Civil Engineering and Development Department

Agreement No. CE 43/2008 (HY) Cross Bay Link, Tseung Kwan O - Investigation

Environmental Impact Assessment Report

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Nomenclature and Abbreviations

ACABAS	Advisory Committee on the Appearance of Bridges and Associated Structures
Arup	Ove Arup & Partners Hong Kong Limited
CBL	Cross Bay Link
CDA	Comprehensive Development Area
CEDD	Civil Engineering and Development Department, HKSARG
DEVB	Development Bureau, HKSARG
EIA	Environmental Impact Assessment
EIAO	Environmental Impact Assessment Ordinance
EPD	Environmental Protection Department, HKSARG
ETWB	Environment, Transport and Works Bureau, HKSARG
ETWB TCW	Environment, Transport and Works Bureau Technical Circular (Works)
GIC	Government, Institution or Community
HKPSG	Hong Kong Planning Standards and Guidelines
HKSAR	Hong Kong Special Administrative Region
HKSARG	The Government of HKSAR
LCA	Landscape Character Area
LR	Landscape Resources
LVIA	Landscape and Visual Impact Assessment
MTRC	Mass Transit Railway Corporation
NB	Northern Bridge
PCW	Prescribed Construction Work
PME	powered mechanical equipment
SB	Southern Bridge
TKO	Tseung Kwan O
TKO-LT	Tseung Kwan O – Lam Tin
TKO-LTT	Tseung Kwan O – Lam Tin Tunnel
TM	Technical Memorandum on Environmental Impact Assessment Process
WBTC	Works Bureau Technical Circular
VSR	Visually Sensitive Receiver
ZVI	Zone of Visual Influence

1 Introduction

1.1 General

1.1.1 An application (No. ESB-196/2008) for an Environmental Impact Assessment (EIA) Study Brief under section 5(1) of the Environmental Impact Assessment Ordinance (EIAO) was submitted by the Civil Engineering and Development Department (CEDD) on 17 July 2008 with a Project Profile (No.PP-362/2008) for the Cross Bay Link, Tseung Kwan O (The Project). EPD issued an EIA Study Brief (No. ESB-196/2008) in August 2008 to the Project Proponent to carry out an EIA study.

1.1.2 Ove Arup & Partners Hong Kong Limited (Arup) has been commissioned by the Civil Engineering and Development Department (CEDD) to undertake the Investigation Assignment of Cross Bay Link (CBL) as well as an EIA according to the EIAO for identification and evaluation of the environmental impacts and the mitigation measures required.

1.1.3 The Project is a designated project under Part I of Schedule 2 to the EIAO (Cap. 499) and hence an Environmental Permit (EP) is required for its construction and operation.

1.1.4 **Drawing no. 209506/EIA/IN/001** illustrates the proposed alignment of the CBL.

1.1.5 Together with Route 6, including the Tseung Kwan O – Lam Tin Tunnel (TKO-LT Tunnel), the CBL will provide an east-west highway link between Kowloon and Tseung Kwan O South.

1.2 Background Information & Previous Studies

1.2.1 The “Feasibility Study for Further Development of Tseung Kwan O (TKO)”, which was commissioned by CEDD in July 2002 and substantially completed in 2005, recommended that a new external road network comprising CBL and TKO-LT Tunnel should be provided around 2016 to meet the anticipated traffic demand.

1.2.2 CBL is a dual two-lane carriageway of approximately 1.8km length across the Junk Bay mainly on viaduct, connecting TKO-LT Tunnel to Wan Po Road at the southeastern part of TKO. The viaduct section of CBL has a cycle track and a footpath in addition to the road carriageway.

1.2.3 The proposed CBL is at close distance to the Northern Bridge (NB) and the proposed Southern Bridge (SB) located at the Eastern Channel of TKO. As suggested by the Advisory Committee on the Appearance of Bridges and Associated Structures (ACABAS) in the 251st ACABAS meeting held on 21st December 2004, it is necessary to match the design of CBL, SB and NB in respect of their aesthetic design, appearance and structural form.

1.2.4 The CBL project is a designated project under Schedule 2 of the EIAO. An EIA Study Brief was issued by the Director of Environmental Protection on 26th August 2008 to CEDD for an EIA Study of the CBL project.

1.2.5 On 9th March 2009 CEDD commissioned Arup as the Consultant to undertake the Investigation Assignment of Cross Bay Link, Tseung Kwan O under Agreement No. CE 43/2008 (HY) with commencement date of 16th March 2009.

1.3 Project Description

1.3.1 The scope of the Project will comprise the following:

- construction of an approximately 1.8km long dual two-lane road mainly on viaduct with a footpath and a cycle track; and
- the associated civil, structural, marine, ship impact protection, geotechnical, landscape, and environmental protection and mitigation works.

1.3.2 The construction of a 900mm diameter salt water main to link up the trunk salt water supply system along Wan Po Road to those in TKO Town Centre and Tiu Keng Leng was previously considered to be mounted along the bridge structure of CBL. However, due to serious concern on the structural integrity and future maintenance for the inclusion of the salt water main in the bridge structure of CBL, an alternative route is proposed for the construction of the salt water main (and will no longer mounted on the CBL). The construction of the salt water main is therefore excluded from the scope of the Project.

1.3.3 An alternative route for the salt water main would not be within any country park nor any conservation area, site of cultural heritage, marine park, marine reserve or Site of Special Scientific Interest. The pipe laying works would not involve dredging operation within 100m from the seawater intake point at TKO Area 86. Hence, the proposed 900mm diameter salt water main is not considered to be a Designated Project.

1.3.4 Given that the salt water main is no longer within the scope of CBL and its construction programme is uncertain at this stage, the salt water main is not addressed in this EIA report for the CBL Project.

1.4 EIA Study Brief

1.4.1 The CBL Project is a designated project (DP) under: Item A.1 and A.8, Part I, Schedule 2 of the EIAO: “A.1 – A road which is an expressway, trunk road, primary distributor road or district distributor road including new roads, and major extensions or improvements to existing roads”, “ A.8 – A road or railway bridge more than 100m in length between abutment”.

1.4.2 In accordance with Section 5(1) (a) of the EIAO, a person who is planning a DP shall apply to the Director of Environmental Protection (the Director) for an EIA Study Brief to proceed with an EIA study for the Project.

1.4.3 Pursuant to Section 5(7) (a) of the EIAO, the Director issues this Environmental Impact Assessment (EIA) Study Brief to the Applicant to carry out an EIA study.

1.4.4 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 taking place concurrently. This information will contribute to decisions by the Director on:

(1) the overall acceptability of any adverse environmental consequences that are likely to arise as a result of the proposed project;

(2) the conditions and requirements for the detailed design, construction and operation of the Project to mitigate against adverse environmental consequences wherever practicable; and

(3) the acceptability of residual impacts after the proposed mitigation measures are implemented.

