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Desalination Plant at Tseung Kwan O – Feasibility Study

Executive Summary

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1 INTRODUCTION

1.1 Background

The Water Supplies Department (hereinafter referred to as WSD) is proposing the development of a medium-sized desalination plant in Hong Kong, at a site reserved in Tseung Kwan O (TKO Area 137). The proposed desalination plant will produce potable water with an initial capacity of 135 million liter per day (MLD), expandable to an ultimate capacity of 270Mld in the future to provide a secure and alternative fresh water resources complying with the World Health Organization (WHO) standards. This project is entitled "Desalination Plant at Tseung Kwan O" (hereinafter referred to the Project).

Under the Environmental Impact Assessment Ordinance (EIAO), an Environmental Permit (EP) will be required for the construction and operation of the proposed Project. In relation to this, WSD has prepared a Project Profile for application for an Environmental Impact Assessment (EIA) study brief under section *5(1)* of the *EIAO (No. PP-497/2013)*. The Project Profile was submitted to EPD on 5 December 2013. The EIA Study Brief (*No. ESB-266/2013*) was issued by EPD on 16 January 2014.

Black & Veatch Hong Kong Limited (B&V) was commissioned by WSD under Agreement No. CE 21/2012 (WS) to provide consultancy services to investigate and formulate a detailed proposal for the Project and conduct the EIA study.

The EIA Report addresses potential environmental impacts associated with the construction and operation of the Project. This *Executive Summary* summarises the key findings of the EIA.

1.2 Purpose & Nature of the Project

The proposed Project comprises the following:

- Construction of a new desalination plant in TKO Area 137 with a capacity of 135 Mld, expandable to 270 Mld in the future;
- Natural slope mitigation works consist of soil nailing, construction of flexible barriers and rock slope stabilization at the lower portion and toe of the natural slope within and in the close proximity of the Clear Water Bay Country Park (***Figure 1.1***), which overlooks the northeast boundary of the new desalination plant at TKO Area 137;
- Construction of a dedicated trunk feed system for the transfer of fresh water output from the desalination plant to the existing Tseung Kwan O Fresh Water Primary Service Reservoir (TKOFWPSR). The system consists of an about 9 km of 1200 mm diameter fresh water mains along Wan Po Road, Po Hong Road and Tsui Lam Road (fresh water main is indicated in ***Figure 1.1***), the associated pipeworks and ancillary facilities including fittings/valves, leakage, flow and pressure monitoring facilities, and a new treated water pumping station and new treated water storage tank with estimated size about 22,500m^3 located in the desalination plant; and,

- All the associated civil, structural, geotechnical, landscaping, electrical and mechanical works.

The location of the Project and the associated works are shown in ***Figure 1.1***.

The following elements of the Project are classified as Designated Projects under the *Environmental Impact Assessment Ordinance* (*Cap. 499*) (EIAO) and are addressed in this EIA Report:

- Schedule 2, Part I, Item E.2 – Water treatment works with a capacity if more than 100,000 m3 per day.
- Schedule 2, Part I, Item K.13 – A dangerous good godown with a storage capacity exceeding 500 tonnes.
- Schedule 2, Part I, Q.1 – Earthworks partly in an existing country park.

1.3 Purpose of this EIA Report

This EIA Report is prepared in accordance with the *EIA Study Brief (No. ESB-266/2013)* and the *Technical Memorandum of the Environmental Impact Assessment Process* (*EIAO-TM*).

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 and related activities that take place concurrently. This information will contribute to decision by the Director on:

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

The specific objectives of the EIA Study are described in *Clause 2* of the *EIA Study Brief*, and the detailed requirements of the EIA Study are set out in *Clause 3* of the *EIA Study Brief*. As specified in the *EIA Study Brief*, the EIA Study has addressed the key environmental issues associated with the construction and operation of the Project in Hong Kong waters and land.

1.4 Justification for the Need of the Desalination Plant

A secure water supply is of utmost importance in sustaining Hong Kong's development. Currently, under the Dongjiang Water Supply Agreement, the Government of Guangdong Province agrees to supply up to an ultimate annual quantity of 1,100 million m^3 of freshwater to Hong Kong. However, when a severe drought happens, the whole region of Dongjiang River Basin will likely face water shortage. To better prepare Hong Kong for uncertainties such as acute climate changes and low rainfall, the Total Water Management (TWM) strategy has been promulgated by the Hong Kong SAR Government in 2008. To this end, the WSD has kept abreast of the latest developments in

desalination technology and prepared for the related planning and studies so that other water sources can be tapped in good time in case of water shortage. A Feasibility Study (CE 71/2000 (WS)) and a Pilot Plant Study (CE 97/2002 (WS)) on developing desalination facilities in Hong Kong have been conducted in 2002 and 2007 respectively. These studies confirmed the technical feasibility of using desalination technologies to produce potable water complying with the World Health Organisation (WHO) standards. WSD has assessed the feasibility and cost effectiveness of building a medium-sized desalination plant in Hong Kong, at a site reserved in Tseung Kwan O (Area 137) to cope with the projected water demand.

