fishing grounds or species of importance to the

fishery. While no special mitigation measures are required, constraints on jetting and dredging operations recommended to control impacts to water quality to within acceptable levels are also expected to mitigate impacts to fisheries resources.

5.5.2 Operation

The Project will involve the intake of seawater into the regasification equipment and the discharge of cooled seawater back into the sea. The volume of seawater intake and the cooled seawater discharge including the associated antifoulants in the effluent has the potential to impact juvenile fish and fish fry. The design studies to be conducted during the EIA Study will have, as one of the key issues, an examination of measures to minimise impacts to fisheries sensitive receivers, such as fisheries spawning and nursery grounds, due to seawater intake and discharge.

Indirect impacts to fisheries resources as a result of perturbations to water quality due to any maintenance dredging that may be required and accidental fuel spillage will be assessed in the EIA Study.

5.6 WASTE MANAGEMENT

5.6.1 Construction

The most significant construction waste impact for the Project will be handling and disposal of marine sediment associated with the dredging works. The management and disposal of the dredged material will follow the procedures and requirements specified in *PNAP ADV-21 – Management Framework for Disposal of Dredged/ Excavated Sediment*, and a Marine Dumping Permit will be obtained under the *Dumping at Sea Ordinance (Cap. 466)*. Other construction wastes, such as general refuse, will be generated in limited quantities, and normal waste management practices will be implemented.

5.6.2 Operation

During the day-to-day operations of the FSRU facility waste will be largely limited to general refuse, and standard waste management practices will be implemented.

If maintenance dredging is required, the areas for maintenance dredging will be clearly defined to minimise waste generation. The dredging process will be carried out carefully to minimise the leakage of dredged material back into the waters.

5.7 CULTURAL HERITAGE AND ARCHAEOLOGY

5.7.1 Construction

The proposed dredging areas have marine archaeological potential due to the historical use of the Pearl River Delta areas for trade and fishing activities. Consequently, the potential exists for impacts to occur to marine archaeological materials. The procedures outlined by the Antiquities and Monuments Office (AMO) will be followed which consist of the following:

- Baseline review of existing information, including geophysical surveys conducted in the areas of the FSRU facility and both subsea gas pipelines;
- Geophysical survey of these dredging areas using high resolution boomer, side scan sonar and an echo sounder;
- Establishment of archaeological potential will then be determined from procedures 1 and 2, and a written report with charts provided to the AMO.

Should a high potential for archaeological material be identified, then recommendations will be made for a watching brief to be maintained during the FSRU facility and both subsea pipeline construction works.

5.7.2 Operation

No adverse cultural heritage impact is envisaged during the operation of the Project.

5.8 LANDSCAPE & VISUAL

The FSRU vessel that will be moored at the double berth jetty is similar in appearance to a LNGC which, in turn, looks relatively similar to many of the large vessels that transit in and out of Hong Kong waters. The double berth jetty where the FSRU vessel will be moored is also a relatively discrete structure. Views of the FSRU facility from nearby coastlines, such as those on South Lantau, will see a stationary ship in the ocean and hence it is not expected that visual impacts will be significantly adverse. The main sensitive receivers include hikers in the Lantau South Country Park, and visitors to gazetted beaches. Considering that all sensitive receivers would have distant views towards the proposed FSRU facility (> 6 km) and would rely on excellent visibility conditions, the level of visual impact is considered to be of low severity.

5.9 AIR QUALITY

5.9.1 Construction

Some air emissions from plant during construction works is expected; however, due to the large separation distances between the Site of the FSRU facility, the routes of the subsea pipelines and the air sensitive receivers (ASRs), the impacts would be minimal, and well within the relevant standards. No quantitative construction phase assessment is considered necessary.

5.9.2 Operation

During operations, air emissions from emergency generator and diesel-driven firewater pumps on board the FSRU facility and air emissions from the GRS facilities at the BPPS and LPS are potential sources of air quality impacts. The separation distances between the sources and the ASRs at both locations are large and only infrequent operation is expected, therefore any adverse air quality impacts are not envisaged. Air dispersion modelling will be carried out during the EIA Study in order to confirm the scale and significance of any impacts.

5.10 NOISE

5.10.1 Construction

Construction works including dredging for the subsea pipelines and the FSRU facility construction will involve the use of Powered Mechanical Equipment (PME). The use of PME has the potential to generate construction noise. The closest noise sensitive receivers (NSR) to the FSRU facility are village houses at Shek Pik on Lantau Island (> 6 km from the FSRU facility). These NSRs are remote and are consequently not expected to be affected by noise from the construction works. The EIA Study will confirm this interim conclusion.