1.4.5 The objectives of the EIA study are as follows:

(1) to describe the Project and associated works together with the requirements for carrying out the Project;

(2) to identify and describe the elements of the community and environment likely to be affected by the Project and/or likely to cause adverse impacts to the Project, including both the natural and man-made environment;

(3) to provide information on the consideration of alternatives/options for site locations and layouts of the Project to avoid and minimise potential environmental impacts to environmentally sensitive areas and other sensitive uses; to compare the environmental benefits and dis-benefits of each of the different options; to provide reasons for selecting the preferred option(s) and to describe the part of environmental factors played in the selection of the preferred option(s);

(4) to identify and assess air quality impact, noise impact, water quality impact, waste management implication, marine ecological impact, fisheries impact, cultural heritage impact and landscape and visual impact; and determine the significance of impacts on sensitive receivers and potential affected uses;

(5) to propose the provision of infrastructure or mitigation measures so as to minimize pollution, environmental disturbance and nuisance during construction and operation of the Project;

(6) to identify, predict and evaluate the residual (i.e. after practicable mitigation) environmental impacts and the cumulative effects expected to arise during the construction and operation phases of the Project in relation to the sensitive receivers and potential affected uses;

(7) to identify, assess and specify methods, measures and standards, to be included in the detailed design, construction and operation of the Project which are necessary to mitigate these environmental impacts and reducing them to acceptable levels;

(8) to investigate the extent of the secondary environmental impacts that may arise from the proposed mitigation measures, and to identify constraints associated with the mitigation measures recommended in the EIA study as well as the

provision of any necessary modification;

(9) to identify any individual project element(s) and associated works of the Project that fall under Schedule 2 of the EIA Ordinance; to ascertain whether the findings of this EIA study have adequately addressed the environmental impacts of those projects; and, where necessary, to identify the outstanding issues that need to be addressed in any further detailed EIA study; and

(10) to design and specify the environmental monitoring and audit requirements to ensure the effective implementation of the recommended environmental protection and pollution control measures.

1.5 Need of the Project

Purpose and Objective of the Project

1.5.1 In July 2002, CEDD commissioned the Feasibility Study for Further Development of Tseung Kwan O (TKO Study) to formulate a comprehensive plan for further development of TKO and improvement of its overall design with a view to building TKO into a new town that can boast of its convenience, vibrancy, distinctive urban design and quality living environment. As an integral part of the TKO Study, the long-term transport need of TKO was examined.

1.5.2 The TKO Study was substantially completed in 2005 with its recommendations endorsed. The TKO Study identified that the existing TKO Tunnel would have insufficient capacity to cater for projected traffic flow to be generated from further population intake and industrial developments in TKO. It recommended that a new external road network comprising CBL and TKO-LT Tunnel should be provided to meet the anticipated traffic flow.

1.5.3 At present, the existing TKO Tunnel is the main connection between TKO and the urban areas of Kowloon and Hong Kong. However, it has nearly reached its capacity limit due to further development of TKO. Thus, the existing TKO Tunnel will hardly meet the anticipated future demand in terms of capacity, convenience and level of comfort. The proposed new TKO-LT Tunnel with CBL will alleviate traffic congestion and meet the long term traffic demand between TKO and the external areas.

1.5.4 CBL is required to be implemented together with TKO-LT Tunnel to relieve traffic congestion on the existing TKO Tunnel, which prior to the opening of CBL and TKO-LT Tunnel will be seriously congested with anticipated volume/capacity (v/c) ratio as high as 1.4 during the morning peak for Kowloon bound traffic. A v/c ratio is normally used to reflect traffic situation during peak hours and a ratio of 1.0 is considered acceptable while ratios between 1.0 and 1.2 indicate a manageable degree of congestion and a ratio above 1.2 indicates the onset of more serious congestion. Hence, congestion at the existing TKO tunnel is considered serious.

1.5.5 The Legislative Council, Sai Kung District Council and the local community have been urging for early construction of TKO-LT Tunnel together with CBL such that these new roads will provide the much needed additional transport capacity in step with the continuing development of TKO.

1.5.6 Political and public pressure is expected to build up as the traffic situation continues to deteriorate, further phases of housing are announced at Area 86 Lohas Park and housing sites in TKO Town Centre South sold by the Government for development. Any delay in the implementation of CBL and TKO-LT Tunnel will be taken as the Government being irresponsible in proceeding with land sales in TKO without the providing proper corresponding transport infrastructure to cope with the resultant increase in traffic and allowing current the traffic situation to worsen.

1.5.7 At the time of this EIA, the CBL project is now near the completion of the investigation and preliminary design stage. Sai Kung District Council and the local community pressed for early implementation of the project during the most recent public engagement meeting in January 2013. CBL is scheduled for commencement at end 2016 for completion in 2020.

Scenario Without The Project

1.5.8 According to traffic impact assessment, the existing road network in Kowloon East and Tseung Kwan O will experience serious congestion if an alternative external road link is not provided to meet the population growth and the continuing commercial and industrial development in the TKO area. The CBL and TKO-LT Tunnel projects would provide this alternative external road link and meet demand from previously approved development projects and expected future development.

1.5.9 The consequence of not proceeding with the Project would have been a constraining factor upon the planning and development of Area 86 Lohas Park and Area 137 due to traffic congestion along Wan Po Road and at the existing TKO tunnel. Development of these areas has since begun and parts are completed in the knowledge that CBL and TKO-LT Tunnel would be provided in the future to meet the anticipated traffic demand.

1.5.10 In the absence of CBL, there would therefore be increased traffic through TKO Town Centre overloading its road network and causing heavy congestion. Higher traffic flows through TKO Town Centre will result in greater levels of air and noise impacts. The EIA Study for Further Development of Tseung Kwan O Feasibility Study concluded in 2005 that a route option without CBL would be environmentally undesirable and was not suitable for further consideration.

1.5.11 Hence, CBL and TKO-LT Tunnel are necessary to alleviate undesirable environmental consequences that would result in TKO Town Centre from committed and future development.

1.5.12 In particular, heavy vehicles travelling to and from TKO South would be rerouted to CBL and TKO-LT Tunnel and hence would avoid TKO Town Centre. As these vehicles presently pass the eastern side of Lohas Park along Wan Po Road, the rerouting will reduce environmental impact to the existing residential property in this location.

1.5.13 According to traffic impact assessment for future years, between Tseung Kwan O South and Kowloon, capacity problem is anticipated at the following key road links and junctions:

- Kwun Tong Bypass (near Hoi Bun Road)
- Tsueng Kwan O Tunnel
- Clear Water Bay Road (near Ying Yip Road)
- Eastern Harbour Crossing
- Hang Hau Road

- Ying Yip Road
- Po Lam Road (East of Sau Mau Ping Road)
- Ramp connecting Kwun Tong Bypass and Kai Fuk Road
- Kai Cheung Road / Wang Chiu Road
- Sheung Yee Road / Wang Chiu Road
- Kwun Tong Road / Hoi Yuen Road / Hip Wo Street Roundabout
- Cha Kwo Ling Road / Wai Yip Street Junction
- Lei Yue Mun Road / Tseung Kwan O Road
- Lei Yue Mun Road / Kai Tin Road Roundabout
- Cha Kwo Ling Road / Ko Fai Road Junction
- Po Lam Road North / Po Hong Road Junction
- Po Lam Road North / Tsui Lam Road Junction
- Po Lam Road North / Lam Shing Road Junction
- Ying Yip Road / Po Ning Road / Sheung Ning Road Roundabout
- Clear Water Bay Road / Hang Hau Road / Yip Yip Road Roundabout
- Wan Po Road / Po Yap Road / Chiu Shun Road
- Po Yap Road / Tong Yin Street (future Road L671)
- Po Yap Road / Tong Chun Street (future Road L661)
- Wan Po Road / Pak Shing Kok Access Junction
- Wan Po Road / Lohas Park Road
- Wan Po Road / Shek Kok Road

1.5.14 In around 2021 when other components of the Route 6 (TKO-LT Tunnel, Central Kowloon Route and Trunk Road T2) are assumed to be in place, CBL will enable external heavy traffic to and from the southeast industrial area to by-pass the TKO town centre, thus minimizing adverse traffic and environmental impacts on the residential areas of TKO.