There are a number of benefits to develop the desalination plant for providing a secure and alternative fresh water resource, including:

- Secure and alternative freshwater resources: the proposed desalination plant will produce up to 135 Mld during initial commissioning, which is equivalent to 22% of the mean gross yield collected from water gathering grounds over the past decade. After the expansion of the desalination plant, it can produce 270 Mld, which is equivalent to 44% of mean gross yield collected from water gathering grounds over the past decades. The proposed desalination plant can provide approximate 5% and 10% of contribution to the total freshwater demand in Hong Kong.
- Adequate freshwater resources available during climate change: as a coastal and well-developed city with scarce freshwater resources, Hong Kong has unlimited supply of seawater from the ocean that is not affected by the acute climate changes. Thus, the proposed desalination plant would be an appropriate solution to provide potable water and to provide alternative of the freshwater resources.
- Environmental Benefits: the seawater reverse osmosis technology adopted in the desalination plant is one of the low energy consumption and cost effective way to produce freshwater without imposing adverse impact to the environment than other desalination technologies.

According to Hong Kong Observatory's study report, climate change will bring about more frequent extremely dry weather and increase the likelihood of the occurrence of consecutive droughts. This will not only affect the local yield collected in Hong Kong, but also impact on the water resources in Dongjiang which contributes 70 – 80% of the freshwater demand in Hong Kong. Without the proposed Project, Hong Kong lacks an alternative of freshwater resources and will be subjected to water shortage arising from severe droughts which impact the water supply reliability in Hong Kong. As such, the development of proposed desalination plant is essential to secure Hong Kong's freshwater supplies.

2 PROJECT DESCRIPTION

2.1 Project Components and Layout

Table 2.1 presents a summary of the project details. The footprint of the proposed desalination plant development at Tseung Kwan O Area 137 will be approximately 10 hectares (ha), with the trunk feed system consisting of a 9.5 km of 1,200 mm in diameter of fresh water rising main along Wan Po Road. A maximum total marine dredging volume of 6,330 m^3 (in situ) of marine sediments will be generated from the two submarine utilities. Natural slope mitigation works will be undertaken within 0.49 ha of the Clear Water Bay Country Park.

The preliminary layout plan for this Project is presented in ***Figure 2.1***.

Table 2.1 Summary of Project Description

Details	Preliminary Design Information
Submarine Utilities	
Area of seabed affected by pipeline footprint	
• Intake	0.045 ha
• Outfall	0.065 ha
Marine Dredging volume (*in situ* volume)	
• Intake	1,740 m^3
• Outfall	4,590 m^3
Rock fill volume (*in situ* volume)	
• Intake	905 m^3
• Outfall	4,320 m^3
Length of Submarine Utilities (m)	
• Intake	~ 200 to 250 m
• Outfall	~ 300 to 350 m
Diffuser	
• Number of discharge port	A total of 36 discharge ports with diameter of 150 mm
• Length of diffuser	152 m with port spacing of 4.2 m
• Configuration	alternating and inclined at 60° to horizontal
Desalination Plant	
Area of foundation occupied by the plant	10 ha
Building parameters	17 components with building height ranged between 2 m to 20 m
Trunk Feed System	
Area of land affected by the freshwater rising mains	1.14 ha
Excavation volume	42,733 m^3
Length of the freshwater rising main	9,500 m
Diameter of the freshwater rising main	1,200 mm
Natural Slope Mitigation Works	
Area of slope mitigation works	0.49 ha within the Clear Water Bay Country Park

2.2 Site Location & History

The proposed site for the desalination plant is located in Tseung Kwan O (TKO) Area 137 with a reserved site area of about 10 ha. TKO Area 137 is located to the south of the Southeast New Territories (SENT) Landfill and the Tseung Kwan O Industrial Estate. It

faces the Clearwater Bay Country Park to its east, the Joss House Bay to its south and the Tathong Channel to its west. The nearest residential area is the LOHAS Park which is located about 2.5 km from the site.

The site is on reclaimed land which was reclaimed between 1998 and 2000. The natural slope overlooking the northeast boundary of the new desalination plant at TKO Area 137 has a history of minor landslides and contains some potentially unstable boulders.

No permanent major infrastructure has been built in and around the proposed site. At present, three major facilities are located in the vicinity of the site, namely a temporary public fill bank, a temporary explosive magazine and an explosives off-loading barging pier.

2.3 Project Programme

The preliminary construction programme is provided in ***Figure 2.2***.

The construction for the project will be separated into two major contracts. Package A is for plant and other ancillary facilities and Package B is for mainlaying of the trunk feed. The Package A contract is scheduled to commence in 3rd quarter of year 2017 for completion of the construction in 3rd quarter of year 2020. The Package B contract is scheduled to commence in 2nd quarter of year 2016 for completion of the construction in 4th quarter of year 2019. The major construction activities for the Project would comprise site clearance, excavation and backfilling, erection of formwork and reinforcement, concreting, fabrication of steelwork, and testing and commissioning.