5.10.2 Operation

During operations, noise will be produced by the installed equipment present at the FSRU facility, both on the FSRU vessel and the double berth jetty head, which would include:

- LNG pumps compressors, vapourisers and power generators;
- Special equipment such as nitrogen generator and vents.

Reviews of information from other similar FSRU facilities that are operational worldwide indicate that these LNG import facilities are not considered noisy. Consequently, the remote village houses on Lantau Island are not expected to be affected by operational noise due to the large separation distances. The EIA Study will confirm this interim conclusion.

5.11 *TERRESTRIAL ECOLOGY*

As the Project is marine in nature with the new GRS sites located within the existing boundaries of the BPPS and the LPS, no disturbance to terrestrial ecological resources (e.g. recognized sites of conservation importance, habitats, vegetation and wildlife) is anticipated. No impacts to terrestrial ecology are thus expected to arise from the construction and operation of this Project.

5.12 LAND CONTAMINATION

Considering the current land use at the GRS sites at the BPPS and the LPS, there appears to be a low potential for soil contamination. Limited amount of chemicals may be used during the construction and operation of the Project. With the implementation of proper site management practices and precautionary measures, no land contamination concern is expected.

5.13 OTHER ISSUES

5.13.1 Night-Time Operations

Construction

Night-time construction works may be required. The use of PME during the restricted hours, i.e. 1900 to 0700 will require a Construction Noise Permit (CNP). Assessments to demonstrate that the construction works will not cause adverse noise impacts will need to be provided by the installation Contractor to support an application for a CNP.

Operations

The FSRU facility and both subsea pipelines will operate on a 24-hour, 365-days per year basis to provide a consistent and reliable supply of natural gas to the BPPS and the LPS. Therefore, night-time operation of the FSRU facility, including any berthed LNGCs and the LNG loading arms / inter-connecting cryogenic pipework on the double berth jetty head will occur. The lighting requirement for night-time operations, including the glare impact, will be determined during the EIA Study. Mitigation measures will be proposed if necessary.

5.13.2 Traffic Generation

Construction

Marine traffic will be generated during the construction works for the Project, in particular both subsea pipelines. Vessel movements during construction for material delivery, waste transportation, dredging, subsea pipeline installation, double berth jetty construction and the FSRU vessel hook-up, and

ferries for transporting workers to and from their work sites will be required during the construction period.

Operations

It is envisaged, based on the FSRU facility throughput, that on average one LNGC will unload at the FSRU facility every five to eight days. Marine traffic generated by fuel oil refueling and transportation of operation/maintenance personnel to the FSRU facility is also expected.

5.14 CUMULATIVE IMPACTS

Cumulative impacts due to other existing, planned or committed concurrent projects will be considered during the EIA Study and development phase of the Project. A potential list of projects is included in *Section 3.3*. The assessment of any impacts will be based on the best publicly available information at the time of carrying out the EIA Study.

6 ENVIRONMENTAL PROTECTION MEASURES TO BE INCORPORATED IN THE DESIGN & FURTHER ENVIRONMENTAL IMPLICATIONS

6.1 HAZARD TO LIFE

In addition to the EIA Study there will be several other risk-related permitting procedures that will have to be completed before construction works can commence and the FSRU facility and its subsea pipelines can become operational. Emergency response plans and action plans will be set up and defined to the satisfaction of relevant Government Departments such as Electrical and Mechanical Services Department (EMSD).

6.2 WATER QUALITY

6.2.1 Construction

A number of mitigation measures are expected to be required for dredging for the navigation channel to and the berthing area for the FSRU facility, and the installation of the two subsea pipelines in their trenches. The measures would serve to control the potential impacts to within acceptable levels. The mitigation measures are divided into two facets, general operating procedures and specific measures to reduce the quantities of sediment lost to suspension during dredging. The general mitigation measures relate to the use of closed, watertight grabs, the speed of lowering of the grab, the loading of barges and the operating conditions of the barges. Specific mitigation measures may include:

- Optimisation of the rate of dredging; and
- The use of silt curtains.

The need for these mitigation measures would be established through the use of computer modelling to determine sediment plume dispersion impacts to water quality during the EIA Study.

Although it is expected that unacceptable impacts to water quality will not be caused by the construction of both of the subsea pipelines based on past experience in Hong Kong, mitigation measures could be implemented if exceedances are detected during the monitoring of the construction works such as:

- Optimisation of the rate of dredging;
- A reduction in the speed of the jetting machine and the pressure of the water jets; and
- The use of silt curtains in sensitive areas of the route (e.g. adjacent to the Sha Chau Lung Kwu Chau Marine Park).

