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1 INTRODUCTION

1.1 Need for the Project

1.1.1.1 The Project is to construct and operate a modern Integrated Waste Management Facilities (IWMF) for managing municipal solid waste (MSW) under a design-build-operate (DBO) contract arrangement. The IWMF comprises: (a) an advanced thermal incineration plant with design capacity of 3,000 tonnes per day (tpd) and (b) a mechanical sorting and recycling plant with design capacity of 200 tpd. The non-recyclables sorted from the mechanical plant will be sent to the thermal incineration plant for further treatment. Under any conditions, the total MSW feeding to the thermal incineration plant and the mechanical plant will not exceed 3,000 tpd.

1.1.1.2 Over the past years, the quantity of MSW generated in Hong Kong has been on an increasing trend. At present, Hong Kong generates about 18,000 tonnes of MSW each day, 49% of which are recovered for recycling. The remaining non-recycled MSW together with construction waste, sewage sludge and other waste amounting to 13,300 tonnes each day are disposed of at landfills.

1.1.1.3 Compared with other major cities in the world that have diverse means of disposing of waste, Hong Kong relies solely on three strategic landfills, including the South East New Territories (SENT) Landfill, the North East New Territories (NENT) Landfill and the West New Territories (WENT) Landfill for the disposal of its MSW. Consequently, the three strategic landfills are now projected to approach their capacities in 2014, 2016 and 2018 respectively; hence there is a pressing need for adoption of advanced waste treatment technologies to reduce the volume of unavoidable MSW so as to extend the life span of the strategic landfills and their future extensions.

1.1.1.4 To address this imminent waste problem in a holistic manner, the Government has reviewed the action agenda outlined in the "Policy Framework for the Management of Municipal Solid Waste (2005-2014)" (the Policy Framework) published in 2005 against the latest development in January 2011. To ensure solid waste can continue to be handled properly without causing environmental problems, the Government will:

(a) revise upward the MSW recovery target to 55% by 2015 by stepping up publicity and promotional efforts on waste reduction and recycling;

(b) expedite legislative proposals to introduce new Producer Responsibility Scheme (PRS) and extend current PRS to encourage waste reduction;

(c) engage the public in continued discussions on possible options to introduce MSW charging as a direct economic disincentive to reduce waste at source; and

(d) seek funding approval from the Finance Committee of the Legislative Council (LegCo) in early 2012 so that advanced waste treatment facilities (including an IWMF with a treatment capacity of 3,000 tonnes of MSW daily, two organic waste treatment facilities with total capacity of 500 tonnes of food/ organic waste daily), and extension to the existing landfills will be commissioned in time to ensure continual and more sustainable management of solid waste.

1.1.1.5 Hong Kong needs to confirm on the development of the first IWMF to significantly reduce the bulk of MSW size as soon as possible, otherwise with the decreasing availability of landfill capacity there will be little suitable disposal facilities to handle the MSW we generate by 2018. There is a need to act in time, taking into account the lead time required for project planning and preparation, as well as the relevant statutory and administrative requirements. Hong Kong will not be able to uphold the high standard of environmental hygiene that the local and international community expect~~s~~ of a world class city if there is no timely and adequate provision of appropriate waste treatment and disposal facilities.

1.1.1.6 There are a number of benefits with the implementation of the first IWMF, including:

- **Substantial Bulk Reduction for Landfill Disposal** - The amount of MSW to be disposed of at landfills will substantially decrease as the volume of waste remained after the thermal treatment process would only be about 10% of the original volume. Hence, the existing landfills and their extensions can serve for a longer period of time.
- **Energy Recovery** - The IWMF could generate and export electricity for gainful uses by the community.
- **Greenhouse Gas Reduction** - The production of greenhouse gases due to landfilling of MSW will be reduced. The IWMF will also generate and export electricity for the community's gainful uses thus replacing fossil fuel use for power generation, leading to overall reduction of greenhouse gas emission in Hong Kong.

1.2 Objective of the EIA Study

1.2.1.1 Two potential sites have been identified for the development of the IWMF, they arei Tsang Tsui Ash Lagoons site in Tuen Mun (TTAL site) and an artificial island near Shek Kwu Chau (SKC). Based on the two potential sites, the following elements of the Project are classified as Designated Projects under the Environmental Impact Assessment (EIA) Ordinance:

<u>TTAL Site</u>

- An incinerator with an installed capacity of more than 50 tonnes per day (under Item G.3 of Part I, Schedule 2 of the EIAO)
- A waste disposal facility for refuse (under Item G.4 of Part I, Schedule 2 of the EIAO)
- A waste disposal facility for pulverized fuel ash or furnace bottom ash (under Item G.6 of Part I, Schedule 2 of the EIAO)
- Public utility electricity power plant (under Item D.1 of Part I , Schedule 2 of the EIAO)
- An activity for the reuse of treated sewage effluent from a treatment plant (under Item F.4 of Part 1, Schedule 2 of the EIAO)
- Decommissioning of a waste disposal facility for pulverized fuel ash, furnace bottom ash or gypsum (under Item 8 of Part II, Schedule 2 of the EIAO)

<u>Artificial Island near SKC</u>

- An incinerator with an installed capacity of more than 50 tonnes per day (under Item G.3 of Part I, Schedule 2 of the EIAO)
- A waste disposal facility for refuse (under Item G.4 of Part I, Schedule 2 of the EIAO)
- A waste disposal facility for pulverized fuel ash or furnace bottom ash (under Item G.6 of Part I, Schedule 2 of the EIAO)
- Public utility electricity power plant (under Item D.1 of Part I , Schedule 2 of the EIAO)
- Reclamation works (including associated dredging works) of more than 5 hectares in size (under Item C.1 of Part I, Schedule 2 of the EIAO)
- A dredging operation exceeding 500,000m^3 (under Item C.12 of Part I, Schedule 2 of the EIAO)
- An activity for the reuse of treated sewage effluent from a treatment plant (under Item F.4 of Part 1, Schedule 2 of the EIAO)

1.2.1.2 This EIA Report was prepared in accordance with the EIA Study Brief No. ESB-184/2008. The purpose of this EIA Study is to provide information on the nature and extent of environmental impacts arising from the construction and operation of the Project at the two potential sites. The information will contribute to decisions by the Director of Environmental Protection on:

- The overall acceptability of any adverse environmental consequences that is to arise as a result of the Project and the associated activities of the Project;
- The conditions and requirements for the detailed design, construction and operation of the Project to mitigate against adverse environmental consequences; and
- The acceptability of residual impacts after the proposed mitigation measures are implemented.

2 PROJECT DESCRIPTION

2.1 Site Location

2.1.1.1 The locations of the two potential sites, Tsang Tsui Ash Lagoons site (TTAL site) and an artificial island near Shek Kwu Chau (SKC) are shown in **Figures ES1 and ES2** respectively. The first IWMF will be sited at the TTAL site or the artificial island near SKC.

2.1.1.2 The TTAL site is located at the existing ash lagoons in Nim Wan, Tuen Mun, overlooking Deep Bay in north-western New Territories. The area, comprising the East, Middle and West Lagoons, is leased to China Light & Power Company, Ltd. (CLP) for storing pulverized fuel ash (PFA). The site would occupy an area of approximately 11 hectares in the northern portion of the Middle Lagoon, which was used to stock furnace bottom ash and is currently utilized by CLP for water collection and conservation. Other industrial facilities in the vicinity include the Black Point Power Station (BPPS) to the south-west and the WENT Landfill and its associated waste reception facilities to the east. The Sludge Treatment Facilities, which is under construction would be situated in the northern portion of the East Lagoon adjoining the TTAL site while the planned WENT Landfill Extension would be developed in phases also in the Nim Wan area covering the West Lagoon and the remaining portions of the other two ash lagoons as well as the area between the Black Point Power Station and WENT Landfill.

2.1.1.3 The artificial island near SKC will be formed by reclamation at the south-western coast of Shek Kwu Chau, an island located to the southwest of Cheung Chau and to the south of Chi Ma Wan Peninsula, Lantau Island. The IWMF development would include approximately 11.8 hectares of reclaimed land and berth area, and 4.1 hectares of breakwater protecting the berth area of the IWMF and water basin from strong waves. The area enclosed by the breakwater would be about 31 hectares (including the area of the breakwater). To avoid direct impact on the terrestrial ecology of Shek Kwu Chau and to conserve the natural shoreline of Shek Kwu Chau, the reclamation area will not be connected to Shek Kwu Chau. Instead, the coast of Shek Kwu Chau and the reclamation area will be separated by a water channel.

2.1.1.4 Shek Kwu Chau is granted to the Society for the Aid and Rehabilitation of Drug Addicts (SARDA) for use as a rehabilitation centre, which presently has a population of about 300 rehabilitators and staff. There is no other existing or planned residential, commercial or industrial development on the island.

2.2 Project Scope

2.2.1 Project Facilities

2.2.1.1 The infrastructure for this Project would comprise an advanced incineration plant, a mechanical sorting and recycling plant, and ancillary & supporting facilities. The facilities of the IWMF mainly include the following:

<u>Incineration Plant</u>

- MSW receiving, storage and feeding system
- Moving grate incineration furnaces
- Waste heat recovery and power generation system
- Boiler feedwater treatment system
- Flue gas treatment system
- Flue gas discharge system with stack
- Ash storage and handling system

- Reagent reception and storage system
- Odour control system
- Process control and monitoring system

Mechanical Treatment (MT) Plant

- MSW receiving, storage and feeding system
- Mechanical treatment system including shredding and sorting facilities
- Products and by-products storage and handling system
- Odour control system
- Process control and monitoring system

Ancillary & Supporting Facilities

- Weighbridge
- Site security
- Administration building / visitors and environmental education centre
- Vehicle washing facilities
- Maintenance workshop
- Fuel storage tanks
- Water treatment plant
- Wastewater treatment plant
- Electricity supply and export system
- Utilities
- Berthing area for marine vessels and storage of refuse containers (for the artificial island near SKC only)

2.2.1.2 Design-Build-Operate (DBO) contract arrangement would be adopted for the Project and the operation period would be 15 years. Under this contract arrangement, a DBO contractor would be engaged to conduct the detailed design, construction and operation of the IWMF. For the purpose of the EIA Study, a reference design for the IWMF was prepared. Photomontages showing the IWMF facilities at the TTAL site and the artificial island near SKC are presented in **Figures ES3 and ES4** respectively.

2.2.1.3 In the reference design, the incineration plant consists of six incinerator units, each with a design capacity of 600 tpd. The incineration plant is designed to meet the target emission limits as shown in **Table ES1**. Apart from nitrogen oxides (NOx) standard, these target emission limits are based on the internationally most stringent European Union (EU) standard for MSW incinerators and the Hong Kong Best Practicable Means for Incinerators. For NOx, as it is the most critical parameter in Hong Kong in complying with the Air Quality Objectives (AQOs), the Government has decided to adopt the most advanced air pollution reduction measures for the IWMF. The daily average emission limit of NOx is lowered to 100 mg/m^3, which is 50% reduction when compared with the EU standard, which is set at 200 mg/m^3.

2.2.1.4 An on-site desalination plant will be provided for supplying water to the IWMF. The desalination plant would involve membrane separation of dissolved ions such as chloride ions from seawater, and would not involve any boiling or combustion processes.

2.2.1.5 An on-site wastewater treatment plant will be provided to treat the wastewater generated from floor/ vehicle washing and from staff/ visitors. The treated effluent will be reused in the incineration plant or mechanical treatment plant or for washdown and landscape irrigation within the IWMF. No effluent would be discharged to the nearby water body or any existing sewerage or drainage systems.

2.2.1.6 The heat produced during the incineration process will be recovered and used for electricity generation. The electricity generated will be used to support the normal operation of the facilities within the IWMF. Surplus energy will be exported to other users via the existing electricity grids maintained by power companies. For the TTAL site, underground cables will be laid to export surplus energy to the nearby Black Point Power Station. For the artificial island near SKC, installation of submarine cables will be required in order to export the surplus energy from the artificial island near SKC to an electricity substation at Cheung Sha.

Table ES1 - Air Emission Limits for the IWMF

Air Pollutants	Emission Limits (mg/m^3) (1)		Monitoring Requirements
	Daily	Half - Hourly	
Particulates (2)	10	30	Continuous
Organic Compounds	10	20	Continuous
Hydrogen Chloride (HCl)	10	60	Continuous
Hydrogen Fluoride (HF)	1	4	Continuous
Sulphur Dioxide (SO_2)	50	200	Continuous
Carbon Monoxide (CO) (3)	50	100	Continuous
Nitrogen Oxides (NO_X) as Nitrogen Dioxide (NO_2)(7)	100	200	Continuous
Mercury	0.05 (4)	-	Intermittent
Total Cadmium & Thallium	0.05 (4)	-	Intermittent
Total Heavy Metals (5)	0.5 (4)	-	Intermittent
Dioxins & Furans (6)	1×10^{-7}	-	Intermittent

Notes:
(1) The emission limit is expressed at reference conditions of 0^oC temperature, 101.325 kPa pressure, dry and 11% oxygen content conditions.
(2) The particulate emission limits are assumed to be for respirable suspended particulates (RSP).
(3) The CO emission limits do not apply to the start-up and shut-down periods.
(4) Average values over a sampling period of a minimum of 30 minutes and a maximum of 8 hours.
(5) Including Sb, As, Pb, Co, Cr, Cu, Mn, V and Ni.
(6) The unit is I-TEQ (The emission limit is equal to 0.1 ng I-TEQ m^{-3}), according to the BPM 12/1(08), the averaging time for dioxin is 6 to 8 hours.
(7) The emission levels for NOx are half of that stipulated in European's Emission Limits in EC's Waste Incineration Directive.