2.4 Consideration of Alternative Sites, Development Options, Construction Methods & Sequences

An assessment was conducted to investigate the environmental considerations of alternative sites, development options, construction methods and sequences for this Project. Alternatives considered were as follows:

- Site selection: Comparing to the western waters in Hong Kong, the eastern waters in Hong Kong is oceanic in nature with less turbidity, lower SS levels and relatively consistent in quality with relatively less variation in salinity, which is beneficial to the operations of the desalination plant and should be put in a higher priority for the development of desalination plant.
- Desalination technology using multi-stage flash distillation (MSF) or seawater reverse osmosis (SWRO): Compared with MSF, SWRO technology has definite advantages of less energy consumption, no local emission of fossil fuel consumption and relatively economic viable. SWRO is thus adopted as the preferred method for desalination process.
- Construction of submarine pipeline by dredging or trenchless method: Comparing to dredging method, trenchless method with localized dredging will effectively reduce the dredging volume and greatly minimize the potential impacts on water quality, marine ecology and fisheries associated with dredging

activities. Therefore, trenchless method with localized dredging is the preferred option for the installation of submarine pipelines, intake and outfall.

- Alignment of freshwater rising main along Wan Po Road or via Junk Bay: Alignment of freshwater rising main along Wan Po Road is chosen as the preferred option for the trunk main due to the drawbacks on marine ecology and water quality from alignment of freshwater rising main via Junk Bay.
- Disinfection technologies using chlorination, ozonation or UV radiation: For ozonation and UV disinfection, they are not capable to provide residual disinfectant and chlorination, with lower dosage, is still be required. Thus chlorination is the preferred option for disinfection in the Plant.
- Slope mitigation by set back, passive protection, active protection or mixed protection: Slope mitigation by set back would result in an extensive loss of usable land for implementation of the project and is considered not viable. Slope mitigation by passive protection is not recommended due to the unacceptable residual risk on the desalination plant and its operators from major landslides and boulder fall hazards. For slope mitigation by active protection, extensive disturbance to natural habitat within Country Park would be unavoidable and thus this option is not considered due to the environmental drawback. Mixed protection such as localized stabilization works on the slope area will be optimized to avoid the impact to the existing vegetation and to minimize the impact to the Country Park as much as practicable. To achieve minimization of environmental disturbance, slope mitigation by mixed protection is recommended.
- Concurrent construction works or scheduled in multiple works package: Comparing to concurrent construction works, the construction duration for multiple works package will be shorter and hence reduce potential disturbance to the environment and the local public.

The preferred scenario of the proposed desalination plant development is presented in *Section 2.1* and ***Figure 2.1***. The selection of the preferred alternative has brought about a series of environmental benefits to the Project, including:

- The provision of alternative potable water source and alleviate the shortage of freshwater resources due to climate change and subsequent adverse weather;
- The trunk feed system are proposed to be constructed underneath Wan Po Road to minimize disturbance to sensitive receivers and natural habitats;
- The use of localized soil nailing, localized rock stabilization and localized flexible barrier for slope mitigation has minimized the disturbance to the natural habitats at the Clear Water Bay Country Park;
- The alignment and length of submarine utilities require minimum submarine excavation works and thus the potential impacts on water quality, marine ecology and fisheries are reduced;
- The use of micro-tunnelling machine for construction of the proposed submarine utilities reduces the extent of seabed dredging and dredging volume, thereby reducing the marine footprint of this project and the potential impacts on water quality, marine ecology and fisheries; and,

- The recommended land-based construction methods are expected to avoid prolonged construction duration and hence reduce potential disturbance to the environment and the local public.

2.5 Environmental Friendly Design

In order to preserve the environment in the vicinity of the project, a review of the latest development of various desalination technologies, including seawater reverse osmosis (SWRO) and Multi-stage Flash Distillation (MSF), was conducted for recommendation of environmental friendly design. The results indicated that SWRO is more suitable to be adopted as the desalination technology of the proposed Project, taking into consideration the following advantages:

- No boiler is required, thus no generation of NOx and with least energy consumption
- Proven technology with the capacity to treat large amount of seawater
- Long track record of operation
- Less land requirement for the treatment units
- Less operation complexity
- Less capital and operating costs

3 ENVIRONMENTAL IMPACTS

The potential environmental impacts associated with the Project are summarised in the following sections.

3.1 Air Quality

The air quality impact assessment has examined construction and operation phase impacts of the Project in accordance with the criterial and guidelines stated in the *EIAO – TM Annex 4* and *Air Pollution Control Ordinance (APCO) (Cap. 311)*.

In accordance with the EIA Study Brief *Section 3.4.2.2* of the Project, the Study Area for the air quality impact assessment is generally defined by a distance of 500m from the boundary of the Project Site. A total of 20 ASRs were identified and illustrated in ***Figure 4.1*** of the EIA Report.