1.5.15 Provision of TKO-LT Tunnel without CBL will overload some junctions along Wan Po Road and in the TKO Town Centre area, which will have a future reserve capacity (RC) as low as -40%. The performance of a traffic signal junction is indicated by its reserve capacity (RC). A positive RC indicates that the junction is operating with spare capacity. A negative RC indicates that junction is overloaded, which would result in traffic queues and longer delay time. Hence, there will be longer queues and delay times along Wan Po Road and in the TKO town Centre Area if CBL is not provided with the TKO LT-Tunnel project.

1.5.16 There is no viable alternative to CBL since local junction improvement works would be substantial and could not be accommodated owing to the proximity of adjacent developments.

Scenario With The Project

1.5.17 Upon completion of the TKO-LT Tunnel and CBL projects, capacity problem on traffic flow in the following locations will be eased or even resolved.

- Tseung Kwan O Tunnel
- Clear Water Bay Road (near Ying Yip Road)
- Hang Hau Road
- Po Lam Road (East of Sau Mau Ping Road)
- Kai Cheung Road / Wang Chiu Road
- Kwun Tong Road / Hoi Yuen Road / Hip Wo Street Roundabout
- Lei Yue Mun Road / Tseung Kwan O Road
- Po Lam Road North / Po Hong Road Junction
- Po Lam Road North / Tsui Lam Road Junction
- Po Lam Road North / Lam Shing Road Junction
- Ying Yip Road / Po Ning Road / Sheung Ning Road Roundabout
- Clear Water Bay Road / Hang Hau Road / Yip Yip Road Roundabout
- Wan Po Road / Po Yap Road / Chiu Shun Road
- Wan Po Road / Pak Shing Kok Access Junction
- Wan Po Road / Lohas Park Road
- Wan Po Road / Shek Kok Road

1.5.18 The effects of TKO-LT Tunnel and CBL on journey times have also been examined by the project proponent. From these, it was concluded that TKO-LT Tunnel and CBL will significantly improve traffic conditions by reducing both journey times and queue lengths. The improvement in journey time between the junction of Wan Po Road and Wan O Road (adjacent to Area 86 Lohas Park) and the end of the Central Kowloon Route at Yau Ma Tei will be approximately 20 minutes in 2021 compared with 2011 journey times via the existing TKO Tunnel, Tseung Kwan O Road, Kwun Tong Bypass, Kai Fuk Road, Kai Tak Road, East Kowloon Corridor, Chatham Road North and Gascoigne Road. The improved route will be via CBL and TKO-LT Tunnel and the proposed Trunk Road T2 and Central Kowloon Route (Route 6).

1.5.19 The effect of TKO-LT Tunnel on queue lengths at the existing TKO Tunnel (westbound direction towards Kowloon) will be profound. In 2011 the queue length from the toll plaza was 2km and it is forecasted to increase to 2.9km before CBL and TKO-LT Tunnel would become operational. After implementation of CBL and TKO-LT Tunnel the queue length is expect to shorten significantly to approximately 500m.

1.5.20 According to the traffic improvement proposals under the TKO-LT Tunnel and CBL projects, all the existing public transport facilities including bus, green minibus, red minibus, taxi and ferry will be retained. As such, there will not be any adverse impact on these provisions: in fact, the TKO-LT Tunnel and CBL projects, together with the proposed Trunk Road T2 and Central Kowloon Route will provide new roads and junction improvements thereby resulting in improvement to the existing public transport network.

1.5.21 Overall, CBL will alleviate the traffic congestion and meet the long-term traffic demand of TKO. In particular, CBL will divert heavy vehicles away from the TKO Tunnel – Wan Po Road route which cuts across the densely populated areas of TKO. In this way, CBL will bring the nuisances (noise, air, dust) of the heavy trucks away from the city centre sensitive receivers. The situation for Lohas Park will also be improved as noise mitigation will be provided along Road D9, unlike Wan Po Road which has no noise barrier. The shortening of journey time particularly the alleviation of traffic congestion will reduce the generation of vehicle pollutants in the region.

1.6 Implementation Programme

1.6.1 The CBL project is currently targeted for commissioning by 2020. To meet this target the tentative commencement year for the construction of CBL would be end of 2016 and would take approximately 4 years for completion.

1.7 Concurrent Projects – Construction Phase

1.7.1 The major existing/planned concurrent projects are listed below:

Tseung Kwan O – Lam Tin Tunnel (TKO-LT Tunnel)

1.7.2 With reference to the Project Profile (PP-361/2008) and the EIA Study Brief (ESB-195/2008) on TKO-LT Tunnel, the project is to construct a dual two-lane highway connecting TKO at Po Yap Road in the east with Trunk Road T2 in Kai Tak Development in the west and Lei Yue Mun Road Underpass. The project involves a 4.8km long highway with about 3km of the highway in the form of a tunnel. The TKO-LT Tunnel will connect CBL to form a new external road link to meet the anticipated traffic flow in connection with further population intake and development in TKO New Town.

1.7.3 TKO-LT Tunnel is a separate DP under the EIAO and hence a separate EIA Study has been conducted by the project proponent to address all the impacts (and also including cumulative impacts) during both the construction and operational phases.

1.7.4 According to the information provided by the TKO-LT Tunnel working team, the construction of the TKO-LT Tunnel would tentatively commence in mid-2016 for completion in 2020. The reclamation works for TKO-LT Tunnel are scheduled between July 2018 and October 2018. These would overlap with the marine works of CBL which are proposed to take place between May 2017 and August 2018. Therefore, potential cumulative water quality impacts during construction phase are anticipated and have been addressed in this EIA (see **Section 8** for further discussion on water quality and **Sections's 10** and **11** on fisheries and marine ecology).

1.7.5 Construction sites associated with TKO-LT Tunnel are located beyond the study areas of the CBL noise and air quality assessments. Cumulative noise and air quality impacts from TKO-LT Tunnel during the construction phase are therefore not anticipated (see **Section 5** & **6** for further discussion on air and noise quality).

Trunk Road T2

1.7.6 With reference to the Project Profile (PP-379/2009), T2 is a dual two-lane trunk road of about 3km, with 2.7km of tunnel. T2, together with the proposed Central Kowloon Route (CKR) and TKO-LT Tunnel will form a new strategic highway network, namely, Route 6.

1.7.7 T2 is a separate DP under the EIAO and hence a separate EIA Study will be conducted by the project proponent to address all the impacts (including cumulative impacts) during both the construction and operational phases.

1.7.8 According to the most recent information provided by the T2 project team, as the T2 tunnel is now envisaged as being constructed using Tunnel Boring Machine (TBM), no dredging works are planned to be carried out for the T2 project. However, as a conservative approach, the CBL EIA has considered potential cumulative water quality impacts in the event that the construction method of T2 reverted to dredged immersed tube tunnel construction (see **Section 8** for further discussion on water quality).

Shatin to Central Link (SCL)

1.7.9 The Shatin to Central Link (SCL) will be a through-running line between Tai Wai and the Central Business District of Hong Kong Island. This new strategic railway corridor will increase significantly the cross-harbour and Shatin to Kowloon rail capacities and help redistribute the flows and relieve other railway lines in Hong Kong and Metro Kowloon.

1.7.10 SCL is a separate DP under the EIAO and hence a separate EIA Study has been undertaken by the respective project proponent to address all the impacts (including cumulative impacts) during both construction and operational phases.

1.7.11 According to information from the project proponent of the SCL, the project commenced in 2012 and all major construction works are anticipated to be completed in 2020.