2.2.2 Construction of the IWMF

TTAL Site

2.2.2.1 The Project would require decommissioning of the Middle Lagoon, formation of about 1.2 hectares of pond habitat for Litter Grebe and about 9.8 hectares of land and associated roads and drains, followed by foundation works, construction of superstructures and installation of plants and equipment for the various systems mentioned in **Section 2.2.1.1**.

2.2.2.2 Currently, the land is largely formed by PFA that was filled to this site in previous years. As there are no existing structures in the site area, the works related to the decommissioning of the lagoon would be minimal.

2.2.2.3 The finished ground level of the IWMF will be at a level higher than the average ground level of the existing Middle Lagoon. Therefore, the formation of land for the IWMF would involve mainly filling and levelling work. No disposal of PFA will be required during the construction phase.

2.2.2.4 The construction of the IWMF will include the following stages:

- Site drainage;
- Site formation;
- Foundation piling;
- Civil and building works;
- Mechanical & electrical plant installation;
- Roads, utilities, services and landscaping; and
- Ancillary instrumentation and control works.

Artificial Island near SKC

2.2.2.5 Reclamation will be needed to form about 11.8 hectares of land for the various systems mentioned in **Section 2.2.1.1**. Due to occasionally rough sea condition in the vicinity of the artificial island near SKC, breakwater will be provided to ensure safe loading and unloading operation at the berth area.

2.2.2.6 The reclamation will be formed with filling materials supported on the in-situ marine deposits with suitable geotechnical ground treatment (such as surcharge loading, installation of vertical band drains, etc.) at a finished ground level of about +5mPD high. Seawalls will be constructed to confine the reclamation area and breakwaters will be provided to protect the water basin. To minimize dredging and filling activities and the associated environmental impacts, vertical cellular structure consisting of circular cells instead of sloping gravity structure is proposed to be adopted for the construction of the seawalls and breakwaters. The cellular breakwater protecting the reclamation area and the water basin would be about +9mPD high for resisting waves with significant heights.

2.2.2.7 The berth area, which will be extended from the seawall at the northwest side of the reclaimed area, will be formed by a piled deck structure with precast slab. Tubular piles are proposed to form the foundation of the berth. Non-percussive bore piling method would be adopted for the installation of tubular piles.

2.2.2.8 The construction of the IWMF will include the following stages:

- Construction of cofferdam surrounding the reclamation area;
- Site filling for reclamation;
- Surcharge loading for reclamation area;
- Construction of breakwater;
- Pilling for berth area;
- Site drainage;
- Foundation (spread footing);
- Civil and building works;
- Mechanical & electrical plant installation;
- Roads, utilities, services and landscaping; and
- Ancillary instrumentation and control works.

2.2.2.9 The submarine cables would be installed by burying method using water jets. A cable burying machine which include an injector would be lowered to the seabed. The injector fluidizes a trench using high pressure water jets and a cable is immediately laid within the trench. The sides of the trench then slip around the cable, burying it and leaving a small depression in the seabed.

2.2.3 Operation of the IWMF

2.2.3.1 The IWMF will be operated on a 24-hour basis daily, while the reception of MSW would be limited from 8 am to 8 pm.

2.2.3.2 For the artificial island near SKC, about 3,000 tpd MSW loaded in containers would be delivered by marine vessels from the existing refuse transfer stations, including Island East Transfer Station, Island West Transfer Station and West Kowloon Transfer Station. For the TTAL site, about 3,000 tpd MSW loaded in containers currently delivered to the berth of WENT Landfill by marine vessels or delivered directly to the WENT Landfill or its extension by land transport will be diverted from the WENT Landfill to the adjoining the TTAL site.

2.2.3.3 At the reception hall of the incineration plant, MSW from the containers will be discharged to a bunker. The MSW will then be fed into incineration furnaces for combustion. The heat energy released will be recovered to generate electricity through waste heat boilers and steam turbine generators. Flue gas generated from the incineration furnaces will be treated before discharging to the atmosphere. Bottom ash, fly ash and air pollution control (APC) residues produced from the incineration process will be collected for treatment and disposed of at the WENT Landfill or its extension if they have met the disposal requirements or will be reused if possible.

2.2.3.4 MSW delivered to the MT plant will be discharged to a bunker. A grab bucket will cut the plastic bags commonly used for household waste collection and convey the MSW to the hopper of the mechanical treatment facilities. Large-size MSW will first be cut into smaller pieces by a shredder. The well-prepared MSW will then run through a series of mechanical treatment processes and separate into different types of outputs, including recyclable materials (e.g. metals, papers and plastics) to be collected by recyclers, sorted combustible MSW to be sent to the incineration plant for treatment with other MSW, and non-combustible MSW to be disposed of at the WENT Landfill.

2.3 Construction Programme

2.3.1.1 The tentative construction programmes for the TTAL site and the artificial island near SKC are shown in **Tables ES2 and ES3** respectively.

Table ES2 - Construction Programme of the IWMF at the TTAL Site

Description	Date
Award of Contract	March 2013
Site Clearance & Backfilling	March 2013 – August 2013
Foundation (Pilling)	June 2013 – February 2015
Civil and E&M Works	November 2013 – May 2016
Testing and Commissioning	June 2016 – August 2016

Table ES3 - Construction Programme of the IWMF at the Artificial Island near SKC

Description	Date
Award of Contract	March 2013
Construction of Cofferdam Surrounding Reclamation Area Phase 1	June 2013 – November 2013
Construction of Breakwater Phase 1	June 2013 – November 2013
Construction of Cofferdam Surrounding Reclamation Area Phase 2	June 2014 – July 2014
Site Filling for Reclamation	January 2014 – October 2014
Surcharge Loading for Reclamation Area	May 2014 – July 2015
Construction of Breakwater Phase 2	June 2014 – October 2014
Installation of Anti-scouring Layer	November 2014
Pilling for Berth Area	June 2014 – November 2014
Construction of Submarine Cables	June 2015
Foundation (Spread Footing)	May 2015 – October 2015
Civil and E&M Works	August 2015 – February 2018
Testing and Commissioning	March 2018 – May 2018

3 CONSIDERATION OF ALTERNATIVES

3.1 Site Selection

3.1.1 Identification of Potential Sites

3.1.1.1 A site search exercise was completed in 2008 under the study *Site Search for Integrated Waste* Management *Facilities in Hong Kong for Municipal Solid Waste* for the identification of potential sites for the development of the IWMF. The Legislative Council, the Tuen Mun and Islands District Councils and the Advisory Council on the Environment were briefed on the findings of the site search in 2008.

3.1.1.2 The Government formed an Advisory Group (AG) on Waste Management Facilities and five AG sub-groups comprising 24 non-official members from the professional bodies, green groups, academic and business sectors. Based on the recommendations from the AG, the following 23 types of areas were excluded from the preliminary search for potential sites:

- All areas for Residential and Commercial Use;
- All 23 existing or potential Country Parks;
- All existing or potential Marine Parks and Marine Reserves;
- All Special Areas (outside Country Parks);
- All Sites of Special Scientific Interest (SSSI) (including buffer areas);
- All Restricted Areas (Wildlife);
- The RAMSAR Site (including buffer area);
- All Green Belt (GB) and Urban Fringe Parks;
- All Conservation Areas (CA);
- All Coastal Protection Areas (CPA);
- All Water Gathering Grounds;
- All Wetlands Areas;
- All Fish Culture Zones;
- All Proposed Fisheries Protection Areas;
- All Gazetted Beaches;
- All Declared Monuments, Graded Historical Buildings and Structures, Deemed Monuments and Archaeological Sites;
- All Cemeteries, Burial Grounds or Grave Zones;
- All Fairways and Shipping Lanes and Port Areas;
- All Airports and Restricted Areas around them (including the Military Airport);
- All Tunnels and Roads, existing and proposed Railways;
- All Other Major Infrastructure (including Castle Peak Firing Range);
- All Major Tourism Development Areas; and
- All Priority Sites for Enhanced Conservation promulgated under the New Nature Conservation Policy.

3.1.1.3 **Figure ES5** shows the locations of the existing or potential Country Parks, the existing or potential Marine Parks and Marine Reserves, and Special Areas (outside Country Parks). In additional to the existing Country Parks, Marine Parks and Marine Reserves, and Special Areas, the potential locations for Marine Parks, and Country Parks (e.g. Po Toi, Tung Lung Chau) were also not considered for the development of the IWMF.

3.1.1.4 Soko Islands were not considered for the development of the IWMF because Soko Islands have been designated for the development of the proposed Soko Islands Marine Park. The area is an important habitat of Chinese White Dolphins and Finless Porpoises, and the only area in Hong Kong with a major spatial overlap in the distribution of these two types of marine mammals. It is also a spawning and nursery ground of commercial fisheries resources. The development of the IWMF in the potential marine park was not considered suitable.

3.1.1.5 Apart from the above recommendations of the AG, the following factors were also taken into account in identifying the potential sites:

- The IWMF should be located in areas compatible with neighboring activities;
- It should have marine access; and
- It should be less exposed to waves or typhoons in case outlying islands are chosen.

3.1.1.6 The islands in Sai Kung (e.g. Kau Sai Chau, Jin Island) were not considered for the development of the IWMF because the islands and their nearby waters are popular locations for various recreational activities including swimming, diving, golfing, hiking, etc. The southern parts of Kau Sai Chau and Jin Island have been proposed as Landscape Protection Areas and are to be used for seabirds/ other wildlife conservation. The islands are also viewed by the nearby Sai Kung East Country Park, Sai Kung West Country Park, Kiu Tsui Country Park and Clear Water Bay Country Park. The development of the IWMF was not considered compatible with neighbouring activities.

3.1.1.7 The above have resulted in forming an initial list of 21 sites, including 13 closed landfills as follows:

<u>Outlying Islands</u>

- Ex-Lamma Quarry, Lamma Island;
- Artificial Island near Shek Kwu Chau;
- Siu Ho Wan;
- Ha Mei Wan, Lamma Island.

<u>Large Scale Artificial Islands for New Landfill Development</u>

- Eastern Waters;
- Lamma South West;
- North West Lantau;
- South Cheung Chau;
- South East Offshore;
- Tai Long Wan Offshore.

<u>Other Regions</u>

- Ha Pak Nai;
- NENT Landfill Extension B;
- Nim Wan;
- Pillar Point Valley;
- Stonecutters Island;
- Tseung Kwan O Area 137;
- Tuen Mun Area 38;
- Tuen Mun Port (near Black Point Headland);
- WENT Landfill Extension A;

- WENT Landfill Extension B;
- Tsang Tsui Ash Lagoons.

3.1.1.8 The initial list of potential sites was then subject to further consideration with respect to their site characteristics, latest development status, prevailing wind directions and the dominant environmental conditions to form a site proposal.

3.1.1.9 All the 13 closed landfill sites were considered not suitable due to the lack of large flat platforms, unstable foundations and commitment to other uses.

3.1.1.10 Under the study of "Extension of Existing Landfills and Identification of Potential New Waste Disposal Sites", some sites were identified and assessed for the feasibility to be developed as large scale artificial islands for landfill purpose. These large scale artificial islands could be the potential locations for the development of the IWMF. However, since these sites were not selected for the development of new landfills, the development of the IWMF at these sites were not considered.

3.1.1.11 For the remaining sites, commitments have been made to reserve some of them for other developments (e.g. Siu Ho Wan for Organic Waste Treatment Facilities and Stonecutters Island for the Harbour Area Treatment Scheme).

3.1.1.12 As a result, eight potential sites (as shown in **Figure ES6**) were shortlisted as follows:

- S1 - Tseung Kwan O Area 137
- S2 - Ex-Lamma Quarry, Lamma Island
- S3 - Ha Mei Wan, Lamma Island
- S4 - Artificial Island near Shek Kwu Chau
- S5 - Tsang Tsui Ash Lagoons
- S6 - Tuen Mun Area 38
- S7 - Ha Pak Nai
- S8 - Tuen Mun Port (near Black Point Headland)

3.1.1.13 With due consideration of site availability, land use, traffic, environmental, social and other relevant aspects, it was concluded that the last two of the above sites, Ha Pak Nai (S7) and Tuen Mun Port (S8), be dropped from further consideration. The reasons for dropping the Ha Pak Nai site are that it is located at the ecologically sensitive coastal area at Deep Bay and embraces numerous active fish ponds. The site is zoned as a "Coastal Protection Area" on the Outline Zoning Plan and the proposed development of the IWMF is not in line with the planning intention of the area. Moreover, it is located immediately next to the Ha Pak Nai Archaeological Site which is worthy of preservation. As for Tuen Mun Port site, the site area has not yet been formed. The plan under a previous study was to use part of the site formed through reclamation for the proposed Tuen Mun Port Development (TMPD) project to build the waste treatment facility. As currently there is no programme to implement the TMPD project and no reclamation has been carried out in that area, locating an IWMF on that site is therefore not possible. Moreover, the proposed site is very close to Lung Kwu Sheung Tan where a number of indigenous villages exist, also Lung Kwu Tan has already been developed as a popular recreational spot. It is also close to the Sha Chau and Lung Kwu Chau Marine Park designated for the conservation of Chinese White Dolphins. All these have rendered the Tuen Mun Port site not suitable for the IWMF development.