Potential dust nuisance from construction activities and gaseous emissions from plant have been evaluated. With the implementation of the recommended dust control measures and good construction site practices, it is not anticipated that the construction of the Project will cause adverse dust and air quality impacts.

By reviewing the process flow during the operation phase, unacceptable impacts due to gaseous emission from the standby generator within the desalination plant and odour nuisance from chemical sludge are not anticipated.

With the implementation of good management practices and proper odour control measures, no unacceptable residual impacts have been predicted to occur during the construction and operation phases. Regular site inspections and audits will be

undertaken during the construction phase to verify that proposed mitigation measures are being implemented.

3.2 Noise

The potential impacts of noise caused by construction and operation activities of this Project have been assessed in this EIA Report. The impacts have been identified and analysed to be in compliance with the criteria and guidelines stated in the *EIAO-TM Annexes 5* and *13* respectively.

In accordance with the EIA Study Brief *Section 3.4.3.2* of the Project, the Study Area for the noise assessment includes all areas within 300 m from the Project Boundary. A total of 36 NSRs were identified and illustrated in ***Figure 5.3*** of the EIA Report.

To minimize construction noise and disturbance to the local public and road users, the freshwater mains shall be constructed in multiple works packages with restricted 40m per workfront (not more than 4 concurrent workfronts).

Since the desalination plant is located distant from the representative noise sensitive receivers (NSRs), the predicted noise levels at the representative NSRs would comply with the stipulated construction noise criteria. For mainlaying works, the predicted unmitigated noise levels would range from 37 to 93 dB(A) at the representative NSRs. To mitigate the noise impact, construction noise control measures such as adopting quiet plant, use of movable noise barriers close to construction plants, noise insulation sheets, noise scheduling of construction activities and noise enclosure, have been recommended. Predicted mitigated noise levels at all NSRs are in the range of 38 to 75 dB(A) and 37 to 87 dB(A) at residential NSRs and educational NSRs, respectively. To further mitigate the residual noise impacts at the corresponding educational NSRs during construction phase, the construction work in the influence areas near the corresponding educational NSRs will be scheduled during long school holidays (e.g. summer holiday, Easter holiday or Christmas holiday, etc.) as far as practicable. No adverse noise impacts are anticipated with the implementation of the practical mitigation measures. Full compliance with the EIAO requirements is anticipated with proper implementation of the proposed mitigation measures. A systematic EM&A programme will be carried out to ensure proper implementation of both construction phase mitigation measures and the construction schedule of the works of freshwater rising mains.

All equipment within the desalination plant will be accommodated inside plant room and fully enclosed, thus no adverse noise impacts are expected during the operation phase of the Project.

3.3 Water Quality

The water quality impact assessment has examined construction and operation phase impacts of the Project in accordance with the criterial and guidelines stated in the *EIAO – TM Annexes 6* and *14,* and applicable assessment standards/ criteria. The assessment, utilising water quality and hydrodynamic computational models, has been examined the

potential impacts caused by marine works during construction phase and effluent discharge of reverse osmosis (RO) concentrates during operation phase.

Trenchless method with localised minor dredging will be adopted as the preferred option for the construction of the proposed submarine outfall to reduce potential impacts of the marine dredging works on water quality, marine ecology and fisheries of the Joss House Bay.

Computational modelling has been conducted to predict various potential water quality impacts from the proposed marine dredging for the construction of submarine pipelines, including sediment solids (SS) elevation, sedimentation, dissolved oxygen (DO) depletion, release of nutrient, heavy metal and trace organic pollutants. The estimated dredged volumes are about 1,740 m^3 (seawater intake) and 4,590 m^3 (submarine outfall). Working hours are assumed to be 12 hours per day with a maximum dredging rate of 3,500 m^3/day (i.e. 0.081 m^3/s). It is assumed that dredging for seawater intake and submarine outfall would not be conducted concurrently. Only one closed grab dredger would be working and spillage of mud from closed grab dredgers is assumed to take place uniformly over the water column. Under unmitigated scenario, full compliance is predicted at all identified water sensitive receivers, with the exception of exceedance in SS elevation predicted at four coral WSRs, including SR4 (Tai Miu Wan), SR16 (Fat Tong Chau), SR36 (Kwun Tsai) and SR37 (Tit Cham Chau). With the implementation of silt curtain during dredging works and reduced dredging rate at seawater intake, the predicted SS elevation at these WSRs would be in full compliance.

The discharge of RO concentrate from the desalination process is the main environmental concern for the Project operation. Results of the modelling works indicate that the effluent plume of RO concentrates would be highly localized and the elevation in salinity and other chemicals would be diluted soon after discharging from the submarine outfall. No observable mixing zone is predicted for most discharge scenarios for most chemicals constituents. Where mixing zone is predicted, it would be closely confined near the submarine outfall and would not encroach to any nearby WSRs. Thus, impacts on water quality and hydrodynamics are predicted to be within acceptable levels.