1.7.12 The dredging work for SCL is scheduled from July 2012 to December 2012 for the Kai Tak Runway barging point and also in 2016 for the submarine railway tunnel from Hung Hom to Admiralty Station. This would overlap with the marine works programme of CBL. Hence, the cumulative water quality impacts during the construction phase of CBL have been considered (see **Section 8** for further discussion on water quality).

Cruise Terminal

1.7.13 The development of the Cruise Terminal in Kai Tak is one of the key features in the South East Kowloon Development (SEKD) for formation of a new tourism, sports and recreation centre in the Metro Area.

1.7.14 According to the EIA report on the "Installation of Submarine Gas Pipelines and Associated Facilities from To Kwa Wan to North Point for Former Kai Tak Airport Development" (EIA-182/2010), the cruise terminal is planned to be implemented in two phases. Dredging work for Phase I Berth (the southern portion) was scheduled between 2011 and 2012, and the tentative programme for Phase II Berth dredging work is planned to be between 2013 and 2014.

1.7.15 No cumulative impact on water quality is anticipated during the construction phase of CBL, but impacts, including cumulative impact on hydrodynamic regime, have been considered (see **Section 8** for further discussion on water quality).

Tseung Kwan O (TKO) Area 86 Development

1.7.16 TKO Area 86 property development has a site area of about 33 hectares. The development is expected to comprise some 21,500 flats in 50 residential towers and will be home to a population of 58,000 people. It will also provide retail accommodation of about 50,000m^2 and comprehensive GIC facilities including educational institutes, nurseries, and a community hall, etc.. The total landscaped area in the development site will be about 55,000m^2, which includes the Central Park of 19,000m^2.

1.7.17 According to the indicative development programme of Area 86, the site is already under construction and the construction period is expected until 2020. Area 86 is therefore a concurrent project and the associated cumulative air and noise quality impacts during construction phase have been considered in this EIA (see **Sections 5** and **6** for further discussion on air and noise quality respectively).

Submarine Gas Pipelines

1.7.18 An EIA has been conducted for the "Installation of Submarine Gas Pipelines and Associated Facilities from To Kwa Wan to North Point for Former Kai Tak Airport Development" (EIA-182/2010).

1.7.19 According to the EIA report (EIA-182/2010), the construction would commence in January 2012 and be completed in June 2014. Dredging is required for the period from April 2012 to December 2012 and therefore will be completed before the CBL works commence. The installation of the submarine gas pipelines and associated facilities are therefore not included as a concurrent project with CBL.

Hong Kong Offshore Wind Farm in Southeastern Waters

1.7.20 With reference to the Project Profile and the EIA Study Brief (ESB-146/2006), the Project is to construct and operate an offshore wind farm in the Southeastern waters of Hong Kong. The project component includes an installation of up to 67 wind turbines, an offshore transformer platform, sub-sea collection and transmission cables, and Research Mast. There will be a landing cable area and proposed cable at the west of Junk Bay connecting the collection cables from the turbines and the CLP existing grid connection network.

1.7.21 According to the latest information provided by CLP, marine works (including dredging, jetting and suction caisson) for the construction of the wind farm would be required for the period from January 2017 to September 2017 which would overlap with the marine works programme of CBL. Hence, the cumulative water quality impacts during construction phase of CBL have been considered in this EIA (see **Section 8** for further discussion on water quality).

1.7.22 It is anticipated that the distances from the proposed cable landing area and cable route in Junk Bay to the identified noise sensitive receivers (NSRs) and air sensitive receivers (ASRs) of CBL are larger than the 300m and 500m study areas, respectively. Impacts arising from the wind farm construction work to the NSRs and ASRs in the CBL study area are therefore not expected. Hence construction of the wind farm would not have any contribution to the cumulative construction noise and air quality impacts.

Planning review on Development of ex-Cha Kwo Ling Kaolin Mine Site

1.7.23 The planning review on development of ex-Kaolin Mine site was commissioned by the Planning Department in July 2011 and is to be read as an update of the previous feasibility study completed in 2003 by the Civil Engineering Department. It sets out to examine the viability of private residential development at the upper platforms of the development site. The purpose of the study is to devise a development layout plan that is compatible and cognisant with current and proposed development in the area.

1.7.24 The programme of this planning review is not available at the time of preparation of this report, and furthermore, the CKLKMS site would be located outside the 300m and 500m study areas of the CBL project. The CKLKMS project is therefore not included as a concurrent project with CBL.

Yau Tong Bay Development

1.7.25 The proposed Yau Tong Bay (YTB) redevelopment is located in the southern part of East Kowloon on the waterfront between Kwun Tong and Lei Yue Mun and the site is surrounded by Cha Kwo Ling Road and Ko Fai Road. The Eastern Cross Harbour Tunnel is located to the north of the redevelopment site, and to the south of the redevelopment site lays the Yau Tong Industrial Area.

1.7.26 The overall site area on the waterfront is approximately 10 hectares. The low rise structures which were erected on the site in the past, such as shipyards, timber yards and sawmills, etc., were demolished recently for re-development. There is also an existing ice making and cold storage factory operated by Dairy Farm, a salt water pumping station operated by Water Supplies Department, and a site reserved for CEDD's maintenance depot, which is included as part of the redevelopment.

1.7.27 The proposed redevelopment is characterized by an urban development with 14 residential towers and 4 hotels, together with one GI/C block, clubhouses, retails and internal roads. A minimum

15m wide promenade will also be provided along the sea front for recreational use.

1.7.28 The construction works would commence in early 2013 and are to be completed by 2017-2019. It is anticipated that the population in-take year for the proposed redevelopment would begin around year 2017. As the project site is located outside the 300m and 500m study area, cumulative impacts during the construction phase of CBL are not anticipated.

Proposed Residential Site at Kwun Tong

1.7.29 Three pieces of land in Kwun Tong are suggested to be rezoned as residential land by the Planning Department during the Kwun Tong District Council meeting held on 8 January 2013. The three sites are located at Choi Hing Road, Ngau Tau Kok; Pik Wan Road/Ko Chiu Road Junction; and, Lei Yue Mun Path.

1.7.30 All three lands are located outside the 300m and 500m study areas of CBL. The proposed residential site at Kwun Tong is therefore not considered as a concurrent project with CBL.

New Broadcasting House of Radio Television Hong Kong (RTHK)

1.7.31 The existing RTHK's broadcasting facilities and programme production centres came into operation in 1969, 1971 and 1975. Given the age of the facilities and that they were inadequate to meeting RTHK's service needs, a site has been reserved in the sourthern part of TKO Area 86 for the re-provisioning of the Broadcasting House. The site is approximately 31,000m^2.

1.7.32 As the location and the programme of the construction site are still not yet approved, the new broadcasting house of RTHK is not considered as a concurrent project with CBL.

The Beaumont Development

1.7.33 The Beaumont is a seven tower residential development currently under construction at Area 85, Tseung Kwan O. As the scheduled completion date is 31 December 2013, cumulative air and noise impacts during the construction phase of CBL are not anticipated. The Beaumont Development is therefore not considered as a concurrent project with CBL.

1.8 Concurrent Projects – Operational Phase

During the operational phase of the CBL, it is anticipated that potential cumulative noise and air quality impacts could arise from the TKO Area 86 Development. Moreover, projects that could affect the hydrodynamic regime during the operational phase of CBL include TKO-LT Tunnel and Cruise Terminal.

1.9 Summary

1.9.1 **Table 1.1** summarises the potential concurrent projects that would contribute to the cumulative environmental impacts during construction and/or operational phase.