3.1.1.14 The remaining six sites were the shortlisted sites for further site selection assessment.

3.1.2 Site Selection Criteria

3.1.2.1 The six shortlisted sites were further evaluated based on the following criteria. They were grouped into the following five main categories:

Environmental

- Air Quality
- Noise
- Visual and Landscape
- Terrestrial Ecology
- Drainage, Water Quality, Marine Ecology & Fisheries
- Hazard to Life

Engineering / Technical

- Ease of Integration with Existing or Planned MSW Infrastructure
- Site Access
- Constraints to Site Layout
- Utilities
- Construction Duration
- Construction Risk
- Operational Risk

Economics

- Capital Cost
- Operating Cost
- Opportunity Cost of Land

Social

- Land Use
- Land Ownership
- Traffic Impact

Consumer & User

- Community Impacts

3.1.3 Evaluation of Shortlisted Sites

S1 - Tseung Kwan O Area 137

3.1.3.1 The proposed site is located at the southwest edge of Area 137 reclamation near Tit Cham Chau in Tseung Kwan O. It has been reserved for the use of “Potentially Hazardous Installations (PHIs)”.

3.1.3.2 This site is currently the only available site in Hong Kong designated for PHIs such as oil depots, gas production plants, explosive depots and liquefied petroleum gas bottling and storage facilities. Due to stringent safety requirements, there is great difficulty in identifying other PHIs sites that could meet with Hong Kong’s future PHIs needs. Hence, should this site be taken for the development of the IWMF, there would be no other available site to accommodate Hong Kong’s future PHIs requirements.

3.1.3.3 In addition, as the site is directly facing Siu Sai Wan, Chai Wan, and Heng Fa Chuen on the eastern side of Hong Kong Island as well as the Lohas Park of Tseung Kwan O, it would have significant visual impact on the substantial population residing in these areas.

S2 - Ex-Lamma Quarry, Lamma Island

3.1.3.4 The proposed site is located at the ex-Lamma Quarry at the northeast side of the island. It is directly facing a popular tourist spot, Sok Kwu Wan where seafood restaurants and a mariculture zone exist, and is in proximity to various indigenous villages such as Luk Chau village. The overall planning intention for Lamma Island is to conserve the natural landscape and rural character and to enhance the island as a leisure destination. Hence, the development of an IWMF at this location is not compatible with these existing land uses as well as the future planned development, and will fundamentally change the nature of this part of the Island.

3.1.3.5 The IWMF development would be incompatible with the planning intention of the remaining portion of the ex-Lamma Quarry site which is proposed for tourism and recreation purposes, and the adjoining "Comprehensive Development Area" (CDA) site which is planned for comprehensive low-rise residential development. The Planning and Development Study on Hong Kong Island South and Lamma Island has identified the ex-quarry site as having potential for development of tourism and recreation activities. A zoning review of the site will be initiated pending detailed consideration of the appropriate uses/ proposal. Regarding the "CDA" site, with an open sea view and easy access to Sok Kwu Wan ferry pier, it has high potential for a comprehensive residential scheme to bring significant improvement to the existing environment.

3.1.3.6 As the site is directly facing Wah Fu, Aberdeen, Ap Lei Chau and Wong Chuk Hang on the southern side of Hong Kong Island, it would cause significant visual effect on the substantial population residing in these areas.

S3 - Ha Mei Wan, Lamma Island

3.1.3.7 The proposed site is an artificial island to be reclaimed at the west end of Lamma Island, it is close to the core habitat of Finless Porpoises and to the planned marine park near South Lamma Island. Moreover, waters around Ha Mei Wan are high productive fishing grounds and spawning/ nursery grounds. In view of its close proximity to the various ecological sensitive receivers, and that development of the IWMF on this site would entail substantial dredging and massive reclamation works for the creation of an artificial island, there would be substantial adverse impacts on the water quality, the core habitat of Finless Porpoises, the fishing ground, spawning/ nursery grounds and the marine ecology during the construction stage.

3.1.3.8 Like the Ex-Lamma Quarry site, should the IWMF be built here, it would cause significant visual impact on the substantial population residing in Wah Fu, Aberdeen, Ap Lei Chau and Wong Chuk Hang.

S4 - Artificial Island near Shek Kwu Chau

3.1.3.9 The site is to be formed by reclamation at the south-western side of the Shek Kwu Chau which is located to the south of Chi Ma Wan Peninsula of Lantau Island. The key advantages of the site for the IWMF development are:

- It is located far from any major population clusters. There is only a very light population of about 300 persons living in a rehabilitation centre managed by the Society for the Aid and Rehabilitation of Drugs Addicts (SARDA). As such, any visual impact could be insignificant due to the small number of sensitive receivers.
- Regarding the air quality impact, the only major air sensitive receivers are residents in Cheung Chau, however the impact should be minimal. Moreover, the residents in Cheung Chau are not located at the prevailing downwind direction. Since no other

emission sources exist in the nearby areas, there are no concerns on the cumulative air quality impact.

- Due to its relatively central location with respect to the refuse transfer stations throughout Hong Kong Island and the outlying islands, the aggregate refuse vessel transfer trip length associated with an IWMF at the artificial island near Shek Kwu Chau would be less than the existing operation of refuse transfer to the WENT Landfill. This would offer more environmental and cost-effective marine transportation over reasonable trip length without undue impact on the marine traffic.
- Since the proposed IWMF would be developed on reclaimed land without encroachment onto the existing island, impacts on the terrestrial habitat on the existing island would be minimal.

3.1.3.10 However, the construction of an IWMF on this site would involve reclamation which might affect the natural coastline, statutory gazetting procedures, and installation of power lines and the utilities, which might impact on the natural landscape and would result in longer construction time, higher cost and the development time table may be subject to greater uncertainty due to more complex technical requirements and statutory procedures. There are also some other concerns:

- The nearby marine area is a fish spawning and nursery ground, where Chinese White Dolphin and Finless Porpoise have been sighted.
- The compatibility of the IWMF with the adjacent rehabilitation centre will need to be carefully studied.

S5 - Tsang Tsui Ash Lagoons

3.1.3.11 The Tsang Tsui Ash Lagoons are situated at the northwest New Territories adjacent to the WENT Landfill and the CLP's Black Point Power Station. The ash lagoons were constructed in the 1980s by CLP for the purpose of storing PFA generated from the Castle Peak Power Station. The site is divided by bunds into three approximately equal-sized lagoons: the East Lagoon, the Middle Lagoon and the West Lagoon. Consideration is given to use the Middle Lagoon for developing an IWMF. There are several advantages for doing so:

- Being located right next to the WENT Landfill, the site has an operational advantage of sharing the existing infrastructure (e.g. berthing facilities and waste container storage area etc.) and efficient disposal of the ash residues generated by the IWMF to the WENT Landfill. Because of the above synergy effect, the IWMF could occupy a smaller site area, thus translating into both land and cost saving.
- It is also close to the existing power plant. Surplus energy generated from the IWMF can easily be connected to the power grid.
- Unlike the island options, both marine and land transport of waste and ash are possible, and no reclamation is required.
- As there are no major population clusters in the vicinity, the IWMF should not have significant visual impact on the immediate local community.

3.1.3.12 Regarding air quality impact, preliminary assessment has found that the cumulative air quality impact arising from the IWMF and the existing and proposed emission sources nearby, such as the Black Point and Castle Peak Power Stations, as well as the Sludge Treatment Facilities under construction, etc. on the nearby sensitive air receivers should meet the air quality requirements. Detailed assessment would need to be carried out to confirm the cumulative air quality impact should this site be selected for the IWMF development.

S6 - Tuen Mun Area 38

3.1.3.13 The site is located in an industrial setting adjacent to the EcoPark and is not far from the WENT Landfill. It is in close proximity to the air sensitive receivers at Tuen Mun New Town, in particular the Melody Garden and Butterfly Estate near the Tuen Mun Pier. The main concern of this site is the adverse cumulative air quality impact from the IWMF and several major emission sources, including the Black Point Power Station, Castle Peak Power Station, Shiu Wing Steel Mill and Green Island Cement Plant etc. In view of its close proximity to the air sensitive receivers in Tuen Mun New Town, it is very likely that this site cannot meet the air quality requirements.

3.1.3.14 Another major constraint of this site is its relatively small size. The site in question is currently reserved for another waste management facility and is only about 5.75 hectares, which is not enough to accommodate an IWMF of capacity of 3,000 tpd and of around 10 hectares. Even if developing the IWMF alone, additional land would need to be acquired from the nearby sites. However, other areas in Tuen Mun Area 38 have been planned for other land intensive facilities including EcoPark, construction and demolition materials handling facilities and permanent aviation fuel facility, etc. such that there is no surplus land available. In addition, transfer of waste to this site by marine vessels will be constrained. This is because there is limited space for the development of berthing facilities along the waterfront in Tuen Mun Area 38 as the waterfront area has already been reserved to meet the operational requirements of other planned uses.

Recommendations

3.1.3.15 The outcomes of the assessment indicated that the Tseung Kwan O Area 137 (S1), Ex-Lamma Quarry, Lamma Island (S2), Ha Mei Wan, Lamma Island (S3) and Tuen Mun Area 38 (S6) all had some major constraints and were not recommended for further engineering and EIA studies.

3.1.3.16 An artificial island near Shek Kwu Chau (S4) and Tsang Tsui Ash Lagoons (S5) are worth taking forward for detailed studies and further consideration as potential sites for the IWMF. From an air quality aspect, the artificial island near Shek Kwu Chau is comparatively more favourable. However, its potential impacts on the natural coastal landscape, marine ecology, water quality, and fishery would need further study and detailed assessment. In addition, the compatibility of the IWMF with the adjacent rehabilitation centre would need to be reviewed and carefully considered. Regarding the Tsang Tsui Ash Lagoons site, it has relative overall merits because of the ease of integration with the existing landfill and waste reception facilities, much less impact on local ecology, shorter construction time, and lower construction cost. However, the cumulative air quality impact on the air sensitive receivers would still need to be carefully and thoroughly studied and assessed to confirm its acceptability.

3.2 Technology Selection

3.2.1 Identification of Potential Technologies

3.2.1.1 To identify suitable MSW treatment technologies, the Government conducted an Expression of Interest (EoI) exercise in 2002 in which local and overseas companies were invited to submit proposals on waste treatment technologies. A total of 59 submissions were received. An Advisory Group (AG) on Waste Management Facilities comprising members from the professional bodies, green groups and the academic sector was set up to assess the proposals and to recommend suitable waste treatment technologies for Hong Kong. After the assessment of the EoI submissions, it was recommended that the IWMF should adopt a multi-technology approach because of the heterogeneous nature of the Hong Kong MSW. Incineration may be adopted as the major component of the IWMF strategy. Other technologies (co-combustion, gasification or similar systems) may be considered if the concerns over the technologies such as cost, market, technical feasibility etc. could be resolved. Mechanical biological treatment (MBT) should also be considered

at a suitable scale under particular circumstances and as a component of the overall IWMF strategy.

3.2.1.2 Based on the AG's recommendations, a review of the latest development of the moving grate, fluidized-bed, rotary kiln incineration technologies, eco-co-combustion system, gasification, plasma gasification and pyrolysis technologies was conducted in 2009. It reconfirmed the recommendations of the EoI exercise, including:

- Incineration technology (i.e., moving grate incineration technology) could play a core role in the IWMF for MSW treatment;
- The key issues of the eco-co-combustion including its technical feasibility and long-term commercial viability have still not been satisfactorily solved; and
- Application of the plasma gasification and pyrolysis technologies for untreated MSW treatment is still limited and are of small-scale. These technologies are not able to meet the criteria in the EoI exercise for forming the core technology of the IWMF for treating 3,000 tpd of mixed MSW.

3.2.1.3 Although no proposal on rotary kiln incineration technology was received during the EoI exercise in 2002, a review of its latest development was also carried out in 2009 because of the reported application for MSW treatment. The review results indicate that most of the rotary kiln incineration systems installed are used for sludge, industrial or hazardous waste treatment; whereas their applications for MSW treatment are uncommon and limited to relatively small scale, and therefore is not well proven for the IWMF. Hence, rotary kiln incineration technologies, eco-co-combustion system, plasma gasification and pyrolysis technologies have not been included for further evaluation.

3.2.1.4 There may be development in the fluidized-bed incineration technology and gasification technology since the EoI exercise in 2002, which may prove them to be as effective as the moving grate incineration technology for mixed MSW treatment. Therefore, these two technologies were further comparatively evaluated with the moving grate incineration technology in order to select the most suitable core technology for the IWMF.

3.2.2 Evaluation Criteria

3.2.2.1 The three thermal treatment technologies, including moving grate incineration, fluidized-bed incineration and gasification technologies are evaluated based on the criteria shown in **Table ES4** below.

Table ES4 - Criteria for Selection of Thermal Treatment Technology

Main Criteria	Sub-criteria	Assessment Measures
Environmental Factor	Air Emission	The volume of flue gas produced from the furnaces required for treatment and the amount of gas pollutants generated.
Engineering Factors	Flexibility	Are there any special requirements on the quality of feedstock? How capable is the process of adapting to short term and long term variations in the characteristics of the input waste?
	Electricity Production Efficiency	-
	Reliability	What is the maximum demonstrated capacity of a fully commercial plant? What is the scale up risk? The numbers of suppliers which can provide the system for MSW treatment.