Water quality monitoring is recommended for the construction and operation phases. A silt curtain efficiency test for the combined use of floating silt curtain type and cage type silt curtain for dredging at seawater intake will also be completed prior to intake dredging works commencement to confirm the silt curtain reduction efficiency assumptions of the assessment. The specific monitoring requirements are detailed in the *Environmental Monitoring and Audit (EM&A) Manual* associated with the *EIA Report*.

3.4 Sewerage and Sewage Treatment Implication

The assessment of sewerage and sewage treatment implication is conducted in accordance with the *EIAO-TM Annex 14* and applicable assessment standards/ criteria.

Construction of the section of gravity sewer from the plant to connect with the existing public sewer would mainly involve conventional technology such as cut and cover excavation techniques.

The sewerage facilities provided as part of the proposed plant will be maintained by the government after completion. No specific maintenance operations are envisaged but it is considered desirable that the facilities will be inspected regularly to ensure that these sewers can function properly.

The detailed design of the proposed sewerage system will be circulated to DSD, EPD and other relevant parties for comment during planning and detailed design stage to ensure acceptance by relevant parties. Access for sewers, equipment and personnel for maintenance of the works would also be adequately provided. Therefore, no adverse residual impact on sewage treatment is anticipated.

3.5 Waste Management

The potential impacts to waste management caused by construction and operational activities of this Project have been assessed in this *EIA Report*. The impacts have been identified and analysed to be in compliance with the criteria and guidelines stated in the *EIAO-TM Annexes 7* and *15* respectively. Legislative requirements and assessment criteria relevant to the waste management assessment have also been presented.

The waste arisings during the construction and operation phases include excavated material, construction and demolition material, marine sediments from dredging works, general refuse from daily operations, chemical waste from maintenance of plant and equipment and sludge from the desalination plant. The quantity, quality and timing of these waste arisings have been identified. It is estimated that the quantities of excavated materials to be generated from the construction of the seawater intake and outfall, desalination plant and the mains laying are approximately 785 m^3, 402 m^3, 183,720 m^3 and 42,733 m^3, respectively. The construction of desalination plant shall involve slope mitigation works, which will also generate about 56 m^3 of excavated materials. The total quantity of marine sediments generated will be approximately 7,346 m^3. Approximately a total of 4,556 m^3 of public fill and 1,139 m^3 of construction waste will be generated from the construction of civil structures and buildings at the project site. With good site practices, the potential environmental impacts associated with the storage, handling, collection, transport and disposal of the identified waste arisings from the Project will be within acceptable limits set out in the *EIAO-TM*. No adverse waste management impacts are anticipated.

Regular site inspections and audits will be undertaken during the construction phase to verify that proposed mitigation measures are being implemented.

3.6 Land Contamination

The impacts of land contamination are assessed in accordance with the *EIAO-TM Annex 19* and applicable assessment standards/ criteria.

Based on the review of historical aerial photographs, the Temporary Magazine Storage Site (TMS) was once part of the sea prior to reclamation finished in 2000. After the completion of the reclamation work, the TMS was left vacant until the magazine storages and other associated facilities were constructed in 2012. Therefore the risk of potential land contamination due to land use prior to the 2012 is anticipated to be low.

Before the hand-over of the TMS Site to WSD for further development, the owner of TMS Site and its contractor shall ensure the TMS site is properly cleaned up before handover to CEDD. After the TMS Site is handed over to WSD and before the commencement of any construction work, the contractor of WSD shall prepare a Contamination Assessment Plan (CAP) for EPD endorsement prior to the commencement of site investigation. A Contamination Assessment Report (CAR) shall be prepared to summarise the results of the site investigation. If land contamination is identified, a Remediation Action Plan (RAP) shall be prepared to identify feasible remediation methods and a Remediation Report (RR) shall be prepared to demonstrate completion of remedial actions for EPD endorsement

Regular site inspections and audits will be undertaken during the construction phase to verify that proposed mitigation measures are being implemented.

3.7 Ecology

The EIA has described the impacts on terrestrial and aquatic ecological resources associated with the construction and operation of the proposed submarine facilities and desalination plant. The purpose of the assessment was to evaluate the predicted impacts to ecological resources as per the criteria and guidelines stated in the *EIAO-TM Annexes 8* and *16* respectively.

A total of 11 habitat types were identified within the Study Area. They are terrestrial habitats (i.e. mixed woodland, plantation, shrubland-grassland, agricultural land, wasteland, watercourse and urbanised/disturbed area) and coastal habitats (i.e. rocky shore, sandy shore, subtidal hard and soft bottom habitats and artificial seawall habitat), all of the habitats are of very low or low ecological value, except for subtidal hard and soft bottom habitats, watercourse (natural section), mixed woodland and shrubland/grassland of low to moderate ecological value. Apart from this, the Clear Water Bay Country Park is the recognized ecologically important/ sensitive sites are located within the Study Area in which 0.49 ha of slope mitigation works will be carried out.