Table 1.1 Existing and planned concurrent projects

Project	Construction Programme	Possible Cumulative Impacts	
		Construction Phase	Operational Phase
Tseung Kwan O-Lam Tin Tunnel (TKO-LT Tunnel)	Commence in early 2016, for completion in late 2020	Water quality Marine ecology	Hydrodynamic and water quality
Shatin Central Link (SCL)	Commenced in 2012 for completion in 2020	Water quality	Nil
Cruise Terminal	Commenced in late 2008 for completion in 2014	Water quality	Hydrodynamic and water quality
Trunk Road T2	To tie in with TKO LT Tunnel, between 2016 and 2020	Water quality	Nil
Tseung Kwan O Area 86 Development – 33ha	Commenced in early 2005 for completion in 2020	Airborne noise Fugitive dust	Nil
Submarine Gas Pipelines	Commenced in 2012 for completion in 2014	Nil	Nil
Hong Kong Offshore Wind Farm in Southeastern Waters	Commence in early 2017 for completion in late 2017	Water quality	See Note [1]
Planning review on Development of ex-Cha Kwo Ling Kaolin Mine Site	Programme is not available	Nil	Nil

Project	Construction Programme	Possible Cumulative Impacts	
		Construction Phase	Operational Phase
Yau Tong Bay Redevelopment	Commence in 2013 for completion in 2017-2019	Nil	Nil
Proposed Residential Site at Kwun Tong	Programme is not available	Nil	Nil

Note:

[1] The wind farm location is outside the boundary of the water quality model. Therefore the change of hydrodynamic regime contributed by the wind farm is not considered in Section 8, Water Quality Impact Assessment.

1.10 Structure of EIA Report

1.10.1 The structure of this EIA report is outlined below for ease of reference.

Section	Title	Aims
1	Introduction	Introduces the background information and the layout of the EIA Report
2	Study Scope	Outlines the objectives and scope for various environmental aspects
3	Alternative Options	Summarises the various options considered and the main reasons for adopting the scheme recommended
4	Construction Descriptions	Describes relevant main construction/engineering aspects for the recommended scheme
5	Air Quality Impact Assessment	Presents the legislation, methodology, assessment and recommendations for air quality impacts
6	Noise Impact Assessment	Presents the legislation, methodology, assessment and recommendations for noise impacts
7	Sediment Quality	Presents the legislation, methodology, assessment and recommendations for sediment
8	Water Quality Impact Assessment	Presents the legislation, methodology, assessment and recommendations for water quality impacts
9	Waste Management Implications	Presents the legislation, methodology, assessment and recommendations for waste management
10	Marine Ecological Impact Assessment	Presents the legislation, methodology, assessment and recommendations for marine ecological impacts
11	Fisheries Impact Assessment	Presents the legislation, methodology, assessment and recommendations for fisheries impacts

Section	Title	Aims
12	Cultural Heritage Impact Assessment	Presents the legislation, methodology, assessment and recommendations for cultural heritage impacts
13	Landscape and Visual Impact Assessment	Presents the legislation, methodology, assessment and recommendations for landscape and visual impacts
14	Landfill Gas Hazard	Presents the legislation, methodology, assessment and recommendations for landfill gas hazard
15	EM&A Requirements	Presents the EM&A requirements
16	Summary of Environmental Outcomes	Presents a summary of the key environmental outcomes arising from the EIA study.
17	Conclusion	Summarises the findings and concludes the overall acceptability of the project.

2 Scope of Environmental Impact Assessment Study

2.1 Cross Bay Link (CBL)

2.1.1 According to EIA Study Brief (ESB-196/2008), the EIA for CBL shall address the key issues described below, together with any other key issues identified during the course of the EIA study:

(1) the alternative location(s) and layout(s) of the Project taking into account the latest development of the TKO-LT Tunnel and other interfacing projects on or near Tseung Kwan O, in particular the Tseung Kwan O Future Development, to determine the alignment of the Project and the numbers, size and locations of marine bore piles and pile caps so as to minimise the potential environmental impacts, in particular hydrodynamic and water quality impacts on sensitive areas and uses in the related water control zones;

(2) the potential air quality impacts from the construction and operation of the Project to sensitive receivers near the Project, taking into account the cumulative impact from the construction and operation of existing and planned/committed projects in the vicinity of the Project, in particular the TKO-LT Tunnel and Tseung Kwan O Future Development and major existing and planned/committed air pollutant emission sources within the study area;

(3) the potential noise impacts from the construction and operation of the Project to sensitive receivers near the Project, taking into account the cumulative impact from the construction and operation of existing and planned/committed projects in the vicinity of the Project, in particular the proposed TKO-LT Tunnel and Tseung Kwan O Future Development and the existing and planned/committed sources of pollution in the assessment area of the Project;

(4) the potential water quality impact caused by dredging, piling, fill extraction, filling and any other marine works activities from construction, in particular the potential release of toxic contaminants, and as a result of changes to the flow regime, flushing capacity, and water quality in Hong Kong waters from operation of the Project on the relevant water system(s);

(5) the potential water quality impact caused by the disposal of the

storm-water runoff during the operation of the Project;

(6) confirmation on minimal or no potential losses or damage to flora, fauna and natural habitats and, if otherwise, the potential impact to the ecological sensitive areas, including the following and any other sensitive areas that may be identified during the course of the EIA study shall be identified and addressed:

- colonies of corals located along the western and eastern coast of Junk Bay;
- marine benthic communities; and
- intertidal habitat within the study area

(7) the potential aquatic ecological impacts arising from the construction and operation of the Project, including loss of habitats and disturbance to wildlife in particular the Philippine Neon Goby (Stiphodon atropurpureum) and amphioxus (Branchiostoma belcheri);

(8) the potential fisheries impacts on capture and culture fisheries during the construction and operation of the Project, and including pollution, if any, caused by run-off, or other impacts arising from the Project;

(9) the potential impacts on sites of cultural heritage including marine archaeological deposit in the seabed of the project area likely to be affected from construction of the Project;

(10) the potential landscape and visual impacts from the Project including reclamation, proposed connection road(s) or road bridge(s) and associated works on existing and planned sensitive receivers in particular on residents of Tseung Kwan O during the construction and operation of the Project;

(11) the potential impacts of various types of wastes to be generated from the construction and operation of the Project, in particular the dredged sediment during reclamation and the spoil arising from the construction;

(12) the potential cumulative environmental impacts of the Project, through interaction or in combination with other existing, committed and planned developments in the vicinity of the Project, and that those impacts may have a bearing on the environmental acceptability of the Project. Consideration shall be given to account for impacts from likely concurrent projects, in particular TKO-LT Tunnel and Tseung Kwan O Future Development.

3 Alternative Options

3.1 General

3.1.1 The routing of CBL is proposed as an east-west connection between Wan Po Road and TKO-LT Tunnel, across the south of the TKO Town Centre.

3.1.2 To the east, the connection with Wan Po Road can be made at locations immediately north and south of Area 86, with the CBL being routed along the northern or southern edges of Area 86. There is an opportunity to route CBL even further south across Junk Bay, to connect to Wan Po Road east of Fat Tong Chau (i.e. to the south of the TKO Industrial Estate). This would provide greater separation from the Town Centre South and the proposed waterfront development, but the feasibility of this route would be dependent on the development of Area 137.

3.1.3 To the west, the CBL route is dictated by the connection with the TKO-LT Tunnel and Road P2. According to the Executive Summary for Options Evaluation of the “Tseung Kwan O – Lam Tin Tunnel and Associated Works – Investigation” (2010), the preferred tunnel option would follow a straight alignment beneath Chiu Keng Wan Shan, connecting Road P2 and CBL in the east end. The preferred TKO-LT Tunnel/CBL/Road P2 interchange location arising from the investigation under the TKO-LT Tunnel alternative alignments should be taken as given for the development of the CBL route alignment (**Drawing no. 209506/EIA/AO/001**).