Main Criteria	Sub-criteria	Assessment Measures
	Land Requirement	Footprint of the process, which refers to number of incineration/ gasification units required for treating 3,000 tpd of MSW.
	Operating Experience for Mixed MSW Treatment	How long have the incineration/ gasification systems been adopted for MSW treatment?
Costs	Capital Cost and Operating Costs	-

3.2.2.2 The selection criteria focus on the environmental, engineering and cost considerations. Other considerations, such as visual impacts, employment opportunities and public acceptance, for moving grate incineration, fluidized bed incineration and gasification are considered to be almost the same since all these treatment technologies are thermal treatment technologies. Public health is also not compared since the most advanced flue gas treatment system will be adopted for all the three technologies to meet the most stringent air quality standards in the world. Thus, all the three technologies should pose very low or insignificant risk to public health.

3.2.3 Evaluation of Thermal Treatment Technologies

3.2.3.1 **Table ES5** summarizes the option evaluation for the three thermal treatment technologies based on a qualitative assessment of the criteria.

Table ES5 - Summary of Option Evaluation for Thermal Treatment Technologies(1)

Criteria	Moving Grate Incineration		Fluidized-bed Incineration		Gasification	
Environmental Factors						
Air Emission(2)	Medium	Δ	High	**X**	Low	**O**
Engineering Factors						
Flexibility(3)	High	**O**	Low	**X**	Low	**X**
Electricity Production Efficiency	Medium	Δ	Medium	Δ	Medium to High(7)	**Δ/O**
Reliability - Unit Capacity	10-920 tpd	**O**	10-80 tpd	**X**	20-150 tpd	Δ
Reliability - Plant Capacity	20-4,300 tpd		10-200 tpd		30-405 tpd	
Reliability - Key Suppliers for Mixed MSW Treatment(4)	Many, including B&W Volund, CNIM, Fisia, Hitachi, JFE, Kawasaki, Lentijes (formerly called Lurgi), Seghers, Mitsubishi, Takuma & von Roll Inova		Limited, including Hitachi, JFE, Kawasaki and Mitsubishi		Limited, including Ebara(5), Hitachi(5), IET, JFE(5), Kawasaki(5), Mitsubishi(5) and Nippon Steel(5)	
Land Requirements and System Complexity(6)	Low	**O**	Large	**X**	Large	**X**
Operating Experience for Mixed MSW Treatment	Longest track record	**O**	Limited Experience	Δ	Limited Experience	Δ
Cost Factors						
Capital Costs	Low	**O**	High	**X**	High	**X**
Operation Costs	Low	**O**	High	**X**	High	**X**
Overall	**Most Favorable**		**Least Favorable**		**Less Favorable**	

Note: (1) **O**, Δand **X** represent the most favourable, medium favourable and the least favourable to the IWMF, respectively.

Please note that the ranking shown in each criterion represents comparative rather than absolute ranking.

(2) Air emission criterion refers to the volume of flue gas produced from the furnaces required for treatment and the amount of the air pollutant generated.

(3) Flexibility refers to the applicability of the technology for MSW treatment and the ability to tolerate a fluctuation of the MSW characteristics.

(4) B&W Volund, CNIM, Ebara, Fisia, Hitachi, IET, JFE, Kawasaki, Lentjes, Seghers, Lurgi, Mitsubishi, Nippon Steel, and Takuma refer to Babcock & Wilcox Volund, CHIM/Martin, Ebara Corporation, Fisia Babcock Environment GmbH, Hitachi Zosen, IET Energy, JFE Engineering Corporation, Kawasaki Heavy Industries, Ltd, Lentjes UK Limited, Képpel Seghers, Lurgi Envirotherm GMBH, Mitsubishi Heavy Industries Ltd., Nippon Steel Engineering, and Takuma Co. Ltd, respectively.

(5) The systems are incorporated with ash melting systems.

(6) Land requirement and complexities are compared based on the number of the incineration/ gasification units required for treating 3,000 tpd of mixed MSW.

(7) Electricity production efficiency of gasification is ranked as high if a more efficient approach for converting the chemical energy in syngas to electrical energy is used such as combustion of the syngas after cleaning in a more efficient internal combustion engine or combustion of the syngas after significant cleaning in a gas turbine with further energy recovery though raising steam and generating power in a steam tubine. If the sygnas is combusted in a close coupled combustion chamber, there is no real energy benefits since the electrical energy would be generated from a steam turbine generator similar to conventional incineration plants.

3.2.3.2 As shown in **Table ES5**, moving grate incineration is more favorable to be adopted as a core technology of the IWMF for treating 3,000 tpd of mixed MSW. The advantages of moving grate incineration over the gasification and fluidized-bed incineration technologies in terms of reliability, operating experience, flexibility, land requirements, and capital and operating costs are summarized as follows:

- It is the only thermal technology which has been adopted for treating over 3,000 tpd of mixed MSW, whereas fluidized bed incineration and gasification technologies for mixed MSW treatment are of much smaller scale;
- It has the least scale-up risks, whereas the other two will suffer higher scale-up risk when being adopted in the IWMF for mixed MSW treatment;
- It has the longest track record of operation (over 100 years of operation experience), whereas the other two have little or limited track record for mixed MSW treatment;
- It shows the highest capability to tolerate the fluctuation of MSW characteristics with robust/ forgiving nature when handling mixed MSW, whereas the other two are less robust and usually require pretreatment of MSW;
- It requires the least land area for the treatment units, whereas the other two have larger land requirement because of the requirement of more treatment units;
- It possess over 10 suppliers and thereby ensure adequate tender competition, whereas there are 5 – 6 suppliers of gasification/ fluidized bed technologies and a key gasification supplier is retreating from the MSW market;
- There is a concern for operation failure of the gasification technology due to unpleasant experience in Germany;
- It possesses the least operation complexity in comparison to fluidized bed incineration and gasification technologies; and
- It requires the least capital and operating costs in comparison to fluidized bed incineration and gasification technologies.

3.2.3.3 Theoretically, gasification technology generates less volume of flue gas and less amount of gas pollutants than the incineration technologies. Since gasification requires just a fraction of the stoichiometric amount of oxygen, the volume of process gas flow is smaller. It is however important to note that the quantity of air emission is not the dominating factor. By applying necessary flue gas treatment systems, the quality of air emissions from the moving grate incineration system can be regulated to meet the most stringent international air emission standards.

3.2.3.4 While extensive information on the types and levels of pollutants generated from incineration is available, there is very little published data on emissions from full-scale gasification process. If available, much of the published data for gasification process is

from small scale or pilot operations. Hence comparison of the types and levels of flue gas pollutants generated by different types of thermal treatment technologies based on currently available data is rather difficult, bearing in mind also that a meaningful comparison could only be made provided that the different technologies treated similar type of wastes and employed similar energy recovery system.

3.2.3.5 It was recommended in the EoI exercise that incineration could play a key role in the overall IWMF strategy since it had a favorable treatment cost and was the most cost-effective technology to divert MSW from landfills amongst the other strategy options. Land requirement of incineration is also low. The evaluation result arrives at the same conclusion as the EoI exercise, whereby moving grate incineration technology is the most suitable technology for the IWMF in terms of environmental, engineering and cost factors. It is therefore recommended to adopt moving grate incineration as the core technology for the IWMF for treating of 3,000 tpd of mixed MSW.

3.2.3.6 At the Meeting of Advisory Council on the Environment (ACE) held on 14 December 2009, the Council discussed the findings of the technology review and had no objection to employing moving grate incineration technology as the core thermal treatment technology for the development of the IWMF.

3.2.4 Evaluation of Sorting and Recycling Technologies

3.2.4.1 As highlighted in the EoI exercise, mechanical-biological treatment (MBT) was considered to be a potential sorting and recycling technology to be adopted in the IWMF than the other technologies. This was because MBT could potentially recover both materials and energy from the mixed MSW, whereas the others could only recover recyclables. Due to its ineffectiveness in waste volume reduction and requirement of relatively large footprint than thermal treatment technologies, MBT technology was recommended to be adopted at a small scale in the IWMF.

3.2.4.2 A review of the latest development in MBT technology shows that there is no noticeable advancement in the MBT technology in terms of volume reduction and land requirement since the EoI exercise. The land requirement for MSW treatment, despite being subject to the technology approach selected, odour management adopted, output requirement, waste input characteristics etc, typically ranges from 60 to 130 m^2/tpd, and volume reduction is reportedly about 50%, which are similar to the information (70-90 m^2/tpd, ~50% volume reduction) received during the EoI exercise.

3.2.4.3 At the Meeting of the Waste Management Subcommittee (WMSC) of ACE on 26 January 2010, the WMSC discussed the proposal of whether a sorting and recycling plant should be incorporated in the IWMF project. The WMSC considered the proposal in detail, taking into account previous advice and recommendations by the Advisory Group on Waste Management Facilities in mid 2005 and by the ACE after the delegation's visit to Europe in 2006. As the MBT would generally require more land (about 2-3 times of the footprint required by the incinerator for the treatment of the same amount of waste), and the marketability of the products recovered from the MBT process, such as low quality compost and refuse-derived fuel, was a concern, the WMSC considered there was no strong justification in support of adopting the MBT technology in the context of Hong Kong. However, the WMSC supported in general the adoption of Mechanical Treatment (MT) technology to test the operational viability and cost effectiveness of sorting and recovering the recyclables from the MSW prior to the incineration process. Should this arrangement be found viable and cost effective, the Government could consider putting in place a MT process of suitable scale prior to incineration in future phases of the IWMF. By doing so, it would reinforce the Government's commitment to minimizing the use of incineration and landfilling in MSW management.

3.2.5 Recommendation

3.2.5.1 Based on the results of the evaluation of the shortlisted treatment options and the recommendations of ACE, it was concluded that moving grate incineration would be the most preferable option and would be adopted as the core treatment technology, supplemented with demonstration-scale mechanical treatment facilities, in the IWMF.

3.3 Treatment Capacity

3.3.1.1 A review of the existing incineration plants in the world was conducted. Based on the existing installations in the world, most of the incineration plants have a treatment capacity ranging from less than 1,000 tpd to 4,000 tpd. Selection of plant capacity is normally dependent on local requirements and constraints. Localized small scale incineration plants likely have less traffic impact when compared to centralized large scale incinerations. The advantages of large scale incineration plants are that they are more efficient in cost and land utilization when compared with small scale incineration plants. With due regard to the scarcity of suitable land in densely populated cities and considerations of economy of scale, there is a tendency to maximize the potential of a site and to plan for an incineration plant with higher treatment capacity. Some overseas examples with installed treatment capacity larger than 3,000 tpd are listed below:

- Tuas South Incineration Plant and Senoko Incineration Plant in Singapore with an installed capacity of about 4,300 tpd and 3,300 tpd, respectively; and
- Afval Energie Bedrijf (AEB) Incineration Plant in Amsterdam, the Netherlands with an installed capacity of about 4,000 tpd.

3.3.1.2 In Hong Kong, there is already a very well organized and efficient refuse transfer station network whereby MSW collected in the urban area are being compressed into large dedicated containers and then transferred away in bulk by marine transport. The usual constraint of potential adverse traffic impact on transport network in the vicinity of large scale incineration plants therefore does not exist. To achieve good economy of scale and making reference to the capacity of similar facilities in other densely populated cities e.g. Singapore with similar demographic and geographic situations, it is decided that the first IWMF will have a treatment capacity of 3,000 tpd, which has taken into consideration the waste reduction and recycling programme, the proven reliability of the proposed scale of incineration plants and the site and environmental constraints.

3.4 Stack Height

3.4.1.1 With reference to the “A Guidance Note on the Best Practicable Means for Incinerators (Municipal Waste Incineration) BPM 12/1(08)”, EPD, the design of the chimney height shall be determined by mathematical or physical dispersion modelling techniques. Therefore, wind tunnel tests (physical dispersion modelling technique) were conducted to determine and verify that the stack height for the IWMF would not result in adverse terrain or building wake effects at the TTAL site and the artificial island near SKC. The wind tunnel tests consisted of plume visualization for 75m, 100m, 125m and 150m stack heights.

3.4.1.2 Visualization of stack plume behaviour under various wind directions and speeds has been conducted to provide a qualitative understanding of the effect of the immediate terrain and building structures on the dispersion of the plume emitted from the IWMF stack. The visualization also serves to check whether the plume from the IWMF stack will hit the critical Air Sensitive Receivers in close proximity to the TTAL site and the artificial island near SKC. The findings of the wind tunnel tests verified that both 125m and 150m stack heights for the IWMF would not result in adverse terrain and building wake effects at both the TTAL site and the artificial island near SKC.

3.4.1.3 Besides, a Good Engineering Practice (GEP) stack height requirement has been established in the United States for major air emission sources. GEP stack height is the height necessary to insure that emissions from the stack do no result in excessive concentrations of any air pollutant in the immediate vicinity of the source as a result of atmospheric downwash, eddies or wakes which may be created by the source itself, nearby structures or nearby terrain obstacles. In general terms, GEP stack height is defined as the height of nearby structure(s) plus 1.5 times the lesser dimension of the height or projected width of nearby structure(s). Given that the maximum height of the structures in the vicinity of the IWMF would not be higher than 50m. The GEP stack height would thus be about 125m for the IWMF. In other words, both 125m and 150m stack heights would satisfy the GEP stack height requirement.