It is noted that a majority (~90%) of the Desalination Plant Site consists of man-made habitats with very low to low ecological values. The mixed woodland and shrubland/ grassland habitats of the area for slope mitigation works were located at the edge of Clear Water Bay Country Park with relatively low abundance and diversity of fauna and the trees were mostly native and common species of fair condition, as a result they are considered to be of low to moderate ecological value. The watermain is located on existing roads which are of no particular ecological value, and the submarine facilities are located on the seabed with soft and hard bottom communities typical in other similar habitats of Hong Kong.

One flora (*Marsdenia lachnostoma*) and five birds (including Black Kite, Black-crowned Night Heron, White-throated Kingfisher, Collared Scops Owl and Lesser Coucal) species of conservation interest were recorded within the footprints of the desalination plant and slope mitigation works. Considering the mobility of bird species and the availability of similar habitats in the surrounding environment, the potential impact on fauna species of conservation concern is considered to be minimal. In addition, tree felling has been avoided for the selected slope mitigation works, such that habitats within slope mitigation works area remain to be available to fauna species. The construction of flexible barriers has the potential to directly affect the flora species of conservation interest *Marsdenia lachnostoma* recorded along the indicative alignment of the flexible barriers. All individuals of *Marsdenia lachnostoma* within the slope mitigation areas shall be retained in-situ, by positioning the alignment of flexible barriers at a minimum 1.5 m in a radius away from these individuals. No trees will be felled for the implementation of slope mitigation works. Temporary fencing will be installed to fence off *Marsdenia lachnostoma* specimens to prevent from being damaged and disturbed during construction.

Construction impacts to marine ecological resources have largely been avoided by optimizing the length and alignment of the submarine facilities to avoid key ecologically sensitive areas for coral communities, and by applying the trenchless method for installing submarine intake and outfall and through proper planning design and execution of the works (i.e. optimisation of project construction schedule/ sequence, using good engineering/ industry practice, timely completion of construction works to reduce impact duration, etc.).

During the construction phase, construction activities may cause direct ecological impacts including habitat loss and vegetation removal, whereas indirect impacts on wildlife include disturbances and changes in water quality. Potential impacts of increased human activities and other disturbances due to the Project construction would not be significant provided that regular checks on construction site practices and boundaries will be conducted. In addition, in the view of the availability of surrounding similar habitats, the potential impact on wildlife especially on the species of conservation interest as a result of habitat fragmentation and isolation is considered to be minimal.

The EIA sets out mitigation measures to reduce ecological impacts, such as regular checks in construction site practices and boundaries, which will reduce potential disturbance to the surrounding environment. With the implementation of the proposed mitigation measures, no adverse residual impact due to the land-based and marine-based construction of proposed desalination plant, slope mitigation works, freshwater rising main and submarine intake and outfall pipelines is anticipated.

3.8 Fisheries

The EIA has described the impacts to fisheries resources and fishing operations associated with the construction and operation of the Project. The purpose of the assessment was to evaluate the predicted impacts to fisheries resources and fishing

operations as per the criteria and guidelines stated in the *EIAO-TM Annexes 9* and *17* respectively.

Based on the desktop review of baseline conditions of commercial fisheries resources and fishing operations suggest that the surrounding waters of the Project, the potential fisheries sensitive receivers identified include spawning and nursery ground of commercial fisheries resources at Port Shelter, artificial reefs at Outer Port Shelter area and Fish Culture Zone at Tung Lung Chau. The potential fisheries sensitive receivers are located at least 1 km from the proposed submarine facilities of the Project. Results from the literature review indicate that fisheries importance of the Project Area and its vicinity is low when compared to other waters of Hong Kong.

Impacts to fisheries resources, habitats and fishing operations during construction and operation phase are considered to be within acceptable level. The permanent loss of 0.11 ha of seabed fisheries habitat for the installation of submarine utilities is considered to be of negligible significance and within acceptable level.

Monitoring activities designed to detect and mitigate any unacceptable impacts to water quality during construction phase are also expected to serve to protect against unacceptable impacts to fisheries. No fisheries-specific monitoring measures are required during construction or operation activities.

3.9 Landscape and Visual Impact

The EIA has described the landscape and visual impacts associated with the construction and operation of the Project as per the criteria and guidelines stated in the *EIAO-TM Annexes 10* and *18* respectively.

The majority of the Project Site falls within the existing fill bank at Fat Tong Chau which is currently landscape of low quality with little valuable vegetation or amenity value and therefore in general the Project at construction and operation is considered to have little landscape impact. Based on the broad brush tree survey, approximately 320 trees are located in the direct footprint of the slope mitigation works area, where careful design will seek to work around them and avoid any tree felling. However, approximately 200 trees, which are mainly native and common tree species, within the direct footprint of the desalination plant facilities will require felling. Considering the available space for tree planting within the project boundary, approximately a total of 300 nos. of heavy standard trees and light standard trees are proposed to be planted on-site at the desalination plant site to compensate for the tree to be felled. If needed, off-site compensatory planting at Siu Ho Wan water treatment works and other waterworks facilities maintained by WSD would be undertaken. It is considered that given the compensatory tree planting and the proposed careful greening of the Project Site landscape, the overall residual impact on existing trees and greenery would be reduced to an acceptable level.