3.1.4 Alternative feasible CBL alignments have been investigated. Four alternative route alignment options with different structural form have been identified and appraised in terms of traffic performance, land use impact and potential environmental impacts. Detailed discussion of these is provided in **Section 3.2**.

3.1.5 The feasible structural forms of the preferred alignment options were developed into two alignment schemes: Scheme A (Bridge Arrangement) and Scheme B (Tunnel Arrangement), and subjected to preliminary appraisal to confirm their feasibility. The appraisal is discussed in **Section 3.2**.

3.1.6 A brief discussion on the selection of the preferred bridge design option is also given in **Section 3.3.**

3.2 Cross Bay Link Alignment Options Considered

Preliminary assessment of alternative scheme

3.2.1 The routing of CBL is proposed as an east-west connection between Wan Po Road and TKO-LT Tunnel across and to the south of the Town Centre South and its possible extension area. Four route alignments for the CBL were identified as follows (see **Drawing no. 209506/EIA/AO/001)**:

- Route Alignment Option 1 - CBL at Fat Tong Chau
- Route Alignment Option 2 - CBL to south of Area 86
- Route Alignment Option 3 - CBL to north of Area 86
- Route Alignment Option 4 - no CBL scenario

3.2.2 According to the "Further Development of Tseung Kwan O Feasibility Study – Final Topical Study Report: Cross Bay Link" (2005), the four route alignments options were appraised broadly in terms of traffic performance, compatibility with land use planning intentions, and potential environmental impacts. The outcomes of the evaluation are summarised in **Table 3.1**.

Table 3.1 Summary of alignment options evaluation

Route Alignment Option	Traffic Performance	Compatibility with Land use Planning	Potential Environmental Impact
Option 1	• Longer travelling distance and lesser degree of utilization	• Compatible with planning for Town Centre South but not for South-east TKO	• High value corals at Fat Tong Chau • More ecological impacts
Option 2	• Meet requirement of traffic function	• Compatible with planning for Town Centre South	• No insurmountable environmental impact
Option 3	• Increase in traffic on Wan Po Road Junction capacity problem with constraints for improvement	• Some compromise in land use planning • Tunnel form would not meet Transport Planning and Design Manual standard	• Environmental impact not considered as the option was dropped due to not meeting the planning intention

Route Alignment Option	**Traffic Performance**	**Compatibility with Land use Planning**	**Potential Environmental Impact**
Option 4	• Heavy traffic congestion through Town Centre • Overloaded junctions and creating capacity problems	• Compatible with land use planning	• More air and noise impacts with high traffic flows • Environmentally not desirable

3.2.3 Option 4 (no CBL scenario) was considered undesirable in respect of traffic and environmental impacts. Accordingly, there was no further development of this route alignment option, and in view of the poor performance of this option in the evaluation, options that cross Junk Bay would therefore result in less environmental impact and less traffic impact in TKO Town Centre South and at the existing TKO tunnel.

3.2.4 According to the evaluation, Route Alignment Option 2 meets the requirement of traffic functionality. Both the bridge form (Option 2a) and the tunnel form (Option 2b) are compatible with the land use planning schemes for the Town Centre South. Also, no insurmountable environmental impacts were anticipated with these options. Route Alignment Option 2, including bridge form (Option 2a) and tunnel form (Option 2b), were therefore selected as being suitable to take forward for further preliminary appraisal, leading to the selection of a recommended CBL scheme.

Preliminary assessment of the structural form

3.2.5 Options 2a (referred to as Scheme A (Bridge Arrangement)) and 2b (Scheme B (Tunnel Arrangement)) were subjected to further development as the alternative schemes for the CBL.

3.2.6 According to Further Development of Tseung Kwan O Feasibility Study – Final Topical Study Report: Cross Bay Link (2005), these two schemes were appraised as summarised in **Table 3.2**.

Table 3. 2 Summary of the preliminary assessment of the two alternative schemes of CBL

Performance Criteria	Bridge Arrangement	Tunnel Arrangement
Engineering		
Dredging and Reclamation	Less	More
Drainage, Sewerage, Utilities and Facilities	Same	Same
Project Interfaces	Less	More
Programming Implications	Shorter	Longer
Highway Traffic		
Layout and Alignment	Same	Same
Traffic Impact and Performance	Same	Same
DGV Implications	No	Yes
Environmental		
Noise Impacts	More	Less
Air Quality Impacts	Less	More
Water Quality Impacts	Less	More
Waste Management	Less	More
Marine Ecology	Less	More
Visual	More	Less
Cost		
Construction Cost	Less	More
Recurrent Cost	Less	More

3.2.7 The tunnel scheme was found to be less favourable from an engineering perspective as it requires dredging and reclamation (whereas the bridge scheme does not). As there would be potentially more impact on drainage due to extension of outfalls through the reclamation, more interface issues would arise. Furthermore, it would take longer than the bridge scheme to construct.

3.2.8 In highway and traffic terms, the two schemes are similar but the bridge scheme would perform slightly better as dangerous goods vehicles (DGVs) could also use CBL.

3.2.9 The tunnel scheme would be preferable in terms of noise and visual impacts. In terms of air quality, water quality, marine ecology, landscape and waste management, the bridge scheme would perform better. The bridge scheme, which is in line with the TKO urban design framework, is preferred from the urban design point of view. The development of CBL will be in the form of a landmark feature bridge, which is set as an identity in the district. In overall environmental terms it was considered that the bridge scheme would perform better.

3.2.10 The tunnel scheme would be more costly to construct and operate and would therefore be less favourable economically.

3.2.11 In overall terms, therefore, Scheme A (Bridge Arrangement) would be preferred. Scheme A would be compatible with the land use planning for TKO, meet the necessary functional requirements for this road link and would also perform best in terms of technical criteria including environmental performance. The CBL Scheme A (Bridge Arrangement) was therefore recommended as the preferred CBL scheme (see **Drawing no. 209506/EIA/AO/002).**

3.3 Bridge Design Options

3.3.1 From an evaluation of a long list of bridge design options, six were identified to be technically feasible for the project and shortlisted by the Final Design Options Review Report (2010). The six design options were:

- Design Option 1: The Bow
- Design Option 2: Link with Wings
- Design Option 3: The Sail
- Design Option 4: Alliance Bridge
- Design Option 5: Eternity Arch
- Design Option 6: The Gateway

3.3.2 Consultation with relevant government departments and the Sai Kung District Council in November 2009 confirmed that the six design options would be taken forward for public consultation.

3.3.3 According to the public consultation and feedback from government departments and the Sai Kung District Council, Design Option 5, the

Eternity Arch, gained the most support and was therefore subsequently taken forward as the preferred option for CBL.