3.4.1.4 With a view to further alleviate the potential air quality impacts at critical air sensitive receivers (ASRs) but at the same time to minimize potential visual impact associated with a tall stack, 150m is selected as the stack height for the IWMF at both the TTAL site and the artificial island near SKC. It has considered both the air quality benefit and visual impact due to a tall stack.

3.5 Layout Arrangement

3.5.1.1 With a view to minimize the land use and the associated environmental impacts at the two sites, in particular at the artificial island near SKC, the layout for the IWMF is considered appropriate taking into consideration the functional need for operation of the IWMF, reasonable flexibility in design for future DBO contractor and allowance of suitable size of land for provision of visitors and community facilities. Based on the proposed layouts, the footprint requirement for treating per tonnage of MSW daily is approximately 32m^2 at the TTAL site and 38m^2 at the artificial island near SKC respectively. The area for compensated habitat for Little Grebe at the TTAL site and the area for breakwater at the artificial island near SKC were excluded in the unit footprint calculation. A larger footprint requirement at the artificial island near SKC is due to the additional land required for the berth area.

3.5.1.2 The unit footprint requirement of the IWMF is comparable with other overseas incineration plants, including Afval Energie Bedrijf (AEB) Incineration Plant with design capacity of 4,000 tpd in the Netherlands and Tokyo Edogawa Incineration Plant with design capacity of 600 tpd in Japan. Based on the existing overseas installations, the footprint requirement for treating per tonnage of MSW daily is normally in the range of 30m^2 to 40m^2 subject to the area provided for other uses including visitors and community facilities.

3.5.1.3 At the artificial island near SKC, the artificial island for construction of the IWMF was designed to be apart from the existing SKC Island in order to minimize the impact on the coastline and the associated ecological impact. On the other hand, the artificial island was placed as close to the SKC Island as possible in order to utilize the shallower water area and hence minimize the depth of reclamation and impact on the navigation channel to the south of the artificial island near SKC during the construction and operation of the IWMF. According to the Marine Department, a minimum distance of 100m between the artificial island and the navigation channel is required.

3.5.1.4 Furthermore, the breakwater at the artificial island near SKC was designed to provide protection to the marine vessels and to maintain the loading and unloading needs even during typhoon signal no. 3.

3.6 Construction Sequences

3.6.1.1 Alternative sequences of construction, including concurrent construction sequence and phased construction sequence, have been considered.

3.6.1.2 Concurrent construction sequence involves various construction activities occurring at the same time. The environmental benefit of this construction sequence would be the reduction of the construction period and hence the duration of impact due to the construction. However, the magnitude of the overall environmental impact could be larger.

3.6.1.3 Phased construction sequence involves construction activities being carried out one after another. This construction sequence would help in reducing the magnitude of the overall impacts, but the construction period would be longer.

3.6.1.4 As the two approaches have their environmental benefits and dis-benefits, a balancing approach which involves a combination of concurrent and phased construction sequences at different stages of the construction has been adopted to alleviate the potential environmental impact and to meet the target commissioning date. For instance, at the artificial island near SKC, the construction of the breakwater and berth area would start off after completion of the cellular cofferdam installation surrounding the reclaimed area so as to minimize magnitude of the overall environmental impact.

3.7 Construction Methods

3.7.1.1 To minimize the potential environmental impacts, alternative construction methods have been considered. For the piling works at the TTAL site, percussive piles and socketted H-piles were considered. Percussive piles would cause substantial noise and vibration impacts, whereas the noise and vibration impacts due to the construction of socketted H-piles would be significantly lower. Considering the environmental benefits and dis-benefits of the alternative piling methods, socketted H-piles is recommended for this Project to minimize the potential noise impact during the construction.

3.7.1.2 Sloping seawall was originally proposed to be used at the artificial island near SKC. The width of the sloping seawall at the seabed level would be about 100m. The construction of the seawall involves dredging of a trapezoid trench to a width of 140m, and depth of 10m along the proposed location of the seawall at the seabed, filling of the trench with sand up to 2.5m below the seabed level and formation of the seawall above the sand fill by rock fill. The site area and dredging volume for the construction of the seawall is substantial. To minimize dredging and filling activities and the associated environmental impacts, cellular cofferdam and circular cell breakwater instead of sloping seawall were proposed to be adopted for the construction of the seawalls and breakwaters, respectively.

4 KEY FINDINGS OF THE EIA STUDY

4.1 Assessment Scenarios of the EIA Study

4.1.1.1 Based on the two potential sites, the following three assessment scenarios have been examined in the EIA Study:

(a) developing a 3,000 tpd IWMF at the TTAL site alone;

(b) developing a 3,000 tpd IWMF at the artificial island near SKC alone; and

(c) developing a 3,000 tpd IWMF at each of the two potential sites (co-existing scenario).

4.2 TTAL Site Alone

4.2.1 Air Quality Impact

Construction Phase

4.2.1.1 Air quality impacts from the construction works for the Project would mainly be related to construction dust from excavation, materials handling, filling activities and wind erosion. With the implementation of mitigation measures specified in the Air Pollution Control (Construction Dust) Regulation, dust impact on air sensitive receivers would be minimal.

Operation Phase

4.2.1.2 During the operation of the IWMF, the potential sources of air quality impact would be the air emissions from the incinerator stacks and the odour nuisance from the waste reception halls, the waste storage area, the mechanical treatment plant and the wastewater treatment plant.

4.2.1.3 Advanced air pollution control system, including selective catalytic reduction (SCR) for Nitrogen oxides (NOx) removal and activated carbon for dioxins removal and continuous emissions monitoring system will be installed for the IWMF to ensure that the emissions from the IWMF stacks will meet the target emission limits that are the same as or more stringent than those stipulated in Hong Kong and the European Commission for waste incineration. NOx is the most critical parameter in Hong Kong in complying with the Air Quality Objectives (AQOs). The Government has decided to adopt advanced technology to improve the quality of air emissions. With the adoption of the SCR process, the daily average emission limit of NOx is lowered to 100 mg/m^3, which is a 50% reduction when compared with the European Union (EU) standard.

4.2.1.4 Cumulative air quality impact assessment has been undertaken for the Project at the TTAL site taking into account the emissions from both regional and local sources, including the emissions within the Pearl River Delta Economic Zone and major local air pollution sources in Hong Kong. The predicted maximum cumulative concentrations of relevant AQO parameters at the representative air sensitive receivers in areas that might be impacted by the IWMF emission all complied with the corresponding AQOs.

4.2.1.5 Besides, odour nuisance may arise from the operation of the on-site wastewater treatment plant, the waste reception halls, the waste storage areas and the mechanical treatment plant of the IWMF. The wastewater treatment plant, the waste reception halls and the waste storage areas would be fully enclosed and the odorous air in this facility would be extracted and used as combustion air for incineration to remove the odorous compounds. For the mechanical plant, they would be equipped with deodorizing system of 95% odour removal efficiency. Besides, the wastewater treatment plant, waste reception halls, waste storage areas and mechanical treatment plant would also be operated under negative pressure to prevent odour leaking to the outdoor environment. The predicted cumulative

odour concentrations would comply with the criteria required in the EIAO-TM. Adverse odour impact on nearby ASRs would not be expected.

4.2.2 Noise Impact

4.2.2.1 The TTAL site is situated in a remote location and no existing or planned noise sensitive receiver (NSR) is identified within 300m from the boundary of the site. Adverse noise impacts from the TTAL site on NSRs during both construction and operation phases are therefore not anticipated.

4.2.2.2 Having said that, an assessment has been undertaken to examine the potential traffic noise impact on the NSRs along Lung Kwu Tan Road due to the off-site traffic such as trucks delivering maintenance equipment and coach for employee and visitors that are associated with the operation of the IWMF. The assessment results indicated that the predicted change in noise levels at the NSRs would all be below 1 dB(A). In other words, the off-site traffic generated from the IWMF would not result in significant increase of traffic noise impact on the NSRs along Lung Kwu Tan Road.

4.2.3 Water Quality Impact

Construction Phase

4.2.3.1 The potential sources of water quality impact arising during the construction phase of the Project include construction site runoff and drainage, wastewater generated from general construction activities and sewage from the workforce. With the implementation of the recommended mitigation measures and site practices outlined in ProPECC PN 1/94 (*Practice Note for Professional Persons on Construction Site Drainage*), no unacceptable residual impacts on water quality are expected.

Operation Phase

4.2.3.2 During the operation phase, wastewater will be generated from the proposed incineration plant and mechanical treatment plant. An on-site wastewater treatment plant will be provided. All generated wastewater will be discharged to the on-site wastewater treatment plant for treatment. The treated effluent from the wastewater treatment plant will be reused in the incineration plant and mechanical treatment plant or for washdown and landscape irrigation within the IWMF site. A “net zero discharge” scheme will be adopted during the operation of the IWMF.

4.2.3.3 An on-site desalination plant will be provided for supplying water to the IWMF. Saline water would be discharged from the desalination plant at a low discharge rate. The saline water has been quantitatively assessed to be minor and adverse impacts on water quality due to the saline water discharge would not be expected.

4.2.4 Waste Management Implications

Construction Phase

4.2.4.1 The types of waste that would be generated during the construction phase of the Project include construction and demolition (C&D) materials from the construction activities, general refuse from the workforce and chemical wastes from the maintenance of construction plant and equipment. Provided that the wastes are handled, transported and disposed of properly and good site practices and waste reduction measures are implemented accordingly, adverse environmental impact is not expected during the construction phase of the Project.

Operation Phase

4.2.4.2 The end product from the incineration process of the IWMF would include bottom ash, fly ash and air pollution control residues, which would be disposed of at a landfill after checking for compliance with the proposed incineration residue pollution control limits. Pre-treatment of fly ash and air pollution control residues by cement solidification or chemical stabilization will be undertaken prior to disposal at landfill to ensure that pollutants would not leach to the environment. A small amount of non-combustible inert refuse (e.g. glass, sand etc.) sorted out in the mechanical treatment process would also be disposed of at the WENT Landfill.

4.2.4.3 Limited amount of chemicals or chemical wastes would be used or generated for the operation of the IWMF. With proper implementation of the recommended practices and response procedures on land contamination prevention, the potential for land contamination due to the IWMF operation is expected to be minimal.

4.2.5 Ecology

Construction Phase

4.2.5.1 The major ecological impact of the Project would be the loss of about 11 hectares of ash lagoon habitat, of which about 82% is usually dry and support sparse vegetation which has a low biodiversity and ecological value. The loss of the remaining ash lagoon with low to moderate ecological value including 1.98 hectares breeding ground of Little Grebe would be mitigated by the provision of permanent pond habitat within the IWMF site (about 1.2 ha), as well as the interim habitat enhancement work for the southern unoccupied Middle Lagoon (about 4.5 ha). Disturbance impact to the breeding activities of Little Grebe would be minimized by scheduling the commencement of site formation work in the dry season. As a precautionary measure, the works area would be thoroughly inspected by experienced ecologist(s) to confirm no breeding activities of Little Grebe would be affected by the construction work before commencement of site clearance.

4.2.5.2 Other indirect impacts would include noise and human disturbance, release of PFA leachate and construction site runoff and wastewater. With proper implementation of good site practices including the use of quiet machinery to reduce noise emissions, proper drainage arrangement to minimize construction runoff etc., adverse ecological impact is not anticipated. The implementation of mitigation measures would be subject to regular audit as part of the EM&A programme.

Operation Phase

4.2.5.3 No direct habitat loss would be resulted from the operation of the proposed Project. Disturbance impacts would include human activities and noise due to increased operational traffic. Mitigation measures such as landscape planting and boundary wall have been recommended to screen the visual interface and to limit public access to the adjoining lagoon habitat. The ecological function of the compensatory ponds as an alternative habitat for Little Grebe will be monitored.

4.2.5.4 With the implementation of the recommended mitigation measures, no unacceptable ecological impact due to the operation of the proposed Project would be expected.

4.2.6 Fisheries

4.2.6.1 No loss of fishing ground and resources is expected during construction and operation phases of the proposed Project. The construction of the IWMF would be mainly land-based with only minor work anticipated at the seawall for the construction of the saline water outfall. No unprocessed or processed effluent would be discharged into the Deep Bay during the IWMF operation. With proper implementation of the recommended mitigation measures, including the use of sand/ silt removal facilities to collect and control

construction site runoff and the implementation of "net zero discharge" scheme during the operation phase, no adverse impact on fisheries resources is expected.

4.2.7 Health Impact

4.2.7.1 The cancer risk arising from exposure to compounds of potential concern (COPCs) associated with the emissions of the IWMF has been evaluated in this EIA Study. The highest incremental (excess) cancer risk arising from the IWMF is predicted to be 9.82×10^{-7} which is within the screening level of 1×10^{-5} adopted by USEPA and it is considered that the Project would not present an unacceptable risk and no further analysis is necessary. The highest predicted total Hazard Index (HI) at all receptors are well below 0.25, which is an initial screening exposure benchmark derived from a conservative approach by the USEPA. Cumulative acute non-carcinogenic health impact of the IWMF imposed to the worst impacted human receptors were assessed and compared with local and overseas guideline levels. It was concluded that the levels of non-carcinogenic chemicals were found to be insignificant when compared to the adopted/ derived reference levels. For the classical COPCs of the HKAQO, while it is not possible to rule out adverse health effects from the IWMF with complete certainty, the impact on health from small additional air pollutants is likely to be very small and unlikely to be quantifiable.