It is expected that an Environmental Monitoring and Audit (EM&A) programme will be required to monitor impacts to water quality during both dredging, backfilling and jetting construction works. This monitoring programme would be able to confirm that the necessary mitigation measures are being implemented and that impacts are within acceptable levels. Should unacceptable impacts be detected, the EM&A programme would serve to trigger additional measures.

6.2.2 Operation

The main discharge during the operation of the FSRU facility will be seawater used to regasify the LNG. This water will be discharged at a lower than ambient temperature and will contain antifoulants such as sodium hypochlorite. Measures will be prepared during the EIA to ensure that the effluents comply with the relevant statutory requirements.

Should maintenance dredging be required, mitigation measures would be taken to reduce the potential impact on water quality. Standard operating procedures would be established to reduce the potential of accidental fuel spillage, and appropriate emergency spill response procedures would be identified during detailed design.

6.3 MARINE ECOLOGY & FISHERIES

6.3.1 Construction

Practical measures should be taken to minimise impacts to water quality during dredging, backfilling and jetting construction works so as to prevent subsequent impacts to marine ecological and fisheries resources. It is acknowledged that measures recommended to control water quality impacts to within acceptable levels are also expected to control impacts to ecological and fisheries resources.

Measures that may be adopted to prevent unacceptable impacts from underwater sound during piling from affecting marine mammal species include:

- use of bubble curtain/jacket to ameliorate underwater sound propagation;
- timing of piling to avoid peaks in marine mammal abundance;
- adoption of exclusion zones around the piling barge.

It is expected that an EM&A programme will be required to monitor impacts to marine mammals during the marine works. This monitoring programme would be able to confirm that the necessary mitigation measures are being implemented and that impacts are within acceptable levels. Should unacceptable impacts be detected, the EM&A programme would serve to trigger additional mitigation measures.

6.3.2 Operation

It is acknowledged that measures recommended to control water quality impacts to within acceptable levels are also expected to control impacts to ecological and fisheries resources.

6.4 WASTE MANAGEMENT

6.4.1 Construction

Typical measures for waste management during the construction works, including waste recycling, storage, transportation and disposal measures, will be adopted for this Project allowing maximum waste reduction and recycling. All waste shall be disposal of at designated sites and facilities and relevant disposal permits/ licences shall be obtained from appropriate authorities, if required, in accordance with the *Waste Disposal Ordinance (Cap. 354)*.

Procedures and requirements specified in *PNAP ADV-21 – Management Framework for Disposal of Dredged/ Excavated Sediment* will be followed for the management and disposal of the dredged marine sediment.

6.4.2 Operation

Areas for maintenance dredging, if any, will be clearly defined to avoid unnecessary waste generation. The dredging process will be carried out carefully to minimise the leakage of dredged material back into the waters.

6.5 CULTURAL HERITAGE & ARCHAEOLOGY

Should any archaeological artefacts be identified during the course of the EIA Study, then appropriate mitigation measures will be determined. These may include minor realignment of the route of the subsea pipelines, where practical.

6.6 LANDSCAPE & VISUAL

Adverse impacts to visual sensitive receivers are not expected to occur, as the FSRU facility is located remotely from Visual Sensitive Receivers (> 6 km). Locations at higher elevations on Lantau Island may have a restricted view of the FSRU Facility but this will only occur during weather conditions with high visibility.

6.7 AIR QUALITY

Given the relatively remote location of the FSRU facility it is not anticipated that adverse air quality impacts will occur at sensitive receivers.

During operation of the FSRU facility and the GRS, venting does not occur during normal operating procedures. Even if venting is required under exceptional circumstances, it is not expected to cause unacceptable air quality impacts, particularly as the location of the FSRU facility and both GRS installations are remote from sensitive receivers.

6.8 NOISE

Given the relatively remote location of the FSRU facility it is not anticipated that adverse noise impacts will occur during either construction works or operations. Standard measures will be implemented to control on-site noise generation.

Measures to control underwater sound impacts to marine mammals during construction are discussed in *Section 6.3*.

6.9 POTENTIAL SEVERITY, DISTRIBUTION AND DURATION OF ENVIRONMENTAL EFFECTS

It is anticipated that the construction works will commence in 2019 with completion targeted in 2020. Water quality, waste, marine ecology, cultural heritage, as well as fisheries impacts are potential issues during the construction works period. Water quality, marine ecology, fisheries, landscape and visual, and hazard to life impacts are potential issues during the operation of the FSRU facility.