3.3.4 The reasons for selecting the Eternity Arch were as follows:

- It received the majority of public support, with more than 35% of the public votes and more than 40% of the public selected it as one of the preferred options.
- It received the most support from the Sai Kung District Council, gaining significantly more marks than any of the other options.
- It has excellent aesthetics appropriate to the site and is a relatively unique structure, particularly in the context of Hong Kong where to date no major arch bridge has been built.
- An arch bridge would offer the best opportunity to create sympathy of form between the Northern Bridge and the Southern Bridge.
- Although it is not the least expensive option, the capital cost would be within the project budget.
- The inspection and maintenance challenges could be mitigated by planning and provision of appropriate facilities and would not affect the feasibility of this option.
- There would be no particular issues with respect to security, safety and emergency vehicle access. In terms of marine navigation safety, it is one of the options which would benefit from a large single navigation span.
- None of the options which received a lesser rating in Public Perception were found to be consistently better in all of the other criteria.
- From the visual point of view, all the design options (1-6) will form a prominent feature. However, as option 5 received the highest score from public votes, the Eternity Arch concept is selected for preferred CBL design option.
- The concept for the Eternity Arch is to create an object with a strong symbolic identity. The symbol of infinity is a well known expression of eternity or never-ending, like the proposed cycle track around Junk Bay, but also of the imagination of the vision for TKO New Town. The cables attaching the deck to the arch will be invisible to distant observers, therefore the arch leaps across the channel with an energetic movement frozen in time, which reinforces the concept of eternity. Introducing the concept of eternity to a bridge structure in this way will stimulate the people visiting Junk Bay to ponder, much like the great philosophers and mathematicians who over the centuries have contemplated the true meaning of eternity. The continuous curved shape of the arch fits in well with the organic shapes of

the surrounding hills. The arch is not a high arch yet it still gives the sense of unity and harmony as though it were an extension of the hillside. V-shaped piers are adopted in the approaches to the navigation bridge in sympathy with the base of the arch to create a continuous aesthetic theme for the entire crossing.

3.4 Consideration of Alternative Construction Methods and Sequences of Works

3.4.1 The main span of CBL would be composed of two types of bridge, each requiring a different construction method. The superstructure of the approach viaducts would be of pre-stressed concrete construction, and the navigation spans and arch would be of steel construction. Alternative construction methods would be possible for each type and the positive and negative environmental factors of these are discussed below.

Concrete Approach Viaducts

In-situ Construction

3.4.2 Under this construction method, temporary supports would be erected in the sea to support the formwork for the box girders. Reinforcement fixing and concreting would be carried out on-site. The temporary supports would need to remain in place for a period of time to allow solidification of concrete and for pre-stressing operations. With fully in-situ construction methods, the activities would be mainly on-site and within the marine environment. The impacts of such methods could likely include:

- Construction noise to nearby sensitive receivers due to operation of PME on-site;
- Exhaust fumes on nearby sensitive receivers from construction plant;
- Increase in risk of oil spillage or other accidental discharge to the sea;
- Disturbance of the sea bed from construction of the temporary support leading to water quality impact; and
- Increase in the quantity of dredged material due to the construction of temporary support.

Off-Site Precast Segmental Construction

3.4.3 This form of construction would reduce the amount of on-site construction activities by pre-casting fabrication of the concrete deck segments off-site. The completed segments would be brought to site by barge and erected using the balanced cantilever method or a span-by-span approach with an overhead gantry.

The benefits of this method would include:

- Reduction of noise levels and activity duration;
- Reduction of exhaust fume on nearby sensitive receivers from construction plant;
- Reduction in environmental risk such as oil spillage or other accidental discharge; and
- No disturbance of seabed as no temporary structures would be required.

Steel Main Bridge

3.4.4 The steel bridge part would be divided into several manageable pieces that could be made at a steel fabrication yard. Once the segments have been made, they would be transported for installation on-site. Two options for erecting the segments, in-situ or off-site, have been considered.

In-situ Erection

3.4.5 For in-situ erection, it is assumed that the deck and arch segments would be fabricated off-site and brought to the site by barge. A tied arch bridge would need to be fully erected before it could support its own weight. Thus, temporary falsework would be required to support the bridge. This would be achieved with temporary supports on the sea bed. This technique would have similar environmental impact as the in-situ concrete approach works.

Off-site Erection

3.4.6 One of the major advantages of the tied arch form is that it is a self-contained structural form. This would allow the bridge to be fully fabricated and assembled off-site and then transported into position by barge.

3.4.7 The main navigation span and arch would be positioned onto the piers by lowering the transporting barge over the supports. The side spans could be erected using strand jacks to lift the side spans into position.

3.4.8 The environmental benefits of this form of construction would be the same as those for precast segmental construction. However, the benefits would be greater as most construction activities could be undertaken away from the bridge site in the controlled environment of the fabrication yard and erection site.

3.5 Preferred Construction Methods

3.5.1 Based on the pros and cons of the different construction methods discussed above, off-site precast segmental construction and off-site fabrication will be adopted for construction of CBL.

3.5.2 Minimisation of environmental impact is one of the key reasons for selecting this method of construction. Off-site construction offers many environmental benefits. In general, by moving construction away from the site, potential nuisance to local residents and the impact on the local environment would be reduced. However, the purpose of the off-site fabrication is not to transfer the problems elsewhere. The concrete pre-casting and steel fabrication yards in China are purpose-built facilities with production line practices implemented, hence, the impacts would be better managed and controlled.

4 Construction Descriptions

4.1 General

4.1.1 CBL is targeted to be commissioned by 2020. Hence, the construction of CBL would start end of 2016 for completion in 2020, involving a construction duration of 4 years.

4.1.2 The CBL project is composed of an approximately 1.8km long dual-lane carriage way mainly on viaduct, an outwardly leaning arch bridge, approach structures, an adjacent road (Road D9) and a cycle ramp. The proposed methodology for the construction of these is described below.

4.2 Construction Methodology for Cross Bay Link

4.2.1 The major construction works would comprise the following activities:

- Foundations – installation of piles by marine piling rigs, erection of cofferdam, building of pile caps and building of piers;
- Substructure and superstructure – erection of concrete deck segments of the approach and installation of main bridge and side spans; and
- Construction of the cycle track ramp.

4.2.2 No dredging works are envisaged for the construction of CBL.

Foundations

4.2.3 Piling and pile cap construction would occur in three different sections for the Main Bridge, Eastern Approach and Western Approach.

4.2.4 Marine drilling rigs would be used for the installation of piles. One drilling rig to be used for the Eastern Approach foundations and one drilling rig to be used for the Western Approach as well as the Main Bridge foundations. There would be two marine piling fronts in total and the works undertaken in the following sequence.

4.2.5 A silt curtain would be placed around each foundation construction location to form the first line of defence against dispersion of sediment plume during pile, pile cap and pier construction. Steel sheet piling would be undertaken within the silt curtain to form a cofferdam and a second line of defence against dispersion of sediment plume during excavation of piles and construction of the pile cap.

4.2.6 Cylindrical steel casings (of the pile diameter) would be installed at each pile location within the steel sheet pile cofferdam. Excavation from within the cylindrical steel casing would be undertaken from the seabed level down to the pile founding level. The excavated materials would be transported from cylindrical steel casing by watertight closed-grab to a construction barge.

4.2.7 Following the excavation stage, a steel reinforcement cage would be lowered to the excavated void within the cylindrical steel casing. Concrete would then be poured by skipper to fill up the excavated void. The cylindrical steel casing would then be slowly retrieved by vertical pull during the concreting work.

4.2.8 For construction of the pile cap, temporary false work and formwork would be erected within the steel sheet pile cofferdam, the reinforcement placed into position and concrete would be placed to complete the pile cap.

4.2.9 This construction method would avoid the need to dredge sediment because the pile cap would be located above the sea bed. Sediment excavated from within the cylindrical steel pile casings would be placed in a barge and disposed in accordance with regulations.

4.2.10 Derrick barges would be used to transport steel pile casings to foundation locations and a crane would lift and place them into position. The pile casing would be installed using a hammer rig and the concrete would be supplied by another barge containing the concrete lorry mixer.