4.2.7.2 As the vast majority of foods in Hong Kong are imported, the impact of waste facility emissions on any one individual's exposure through ingestion of home-grown foods is likely to be very limited. Nonetheless, assessment was undertaken to determine the concentration of certain metals present in home-grown foods in the vicinity of the Project site due to the deposition of the emissions from the Project. The predicted concentrations were compared with the maximum permitted concentration stipulated in "Food Adulteration (Metallic Contamination) Regulations" by the Centre for Food Safety. The predicted concentrations of Antimony, Arsenic, Cadmium, Chromium, Lead and Mercury at all receptors fall under the maximum permitted concentrations listed in the first and second schedules of the Regulations.

4.2.7.3 The existing practices of transporting wastes in enclosed containers will be followed. With regards to the storage and handling of waste and ash, given that all the reception halls and ash storage pits will be fully enclosed with slightly negative air pressure and a closed grab will be use to grab waste and ash, leakage of any fugitive emissions to the outdoor environment is not expected. With the implementation of the recommended health risk control measures, the potential health impacts associated with the transportation, storage and handling of waste and ash are considered to be insignificant.

4.2.7.4 The potential health risk induced by radon emissions associated with PFA arising from the construction and operation was also evaluated. The estimation indicated that there would be no significant radiological hazard to workers working outdoors in the IWMF or in the restored/ operating ash lagoon area adjacent to the IWMF.

4.2.7.5 The IWMF will be designed and operated to the most up-to-date standards and practices. The operator must be well trained to avoid any accidental events as well as to implement industry best practice with reference to international standards and guidelines. To avoid or minimize potential health impacts associated with potential accidental events, an emergency response plan will be developed and properly implemented for the IWMF. It should be noted that the emergency response plan should be specific to the final design and operation of the IWMF. The recommended preventive measures include the use of best available techniques, continuous and regular stack emission monitoring, as well as conducting regular safety monitoring and audit. With the implementation of the recommended preventive measures and an effective emergency response plan for the IWMF, the health impacts associated with any potential accidental events could be minimized if not avoided.

4.2.8 Landscape and Visual Impact

Construction Phase

4.2.8.1 During the construction phase, the impact to the landscape resources and landscape character areas would be "insubstantial", except to the Ash Lagoon (LR1 & LCA1). The impact to the Ash Lagoon (LR1 & LCA1) before mitigation would be "substantial".

4.2.8.2 The visual impact to most of the visual sensitive receivers during the construction phase would be "moderate", and the visual impact to sea travellers of Deep Bay (VSR4) would be "substantial". After the implementation of the mitigation measures, the residual impact to the sea travellers of Deep Bay would become "moderate/ substantial" during construction.

Operation Phase

4.2.8.3 During the operation phase, the proposed works has negligible impact to most of the landscape resources and landscape character areas, except the Ash Lagoon (LR1 & LCA1) where the Project site locates. The impact to the Ash Lagoon would be "substantial". Mitigation measures including proper landscape design blending the facilities into the surroundings, rooftop/ vertical greening design, landscape treatment, provision of compensatory habitat for Little Grebe, etc. are anticipated to mitigate the landscape impact and enhance the overall landscape quality of the environment. The long-term residual impact to the Ash Lagoon would be reduced to "moderate" in day 1 of operation and "slight" in year 10 of operation.

4.2.8.4 The visual impact to most of the visual sensitive receivers during the operation phase would be "moderate", and the visual impact to the residents/ visitors of Ha Pak Lai (VSR5) and the sea travellers of Deep Bay (VSR4) would be "moderate/ substantial" and "substantial" respectively. After the implementation of the proposed mitigation measures, the residual impact to most of the visual sensitive receivers would be reduced to "slight", and the residual impact to the residents/ visitors of Ha Pak Lai and the sea travellers of Deep Bay would be "slight/ moderate" in year 10 of operation.

4.2.8.5 The development of Sludge Treatment Facilities (STF), which is located adjacent to the TTAL site, has been confirmed and the STF will start commissioning before the IWMF. Surrounded by facilities of similar nature (e.g. STF, Black Point Power Station), the development of the IWMF at the TTAL site is considered compatible with the surrounding context. With the architectural and landscape design of the IWMF being coherent with the adjacent STF, the development of the two facilities could be integrated and blend well in the surrounding landscape. The two developments would form a harmonic view, and the cumulative landscape and visual impact of the two developments would be alleviated. Another concurrent project is the WENT Landfill Extension. The construction phase of the IWMF will occur concurrently during the early construction phase of the WENT Landfill Extension while the operation phase of the IWMF will occur during the construction, operation, restoration and aftercare phases of the WENT Landfill Extension. The construction and operation of the WENT Landfill Extension will cause significant cumulative impact to the area due to large-scale site formation. During the restoration & aftercare phases of the WENT Landfill Extension, the IWMF and STF would be in Year 8 and Year 11 of the operation phase respectively. The mature advanced planting at the WENT Landfill Extension can act as screening effect for the WENT Landfill Extension, and the compensatory planting at the WENT Landfill Extension will be provide preliminary vegetation cover for site area of the WENT Landfill Extension. The WENT Landfill Extension will become compatible with the surrounding IWMF and STF in which various landscape mitigation measures, such as landscape planting, green roof, vertical greening, have been implemented for a substantial period of time. After the whole period of restoration and aftercare phases of the WENT Landfill Extension, the impact due to the WENT Landfill Extension would be greatly mitigated by semi-mature compensatory woodland, shrubland and grassland. The IWMF, STF and resorted WENT Landfill

Extension would blend well and be merged as a whole. No significant residual cumulative impact is anticipated.

4.2.8.6 Regarding the visual impacts during the waste transportation/ handling and cumulative visual impacts, the impact is expected to be insignificant. During the operation stage, MSW will be contained in containers and transported to the berth of the WENT Landfill from the Refuse Transfer Stations (RTSs) by marine transport. This is the current mode of transportation for MSW from the RTSs to the WENT Landfill. After arriving at the berth of the WENT Landfill, the containers will be hauled to the IWMF and the MSW will then be discharged from the containers to the bunker at the IWMF reception hall, which is enclosed in a covered building. The potential visual impact due to transportation/ handling is anticipated to be minimal.

4.2.8.7 In conclusion, the potential landscape and visual impacts can be effectively reduced by implementing the proposed mitigation measures during construction and operation phases. With reference to criteria defined in Annex 10 of the EIAO TM, the overall residual impact is considered as “acceptable with mitigation measures” after implementing the mitigation measures.

4.2.9 Cultural Heritage Impact

4.2.9.1 Based on the results of the desktop review and survey, the Tsang Tsui Archaeological Site has a high archaeological potential. However, the Tsang Tsui Archaeological Site is located approximately 150m from the Project boundary and adverse impacts associated with this Project are not expected.

4.2.9.2 The Hung Shing and Dragon Mother Temple and two clan graves are identified within the study area. However, the Temple was built in early to mid 20th century and renovated in the 1980s. Given the large separation between these built heritages and the IWMF, no adverse impacts during the construction and operation phases are anticipated.

4.2.10 Landfill Gas Hazard

4.2.10.1 A qualitative assessment of the potential hazards associated with landfill gas migration from the WENT Landfill Extensions to the IWMF site has been conducted. A source-pathway-target analysis shows that the overall risk level for construction and operation phase of the IWMF are Medium and High respectively.

4.2.10.2 A number of measures have been recommended for the Project to safeguard the safety of all personnel and the general public (i.e. visitors) present at the Project site during construction and operation phase. These include site safety measures and routine monitoring of landfill gas at excavation areas during construction phase, and installation of gas barrier and monitoring wells and other building protection measures as necessary during the operation phase. With the implementation of these measures, no adverse impact of landfill gas hazard on this Project is anticipated.

4.2.11 Environmental Monitoring and Audit

4.2.11.1 Environmental monitoring and audit (EM&A) requirements for the IWMF at the TTAL site have been specified in an EM&A Manual. The EM&A Manual contains details of proposed baseline and compliance monitoring programmes, implementation schedule of the environmental protection/ mitigation measures, EM&A reporting procedures and complaint handling procedures.

4.3 Artificial Island near SKC Alone

4.3.1 Air Quality Impact

Construction Phase

4.3.1.1 Air quality impacts from the construction works for the Project would mainly be related to construction dust from excavation, materials handling, filling activities and wind erosion. With the implementation of mitigation measures specified in the Air Pollution Control (Construction Dust) Regulation, dust impact on air sensitive receivers would be minimal.

Operation Phase

4.3.1.2 During the operation phase, the potential sources of air quality impacts would be the air emissions from the incinerator stacks and the odour nuisance from the waste reception halls, the waste storage area, the mechanical treatment plant and the wastewater treatment plant.

4.3.1.3 Advanced air pollution control system, including SCR for NOx removal and activated carbon for dioxins removal and continuous emissions monitoring system will be installed for the IWMF to ensure that the emissions from the IWMF stacks will meet the target emission limits that is the same as or more stringent than those stipulated in Hong Kong and the European Commission for waste incineration.

4.3.1.4 Cumulative air quality impact assessment has been undertaken for the Project at the artificial island near SKC. The cumulative air quality impact assessment has taken into account the emissions from both regional and local sources, including the emissions within the Pearl River Delta Economic Zone and major local air pollution sources in Hong Kong. The predicted maximum cumulative concentrations of relevant AQOs parameters at the representative air sensitive receivers in areas that might be impacted by the IWMF emission all complied with the corresponding AQOs.

4.3.1.5 Besides, odour nuisance may arise from the operation of the on-site wastewater treatment plant, the waste reception halls, the waste storage areas and the mechanical treatment plant of the IWMF. The wastewater treatment plant, the waste reception halls and the waste storage areas would be fully enclosed and the odorous air in this facility would be extracted and used as combustion air for incineration to remove the odorous compounds. For the mechanical plant, they would be equipped with deodorizing system of 95% odour removal efficiency. Besides, the wastewater treatment plant, waste reception halls, waste storage areas and the mechanical treatment plant would also be operated under negative pressure to prevent odour leaking to the outdoor environment. The predicted cumulative odour concentrations would comply with the criteria required in the EIAO-TM. Adverse odour impact on nearby ASRs would not be expected.

4.3.2 Noise Impact

Construction Phase

4.3.2.1 The assessment results have demonstrated that daytime noise criteria would not be exceeded by the predicted construction noise levels under the unmitigated scenario. Having said that, good practices for the control of noise emissions from construction sites are recommended to further eliminate the potential of noise impact. These include good site practices to limit noise emissions at source and the use of quiet plant and working methods, whenever practicable.

4.3.2.2 Besides, a construction noise EM&A programme is recommended to check the compliance of the noise criteria during normal daytime working hours.

Operation Phase

4.3.2.3 Operation noise impacts from fixed plant noise can be effectively mitigated by including noise control treatment at the source during the design stage and implementing the same during operation. Adverse residual operation noise impacts are not anticipated. The need for noise measurement during commissioning of fixed noise sources should be included in the contract documents of the IWMF.

4.3.3 Water Quality Impact

Construction Phase

4.3.3.1 The potential sources of water quality impact arising during the construction phase of the Project include construction site runoff and drainage, wastewater generated from general construction activities and sewage from the workforce. With the implementation of the recommended mitigation measures and site practices outlined in ProPECC PN 1/94 (*Practice Note for Professional Persons on Construction Site Drainage*), no unacceptable residual impacts on water quality are expected.

4.3.3.2 To minimize dredging and filling activities and the associated environmental impacts, cellular cofferdam and breakwater instead of sloping seawall are proposed to be adopted. Large-scale sediment dredging is therefore not anticipated for the proposed reclamation and breakwater construction works at the artificial island near SKC. Only small-scale dredging may be required along the proposed cofferdam to remove the top 1m of clayey marine deposit for installation of an anti-scouring protection layer. The water quality impact during the dredging for anti-scouring protection layer has been quantitatively assessed using the near field sediment dispersion model. The model results indicated that the water quality impact generated from the dredging works would be localized and minor under the mitigated scenario and would unlikely contribute to any significant water quality impact. Mitigation measures including the employment of silt curtain system, control of dredging and filling rates etc. are proposed to ensure that no unacceptable water quality impact would be resulted from the dredging works.

4.3.3.3 Besides, during installation of submarine cables, the seabed sediment will be released at the bottom of the water column which will result in high localized suspended sediment concentrations. An analysis has been undertaken to determine the potential transport of fine sediments suspended into the water column during the cable laying process. The analysis results indicated that the sediment disturbed during laying of the submarine cable will settle onto the seabed within approximately 80m of the cable alignment. Since all the identified water sensitive receivers are located beyond this impact zone and the whole submarine cable installation works will be completed within a short duration, the potential water quality impacts are considered short term and acceptable.

Operation Phase

4.3.3.4 During the operation phase, wastewater will be generated from the proposed incineration plant and mechanical treatment plant. An on-site wastewater treatment plant will be provided. All generated wastewater will be discharged to the on-site wastewater treatment plant for treatment. The treated effluent from the wastewater treatment plant will be reused in the incineration plant and mechanical treatment plant or for washdown and landscape irrigation in the IWMF site. There would be no wastewater effluent discharged to the coastal waters of Southern Water Control Zone (WCZ).