With the implementation of appropriate mitigation measures, no unacceptable impacts are expected. This will be confirmed in the EIA Study.

6.10 BENEFICIAL EFFECTS

Implementation of the Project will make a significant contribution to managing emissions of air pollutants. Natural gas is acknowledged widely as a comparatively clean burning fuel. In addition, there are a number of advantages to a Hong Kong FSRU Project, which are summarized below.

1. **Fuel security and reliable supply of electricity:** Dependable fuel sources are critical to maintain world-class power supply to CLP and HK Electric customers, while providing environmental benefits. Having an FSRU facility in Hong Kong allows CLP and HK Electric to secure sufficient and dependable supplies of LNG to meet future gas demand needs. The Hong Kong Offshore LNG Terminal, once commissioned, would be operated and maintained to world-class standards, with seamless delivery of LNG from the LNGCs to the FSRU vessel and its regasification and send-out from the FSRU facility into the subsea pipelines to the BPPS and the LPS. The additional source of LNG supply to the power plants also

enhances the supply security of electricity for Hong Kong.

2. **Lower fuel purchasing cost:** At present, the imported purchasing cost for natural gas from Mainland China includes a levy by the Mainland Chinese Government. Such levy does not apply to imported LNG through the proposed FSRU facility in Hong Kong therefore this will result in a lower fuel purchasing cost for CLP and HK Electric, attributable to the avoidance of such levy.

3. **Environmental benefits:** Siting the FSRU facility in Hong Kong offers CLP and HK Electric the flexibility of sourcing LNG from liquefaction plants around the world to meet their future demand for natural gas. As LNG emits virtually no particulates and negligible SO_2, as well as less NO_x and CO_2 than other fossil fuels, it will contribute to further improvements in the air quality in Hong Kong.

4. **Flexibility to directly access competitively priced gas**: The Project would increase the optionality regarding the sourcing of future gas supplies for Hong Kong, and provide flexibility to directly access competitively priced gas from the LNG market worldwide, including its associated spot market, therefore improving the future Hong Kong LNG buyers' overall negotiating position, and diversity of gas supply sources.

5. **Project development schedule:** The Project located within Hong Kong waters enables the defined project development to be carried out under one single jurisdiction, with clear policy and regulations applicable to infrastructure being built in Hong Kong.

7 USE OF PREVIOUSLY APPROVED EIA REPORTS

The approved EIA reports of projects that are of relevance to the Project are listed in *Table 7.1*.

Table 7.1 Previously Approved EIA Reports Relevant to the Project

Register No.	Project Title	Aspect of Relevance
AEIAR-185/2014	Expansion of Hong Kong International Airport into a Three-Runway System	Surrounding environment, sensitive receivers, water quality, ecology and fisheries impact assessment
AEIAR-163/2012	Development of Integrated Waste Management Facilities Phase 1	Surrounding environment, sensitive receivers and air quality impact assessment
AEIAR-152/2010	Development of a 100MW Offshore Wind Farm in Hong Kong	Surrounding environment, sensitive receivers, water quality, ecology and fisheries impact assessment
AEIAR-150/2010	Black Point Gas Supply Project	Surrounding environment, sensitive receivers and water quality impact assessment, marine dredging activities
AEIAR – 146/2009	Tuen Mun – Chek Lap Kok Link	Surrounding environment, sensitive receivers, water quality, ecology and fisheries impact assessment
AEIAR 145/2009	Hong Kong – Zhuhai – Macao Bridge Hong Kong Boundary Crossing Facilities	Surrounding environment, sensitive receivers, water quality, ecology and fisheries impact assessment
AEIAR-144/2009	Hong Kong – Zhuhai – Macao Bridge Hong Kong Link Road	Surrounding environment, sensitive receivers, water quality, ecology and fisheries impact assessment
AEIAR-129/2009	Sludge Treatment Facilities	Surrounding environment and sensitive receivers
AEIAR-107/2007	Permanent Aviation Fuel Facility for Hong Kong International Airport	Surrounding environment and sensitive receivers
AEIAR-105/2007	Liquefied Natural Gas (LNG)receiving Terminal and Associated Facilities	Surrounding environment, sensitive receivers, water quality, ecology, fisheries and hazard to life impact assessments
AEIAR-069/2003	Lamma Power Station Navigation Channel Improvement	Surrounding environment, marine dredging activities
AEIAR-010/1999	1,800 MW Gas-fired Power Station at Lamma Extension	Surrounding environment, sensitive receivers, ecology and water quality impact assessment

The English version of this Project Profile shall prevail wherever there is a discrepancy between the English version and the Chinese version.