The visual impact assessment confirms that overall the visual sensitive receivers (VSRs) will experience moderate to insignificant visual impacts due to the construction and operation of the Project without mitigation. With mitigation measures centred around

the principles of careful detailed design of the facilities to blend with the existing landscape, conserving existing greenery and providing some soft landscaping (e.g. roadside planting, etc), all visual impacts are considered to be slight or insignificant by year 10 of operation.

The landscape and visual impacts of the Project are thus considered acceptable with mitigation measures.

3.10 Landfill Gas Hazard

The potential hazards associated with sub-surface migration of landfill gas from the TKO Stage II/III Restored Landfill, TKO Stage I Restored Landfill, SENT Landfill and SENT Landfill Extension have been assessed in accordance with the *EIAO-TM Annexes 7* and *19*.

The qualitative risk assessment has concluded that the potential for landfill gas to affect the desalination plant and fresh water mains during the operational phase is low to medium. During the construction period, similar hazards may also arise related to the flammability or the potential asphyxiating properties of landfill gas and/ or the potentially toxic nature of leachate. Given the results of the qualitative risk assessment, it should be assumed that the risks due to the landfill gas or leachate during the construction are low to medium.

In general, underground rooms or voids should be avoided as far as practicable in the design of the infrastructure area of the Project. Other precautionary and protection measures during construction and operation phases of the Project have been recommended. It is expected that with the proposed precautionary measures in place, the potential risk of landfill gas migration to the respective targets will be minimal.

Monitoring of landfill gas shall be undertaken in all excavations, manholes, chambers and any confined spaces prior to the entry. Regular site inspections and audits will be undertaken during the construction phase to verify that proposed mitigation measures are being implemented.

3.11 Hazard to Life

A Hazard Assessment of the risks associated with the use, storage and transport of chlorine and dangerous goods (DGs) at the proposed Desalination Plant has been conducted for the operational phase (Year 2036) of the Project. The cumulative risk of the Project, through interaction or in combination with other existing, committed and planned developments involving DGs in the vicinity of the Project has also been assessed.

In all cases, the Individual Risk complies with the Hong Kong Risk Guidelines and the Societal Risk lies in the acceptable region. The societal risk expressed in the form of FN curves, lies in the acceptable region of the HKRG for the use, transport and storage of chlorine at the Desalination Plant.

Therefore, the operation of the Desalination Plant is acceptable in terms of both individual risk and societal risk as stipulated in *Annex 4* of the *EIAO-TM*. Safeguard measures are recommended to ensure the risk associated with the use, storage, and

transport of chlorine and DGs at the proposed Desalination Plant complies with the Hong Kong Risk Guidelines and stays in "Acceptable" region.