4.3.3.5 An on-site desalination plant will be provided for supplying water to the IWMF. Saline water would be discharged from the desalination plant at a low discharge rate. The saline water has been quantitatively assessed to be minor and adverse impacts on water quality due to the saline water discharge would not be expected.

4.3.4 Waste Management Implications

Construction Phase

4.3.4.1 The types of waste that would be generated during the construction phase of the Project include dredged marine sediment, construction and demolition (C&D) materials from foundation works and piling works, general refuse from the workforce and chemical wastes from the maintenance of construction plant and equipment. Provided that the wastes are handled, transported and disposed of properly and good site practices and waste reduction measures are implemented accordingly, adverse environmental impact is not expected during the construction phase of the Project.

Operation Phase

4.3.4.2 The end product from the incineration process of the IWMF would be bottom ash, fly ash and air pollution control residues which would be disposed of at landfill after checking for compliance with the proposed incineration residue pollution control limits. Pre-treatment of fly ash and air pollution control residues by cement solidification or chemical stabilization will be undertaken prior to disposal at landfill to ensure that pollutants would not leach to the environment. A small amount of non-combustible inert refuse (e.g. glass, sand etc.) sorted out in the mechanical treatment process would also be disposed of at landfill.

4.3.4.3 Limited amount of chemicals or chemical wastes would be used or generated from the IWMF operation. Good practices and response procedures for contamination prevention have been recommended. With proper implementation of the recommended practices and procedures, the potential for land contamination due to the IWMF operation is expected to be minimal.

4.3.5 Ecology

4.3.5.1 The waters to the south of Lantau and Lamma Island, including the area near SKC is an important habitat for Finless Porpoise (*Neophocaena phocaenoides*), a species of conservation interest due to their high occurrence in the area. A total of 15 species of corals, including one uncommon species, have been identified along the shore of SKC within and in the vicinity of the Project site. Breeding of White-bellied Sea Eagle (*Haliaeetus leucogaster*), an uncommon species with limited number of known breeding sites in Hong Kong, had been recorded near the proposed reclamation area.

4.3.5.2 The key potential direct impact identified under the Project include permanent loss of 31 ha of important habitat for Finless Porpoise, covering the reclamation and the embayment area within breakwater. Mitigation measures proposed to mitigate the loss include firm commitment from the Project Proponent to seek to designate a marine park of approximately 700 ha in the waters between Soko Islands and Shek Kwu Chau, in accordance with the statutory process stipulated in the Marine Parks Ordinance by 2018, in order to tie in with the operation of the IWMF at the artificial island near SKC. Deployment of artificial reef and release of fish fry have also been proposed as additional enhancement measures for the loss of important habitat for Finless Porpoise and fisheries resources. For the indirect impacts on Finless Porpoise, such as acoustic disturbance, collision with vessels, and alteration of behavioural pattern during construction and operation phases, mitigation measures proposed include avoidance of noisy works during peak Finless Porpoise season, monitoring of exclusion zone, marine mammal watching plan, adoption of regular traffic route, and limitation of vessel speed to ten knots at areas with high Finless Porpoise sighting density. With the implementation of the proposed mitigation measures, adverse impacts on Finless Porpoise would be mitigated to acceptable level.

4.3.5.3 A total of 198 coral colonies of small sizes and low coverage (<1%), comprising one hard coral and 7 octocoral species, within the proposed reclamation area may be directly affected. As all the corals to be affected were recorded to be translocatable, coral

translocation has been recommended to avoid any direct loss. Other corals, including the one uncommon species that are located along the shore of SKC may be indirectly affected by the potential elevation in suspended solid level during construction phase; however the impact could be effectively mitigated through water quality control measures. With the implementation of the proposed measures, unacceptable impacts on corals are not anticipated.

4.3.5.4 The White-bellied Sea Eagle breeding pair and their nest may experience indirect disturbances during construction and operation of the IWMF. Such impacts could be mitigated through avoidance of noisy works during the breeding season of White-bellied Sea Eagle, restriction of vessel access near the nest of White-bellied Sea Eagle, and avoidance of unnecessary lighting and provision of shielding for lights to minimize glare disturbance from the IWMF. It is hence expected that the potential impacts on White-bellied Sea Eagle could be minimized to acceptable level.

4.3.5.5 Besides the above marine works, the construction of the Project also involves laying of submarine cables between SKC and Cheung Sha as well as the construction of a landing portal at Cheung Sha. The benthos communities of the temporarily affected areas are expected to recolonise the seabed areas after the short period of submarine cable laying operation (about 20 working days). In view of the low to moderate ecological value of the subtidal habitats and temporary nature of the impact, the potential impact on subtidal habitat and the associated benthos communities due to submarine cable laying works is considered to be low. Moreover, considering the localized nature of sediment plume and short term duration of the works, as well as the natural adaption of fish, no significant impacts are expected on the potential fish spawning and nursery ground due to the submarine cable laying works. For the construction of Cheung Sha landing portal, considering the small scale of landing portal works, existing turbid condition, and absence of ecological sensitive receiver along the shoreline, with the adoption of good site practice and water quality control measures, potential impact on ecological resources during construction of Cheung Sha portal is considered to be acceptable.

4.3.5.6 Monitoring programmes for Finless Porpoise, coral colonies, and White-bellied Sea Eagle have also been recommended to assess the effectiveness of the proposed mitigation measures. With the implementation of the recommended mitigation measures and the EM&A programme, adverse ecological impacts due to the construction and operation of the proposed Project would be minimized to acceptable levels.

4.3.6 Fisheries

4.3.6.1 Permanent loss of 31 hectares of fishing ground, and 15.9 hectares of fisheries spawning and nursery ground, is expected. Indirect impact on fisheries due to elevation in suspended solids level during construction phase would be temporary and localized. Mitigation measures such as adoption of silt curtain, reduced dredging rate, and phasing of marine works have been recommended, in order to minimize adverse impact on water quality, hence protecting fisheries resources. During operation phase, although the rate of water intake for water supply at the desalination plant of the IWMF is slow, the potential impact from impingement and entrainment of fisheries resources would be further minimized by provision of screen at the seawater intake.

4.3.6.2 With the proper implementation of the recommended mitigation measures, potential impact on fisheries due to the Project is considered to be acceptable.

4.3.7 Health Impact

4.3.7.1 The cancer risk arising from exposure to compounds of potential concern (COPCs) associated with the emissions of the IWMF has been evaluated in this EIA. The highest incremental (excess) cancer risk arising from the IWMF is predicted to be 2.76×10^{-6} which is within the screening level of 1×10^{-5} adopted by USEPA and it is considered that the

Project would not present an unacceptable risk and no further analysis is necessary. The highest predicted total Hazard Index (HI) at all receptors are well below 0.25, which is an initial exposure screening benchmark derived from a conservative approach by the USEPA. Cumulative acute non-carcinogenic health impact of the IWMF imposed to the worst impacted human receptors were assessed and compared with local and overseas guideline levels. It was concluded that the levels of non-carcinogenic chemicals were found to be insignificant when compared to the adopted/derived reference levels. For the classical COPCs of the HKAQO, while it is not possible to rule out adverse health effects from the IWMF with complete certainty, the impact on health from small additional air pollutants is likely to be very small and unlikely to be quantifiable.

4.3.7.2 As the vast majority of foods in Hong Kong are imported, the impact of waste facility emissions on any one individual's exposure through ingestion of home-grown foods is likely to be very limited. Having said that, assessment was undertaken to determine the concentration of certain metals present in home-grown foods in the vicinity of the Project site due to the deposition of the emissions from the Project. The predicted concentrations were compared with the maximum permitted concentration stipulated in "Food Adulteration (Metallic Contamination) Regulations" by the Centre for Food Safety. The predicted concentrations of Antimony, Arsenic, Cadmium, Chromium, Lead and Mercury at all receptors fall under the maximum permitted concentrations listed in the first and second schedules of the Regulations.

4.3.7.3 The existing practices of transporting wastes in enclosed containers will be followed. With regards to the storage and handling of waste and ash, given that all the reception halls and ash storage pits will be fully enclosed with slightly negative air pressure and that closed grab will be use to grab waste and ash, leakage of any fugitive emissions to the outdoor environment is not expected. With the implementation of the recommended health risk control measures, the potential health impacts associated with the transportation, storage and handling of waste and ash are considered to be insignificant.

4.3.7.4 The IWMF will be designed and operated to the most up-to-date standards and practice. The operator must also be well trained to avoid any accidental events as well as to implement industry best practice with reference to international standards and guidelines. To avoid or minimize the potential health impacts associated with potential accidental events, an emergency response plan will be developed and properly implemented for the IWMF. It should be noted that the emergency response plan should be specific to the final design and operation of the IWMF. The recommended preventive measures include the use of best available techniques continuous and regular stack emission monitoring, as well as conducting regular safety monitoring and audit. With the implementation of the recommended preventive measures and an effective emergency response plan for the IWMF, the health impacts associated with any potential accidental events could be minimized if not avoided.

4.3.8 Landscape and Visual Impact

Construction Phase

4.3.8.1 During the construction phase, the impact to the landscape resources and landscape character areas would be "insubstantial", except the Island Landscape (LCA1) which is rated as "moderate" and Seawater (LR3 & LCA2) which are rated as "substantial".

4.3.8.2 During the construction phase, the visual impact to most of the visual sensitive receivers would be "moderate/ substantial", and the visual impact to the sea travellers (VSR4) would be "substantial". After the implementation of mitigation measures, the residual impact to the VSR4 would become "moderate/ substantial" during construction while most of the other VSRs become "slight/ moderate" or "moderate".

Operation Phase

4.3.8.3 During the operation phase, the impact to the landscape resources and landscape character areas would be "insubstantial", except the Island Landscape (LCA1) which is rated as "moderate" and Seawater (LR3 & LCA2) which are rated as "substantial".

4.3.8.4 To avoid direct impact to the valuable landscape resources of SKC, such as the natural shoreline (LR2), the reclamation area is designed not be connected to SKC. The coast of SKC and the reclamation area will be separated by a water channel (about 10 – 40 m in width and 350 m in length). The deeper side of the channel would be about 9m deep. Although the reclamation area will be isolated from SKC and no direct impact to the landscape resources and landscape character areas in SKC is anticipated, mitigation measures are proposed to improve the compatibility of the proposed works which are of industrial nature, with the landscape resources and landscape character areas in SKC. The measures include introduction of architectural and landscaping design emphasizing nature as the design concept. Boulders with the similar textures of the existing rocky shores would be employed for the construction of breakwater and the shoreline of the reclamation area to echo the existing natural shoreline of SKC. Rooftop and vertical greening along the periphery of each building would be implemented to increase the amenity value of the IWMF, and more importantly to blend into the surrounding green environment. Landscape would also be introduced at the stack to further enhance the overall natural and green concept.

4.3.8.5 For LR3, since the seawater will be permanently replaced by the reclamation area, this portion of landscape resource is lost and cannot be recovered or mitigated. However, the quantity of loss of the seawater as landscape resource is relatively small in comparison to the large extent of the adjacent seawater landscape. Together with other measures such as efficient site layout and use of cellular cofferdam for the construction of breakwater and the artificial island, the area occupied by the proposed works is reduced to practically minimum so that the impact to LR3 would be as small as possible.

4.3.8.6 For LCA2, apart from minimizing the landscape impact as mentioned above, extensive landscape areas and greening will be provided as a mitigation measure to improve the naturalness of the Project site. The provision of new landscape elements will transform the existing landscape character.

4.3.8.7 During the operation phase, the visual impact to most of the visual sensitive receivers would be "moderate/ substantial" or "moderate", and the visual impact to the sea travellers (VSR4 & VSR12) would be "substantial" and "moderate/ substantial" respectively. As the view of these VSRs are of transient nature, the proposed works would unlikely create a prolonged visual impact to these VSRs.

4.3.8.8 Regarding the visual impacts induced by the reclamation and construction of facilities, mitigation measures are proposed including aesthetic design with a view to enhance the aesthetic quality and to blend in the proposed works into the natural surroundings, at the same time reducing the visual mass of the structure. This is achieved by rooftop and vertical greening along the building façade, use of natural materials with recessive colour, provision of sky gardens between the stacks, provision of observation deck to diminish the feeling of chimney, etc.

4.3.8.9 To maximize visual compatibility between the existing natural shoreline of SKC and the IWMF site, mitigation measure to adopt natural rocks with similar colour as the SKC rocky shore for the construction of breakwater and artificial shoreline will improve the visual quality.

4.3.8.10 After the implementation of the proposed mitigation measures, the residual impact to some of the visual sensitive receivers would be reduced to 'slight/moderate', and the residual impact to the sea travellers (VSR4 & VSR12) would become 'moderate/substantial' and 'moderate' respectively in day 1 of operation and 'moderate' and 'slight/moderate'

respectively in year 10 of operation. The residual impact to some middle/ long distance VSRs such as Cheung Sha (VSR5), Pui O Beach (VSR8) and Tong Fuk Beach (VSR11) would remain "moderate" in year 10 of operation due to the fact that some of the mitigation measures such as rooftop and vertical greening would not easily be appreciated from a distance.

4.3.8.11 In conclusion, the potential landscape and visual impacts can be reduced by implementing the proposed mitigation measures during construction and operation phases. With reference to criteria defined in Annex 10 of the EIAO TM, the overall residual impacts are considered as "marginally acceptable with mitigation measures" after implementing the mitigation measures, that is to say "there would be some adverse effects, but these can be eliminated, reduced or offset by specific measures".

4.3.9 Cultural Heritage Impact

4.3.9.1 Based on the results of the desktop review and survey, no archaeological site was identified within the study area. No adverse archaeological impact is expected.

4.3.9.2 Geophysical surveys were conducted to examine the marine archaeological potential in the proposed reclamation area, breakwater and cable corridor for the IWMF. A total of 12 unidentified objects were spotted within the geophysical survey area. To minimize the potential impact, the proposed alignments of the submarine cables were revised to avoid direct impact to five unidentified objects. The remaining seven unidentified objects would be directly affected by the proposed works. A diver inspection was carried out, trying to locate these seven unidentified objects and establish their archaeological potential. A detailed search was conducted, but nothing was located. The results of the geophysical survey and diver inspection indicate there are no archaeological resources within the proposed reclamation area, and therefore no adverse marine archaeological impact is anticipated due to the proposed reclamation.

4.3.9.3 One grade 3 historic building (Courtyard Complex on the SKC Treatment and Rehabilitation Centre of the Society for Aid and Rehabilitation of Drug Abusers) and four other built heritage structures with no grading are identified within the study area. However, due to large separation between the built heritages and the IWMF, no adverse impacts during the construction and operation phases are anticipated.

4.4 TTAL Site and Artificial Island near SKC (Co-existing Scenario)

4.4.1 General

4.4.1.1 It is expected that the co-existing scenario with a 3,000 tpd IWMF at each of the sites would likely give rise to potential cumulative air quality and health impacts associated with aerial emissions from the two IWMFs during the operation phase. Other potential impacts arising from construction and operation of the two IWMFs would be localized at the respective sites and significant changes in the level of impacts specifically associated with the co-existence of the two IWMFs are not anticipated.

4.4.1.2 This EIA Report has provided an assessment of the potential air quality and health impacts associated with the operation of the two IWMFs at both the TTAL site and the artificial island near SKC, with the consideration of the potential cumulative impact from other concurrent projects in the vicinity of the TTAL site and the artificial island near SKC. Specific mitigation measures required for the Project, as well as an environmental monitoring and auditing programme, have been developed. A summary of the operation phase air quality and health impacts associated with this co-exist scenario is presented below.

4.4.2 Air Quality Impact

4.4.2.1 Advanced air pollution control system, including SCR for NOx removal and activated carbon for dioxins removal and continuous emissions monitoring system will be installed for the IWMF to ensure that the emissions from the IWMF stacks will meet the proposed target emission limits that is more stringent than those stipulated in Hong Kong and the European Commission for waste incineration.

4.4.2.2 Cumulative air quality impact assessment has been undertaken for the Project for the co-exist scenario. The cumulative air quality impact assessment has taken into account the emissions from both regional and local sources, including the emissions within the Pearl River Delta Economic Zone and major local air pollution sources in Hong Kong. The predicted maximum cumulative concentrations of relevant AQOs parameters at the representative air sensitive receivers of the areas that might be affected by the IWMF emissions all complied with the corresponding AQOs.

4.4.3 Health Impact

4.4.3.1 The cancer risk arising from exposure to compounds of potential concern (COPCs) associated with the emissions of IWMFs under the co-exist scenario is evaluated in this EIA Study. The highest incremental (excess) cancer risk arising from the IWMF is predicted to be 3.49×10^{-6} which is within the screening level of 1×10^{-5} adopted by USEPA and it is considered that the Project would not present an unacceptable risk and no further analysis is necessary. The highest predicted total Hazard Index (HI) at all receptors are well below 0.25, which is an initial exposure benchmark derived from a conservative approach by the USEPA. Cumulative acute non-carcinogenic health impact of the IWMF imposed to the worst impacted human receptors were assessed and compared with local and overseas guideline levels. It was concluded that the levels of non-carcinogenic chemicals were found to be insignificant when compared to the adopted/derived reference levels. For the classical COPCs of the HKAQO, while it is not possible to rule out adverse health effects from the IWMF with complete certainty, the impact on health from small additional air pollutants is likely to be very small and unlikely to be quantifiable.

5 CONCLUSIONS

5.1.1.1 The EIA has determined the likely nature and extent of environmental impacts predicted to arise from the Project. Where necessary and practicable, the EIA has specified mitigation and control measures to reduce the environmental impacts to acceptable levels.

5.1.1.2 With the recommended mitigation measures applied and the adoption of advanced technology, the Project would be environmentally acceptable and no unacceptable residual impacts are anticipated. The schedule of implementation of the recommended mitigation measures has been provided in the EIA Report. Monitoring requirements have also been specified in a separate EM&A Manual to ensure proper implementation of the recommended mitigation measures.

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綜合廢物管理設施第一期工程及環境研究 - 可行性研究

LOCATION OF THE IWMF AT THE TSANG TSUI ASH LAGOONS SITE
建議的綜合廢物管理設施位置（曾咀煤灰湖選址）

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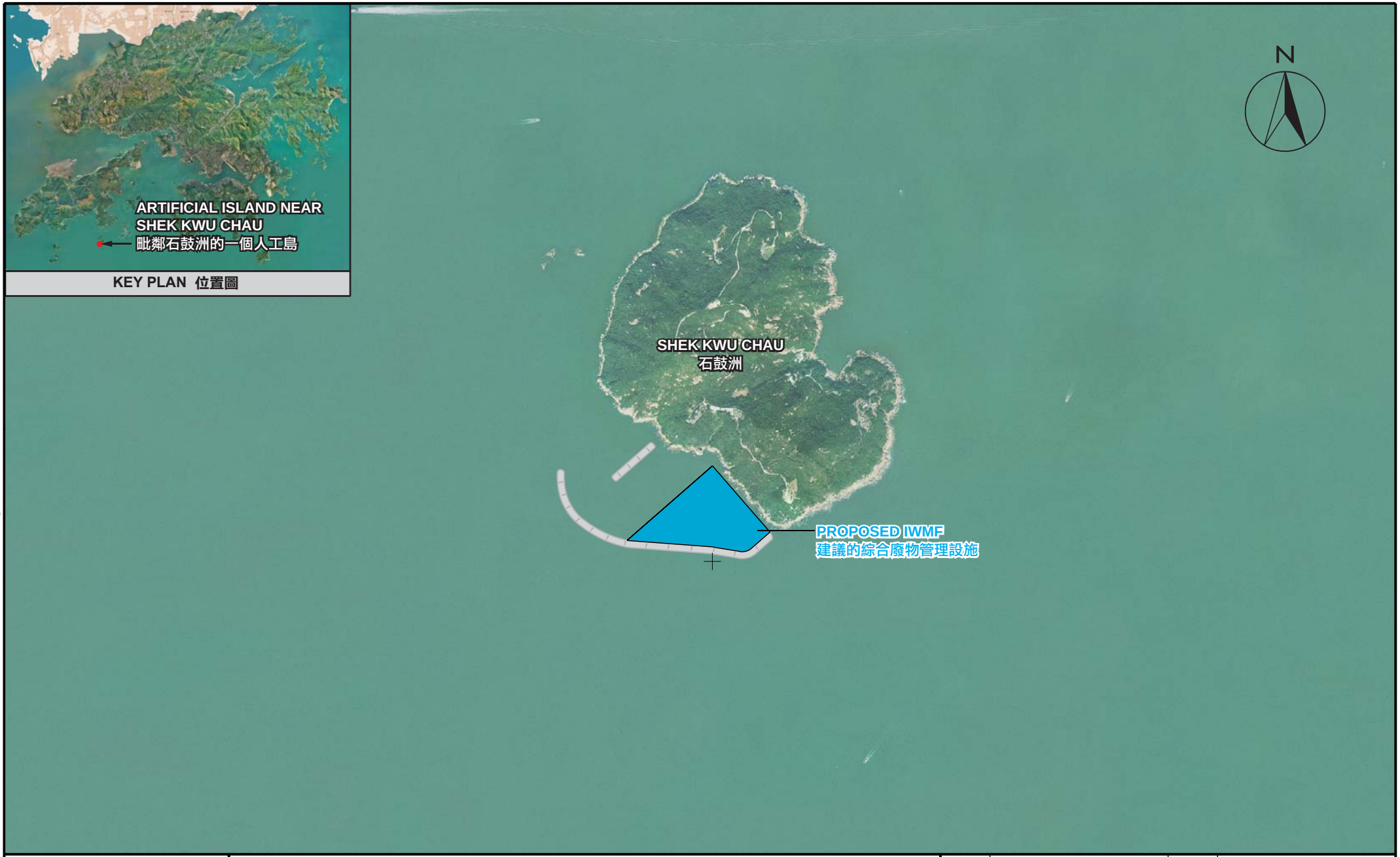
Date 2011-1-12



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LOCATION OF THE IWMF AT THE ARTIFICIAL ISLAND NEAR SHEK KWU CHAU

建議的綜合廢物管理設施位置（毗鄰石鼓洲的一個人工島）

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PHOTOMONTAGE OF THE IWMF AT THE TSANG TSUI ASH LAGOONS SITE
綜合廢物管理設施的電腦模擬圖（曾咀選址）

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PHOTOMONTAGE OF THE IWMF AT THE ARTIFICIAL ISLAND NEAR SHEK KWU CHAU

綜合廢物管理設施的電腦模擬圖（毗鄰石鼓洲的一個人工島）

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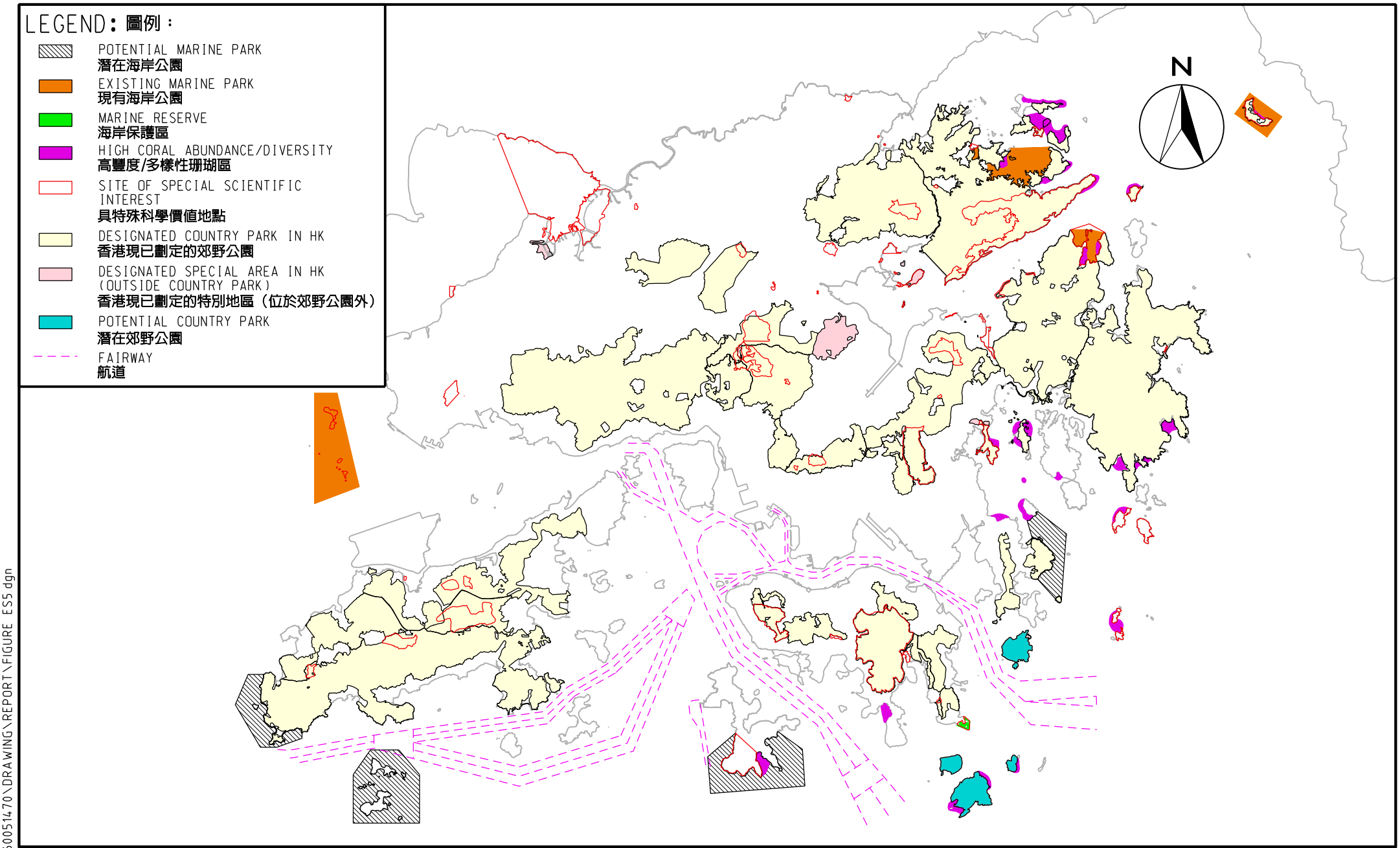

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AREAS OF EXCLUSION FOR DEVELOPMENT OF THE IWMF
不考慮用作發展綜合廢物管理設施的區域

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SHORTLISTED SITES FOR THE IWMF IN SITE SEARCH STUDY
可供考慮發展綜合廢物管理設施的地點

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