3.12 Environmental Monitoring and Audit

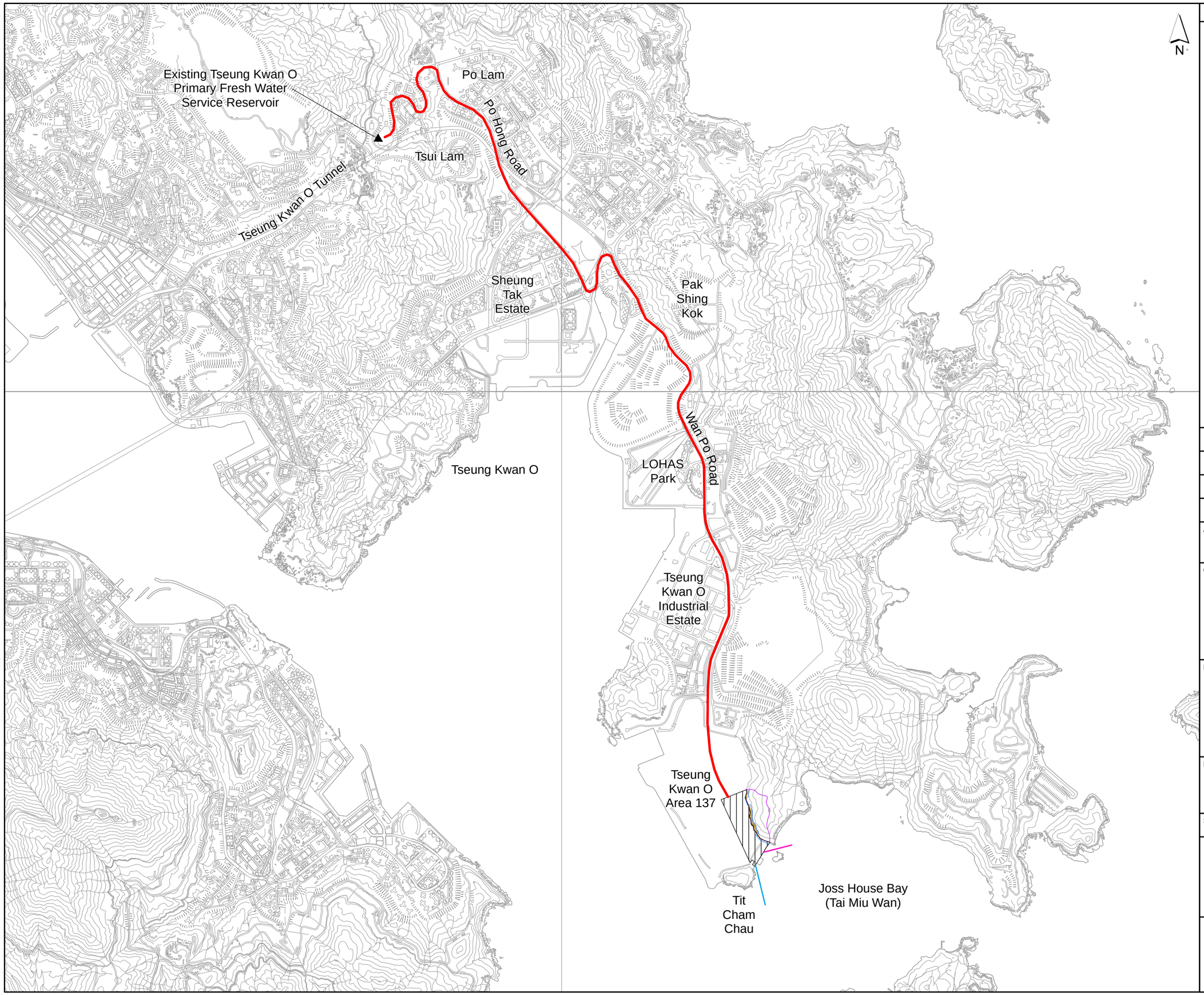
Environmental monitoring and audit requirements have been identified and recommended to ensure the effectiveness of the recommended mitigation measures. These requirements are specified in the *EM&A Manual*. The monitoring requirements cover the area of noise, water quality and landfill gas hazard. Regular site audits throughout the construction and operation of the Project have also been recommended.

4 OVERALL CONCLUSION

The environmental impact assessment (covering air quality, noise, water quality, waste management, land contamination, sewerage, ecology, fisheries, landscape and visual impact, landfill gas hazard, and hazard to life) has concluded that no unacceptable environmental impacts are envisaged as a result of the construction and operation of the Project, provided that the recommended mitigation measures are implemented.

Recommendations for an environmental monitoring and audit programme have been prepared to ensure the effectiveness of the recommended mitigation measures.

Drawings



Legend

- Flexible Barrier
- Indicative location of seawater intake
- Indicative location of submarine outfall
- Proposed Fresh Water Main
- Earmarked Site for Desalination Plant
- Study area for slope mitigation works
- Soil Nailing Area
- Rock Slope Stabilization Area

Revision	Date	Description		Initial
	Designed	Checked	Drawn	Checked
Initial				
Date				

Agreement No.
CE 21/2012 (WS)

Contract title
DESALINATION PLANT AT
TSEUNG KWAN O -
FEASIBILITY STUDY

Drawing title
LOCATION OF THE PROPOSED
DESALINATION PLANT AT
TSEUNG KWAN O

Drawing no.
FIGURE 1.1

Revision

Scale
1:30,000

水務署
Water Supplies Department

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博威工程顧問有限公司

File: T:\GIS\CONTRACT\0189570\Mxd\0189570_Proposed_Plant_Slope.mxd
Date: 26/5/2015

Legend

- Flexible Barrier
- Layout Plan
- Indicative Location of Seawater Intake
- Indicative Location of Submarine Outfall
- Proposed Fresh Water Main*
- Earmarked site for desalination plant
- Study area for slope mitigation works
- Soil Nailing Area
- Rock Slope Stabilization Area

Revision	Date	Description			Initial
	Designed	Checked	Drawn		Checked
Initial					
Date					

Agreement No.
CE 21/2012 (WS)

Contract title
DESALINATION PLANT AT TSEUNG KWAN O - FEASIBILITY STUDY

Drawing title
PLANT LAYOUT

Drawing no.
Figure 2.1

Revision

Scale
1:4,000

水務署
Water Supplies Department

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Date: 26/5/2015

Figure 2.2 Preliminary Construction Programme of the Project

Year	2016												2017												2018												2019												2020											
Month	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Package B - Mainlaying																																																										
Section A (Desalination Plant to Shek Kok Rd)																																																								
Section B (Shek kok Rd to Po Shun Rd)																																																								
Section C (Po Shun Rd to TKOFWPSR)																																																								
Package A - Desalination Plant																																																								
Site Clearance and Ground Investigation																																																								
Foundation and Pilling																																																								
Building Works																																																								
Architectural and Landscaping Work																																																								
Submarine Intake and Outfall																																																								
Slope Mitigation																																																								
E&M Installation, Testing and Commissioning																																																								