Substructure

4.2.11 Barges with cranes would be used to transport the formwork and materials to the pier locations. The cofferdam used for piling would remain in place while the piers would be cast in-situ.

4.2.12 After completion of the substructure, the steel sheet piles of the cofferdam would be retrieved from within the silt curtain by slow vertical pull. The silt curtain would then be removed.

Approach superstructure

4.2.13 The concrete deck segments for the Eastern and Western Approach of the bridge are proposed to be fabricated in Mainland China.

4.2.14 The deck segments would then be transported from the fabrication yard to site by barge. Segment erection would be carried out by floating cranes using balanced cantilever method. Adjacent segments would be connected using in-situ stitching method after completion of the segment erection. For the Eastern Approach, when the depth of water would be too shallow for a floating crane to operate, lifting frames would be used.

Main bridge superstructure

4.2.15 A total of eight steel deck segments of 50m length and two arch segments of 220m (440m in total) have been proposed and would be fabricated off-site in Mainland China.

4.2.16 The arch and main span deck segments, as well as the side span segments, would be brought to an assembly site in Mainland China and assembled before delivery to site in Hong Kong.

4.2.17 Cranes would be used to lift the main bridge onto a large barge at the site before being floated into position. Strand jacks attached to four corners of the bridge would lift and position the main bridge. In-situ welding would be carried out to realize the complete structure.

Cycle Track Ramp

4.2.18 The foundations of the cycle track ramp would be built on land to a suitable depth. The cycle track ramping from the ground level (~5m) up to the deck level (~10m) of Road D9 would be built on columns of varying heights.

4.3 Construction Methodology for Road D9

4.3.1 Earthworks for the modification of the seawall would include excavation and backfilling of general fill material, quarry spall and rubble. In order to avoid excessive water pressure on the existing seawall during excavation, sheet piles would be installed and the water would be pumped out prior to the earthworks.

4.3.2 Other major construction activities would include sea wall strengthening where the existing sea wall would be extended and strengthened, ground improvement works by means of compaction grouting, piling for noise barrier using pre-bored H-piles and noise barrier erection works.

4.4 Tentative Programme

4.4.1 The tentative construction programme of CBL is provided in **Appendix 4.1**

4.5 Plant Inventory

4.5.1 The envisaged construction plant inventory is provided in **Appendix 6.3.**

5 Air Quality Impact

5.1 Legislation and Standards

5.1.1 The air quality impact assessment criteria shall make reference to the Hong Kong Planning Standards and Guidelines (HKPSG), the Air Pollution Control Ordinance (APCO) (Cap.311), and Annex 4 of the Technical Memorandum on Environmental Impact Assessment Process (TM-EIAO).

5.1.2 The APCO (Cap.311) provides power for controlling air pollutants from a variety of stationary and mobile sources and encompasses a number of Air Quality Objectives (AQOs). In addition to the APCO, the Government's overall policy objectives for air pollution are also laid down in Chapter 9 of the Hong Kong Planning Standards and Guidelines (HKPSG) as follows:

- Limit the contamination of the air in Hong Kong, through land use planning and through the enforcement of the Air Pollution Control Ordinance, to safeguard the health and well-being of the community; and
- Ensure that the Air Quality Objectives for 7 common air pollutants are met as soon as possible.

5.1.3 Currently, the AQOs stipulate concentrations for a range of pollutants namely sulphur dioxide (SO_2), total suspended particulates (TSP), respirable suspended particulates (RSP), nitrogen dioxide (NO_2), carbon monoxide (CO), photochemical oxidants, and lead (Pb). The AQOs are listed in **Table 5.1**.

Table 5.1 Hong Kong Air Quality Objectives

Pollutant	Concentration in micrograms per cubic metre [1]				
	1 Hour [2]	8 Hours [3]	24 Hours [3]	3 Months [4]	1 Year [4]
Sulphur Dioxide	800		350		80
Total Suspended Particulates	500 [7]		260		80
Respirable Suspended Particulates [5]			180		55
Carbon Monoxide	30,000	10,000			
Nitrogen Dioxide	300		150		80

Pollutant	Concentration in micrograms per cubic metre [1]				
	1 Hour [2]	8 Hours [3]	24 Hours [3]	3 Months [4]	1 Year [4]
Photochemical Oxidants (as ozone) [6]	240				
Lead				1.5	

Notes:
[1] Measured at 298K and 101.325 kPa.
[2] Not to be exceeded more than three times per year.
[3] Not to be exceeded more than once per year.
[4] Arithmetic mean.
[5] Respirable suspended particulates means suspended particulates in air with a nominal aerodynamic diameter of 10 micrometres or smaller.
[6] Photochemical oxidants are determined by measurement of ozone only.
[7] Not an AQO but is a criterion for evaluating air quality impacts as stated in Annex 4 of TM-EIAO.

5.1.4 The Air Pollution Control (Construction Dust) Regulation specifies processes that require special dust control. The Contractors are required to inform the EPD and adopt proper dust suppression measures while carrying out "Notifiable Works" (which requires prior notification by the regulation) and "Regulatory Works" to meet the requirements as defined under the regulation.

5.2 Description of Existing Environment

5.2.1 Historical air quality monitoring data from the Air Quality Monitoring Station (AQMS) in Kwun Tong operated by EPD has been examined. The latest 5 published years of air quality monitoring data, i.e. 2007 to 2011 are tabulated in **Table 5.2** below.

Table 5.2 Air Quality Monitoring Data at Kwun Tong AQMS (2007-2011)

Pollutant	Annual Concentration (μg/m^3)					
	2007	2008	2009	2010	2011	5-year Mean
TSP	**82**	72	70	67	74	73
RSP	53	47	48	47	49	49
NO_2	63	59	58	59	63	60

Notes: Monitoring results exceeded AQO are shown as bolded characters.

5.2.2 It is observed from the above table that the annual TSP and RSP concentrations have shown overall improving trend from 2007 to 2011, while the ranges of annual TSP and RSP concentrations were 67 – 82μg/m^3 and 47 - 53μg/m^3 respectively. It should be noted that the annual TSP concentrations in Year 2007 had exceeded the criterion of 80μg/m^3.

5.2.3 For NO_2 concentration, monitoring data shows that there is no obvious trend of improvement or deterioration among the last 5 years, and the concentration is well within the relevant criterion.

5.3 Air Sensitive Receivers & Pollution Sources

5.3.1 Study Area

5.3.1.1 With reference to Section 3.4.1 of EIA Study Brief No. ESB-196/2008, the study area for air quality impact assessment should generally be defined by a distance of 500m from the boundary of the project site and shall be extended to include major existing and planned/committed air pollutant emission sources. The study shall also assess the air quality impacts on the air sensitive areas and other sensitive receivers, which may be potentially affected by the Project. **Drawing no. 209506/EIA/AIR/001** illustrates the extent of the study area.

5.3.2 Air Sensitive Receivers

5.3.2.1 According to Annex 12 of the EIAO-TM, Air Sensitive Receivers (ASRs) include domestic premises, hotel, hostel, hospital, clinic, nursery, temporary housing accommodation, school, educational institution, office, factory, shop, shopping centre, place of public worship, library, court of law, sports stadium or performing arts centre. Any other premises or places with which, in terms of duration or number of people affected, have a similar sensitivity to the air pollutants as the aforelisted premises and places would also be considered as a sensitive receiver. Representative ASRs within a distance of 500m from the alignment, temporary work areas, and associated barging facilities have been identified.

5.3.2.2 These ASRs include both the existing and planned developments. Existing ASRs are identified by means of reviewing topographic maps, aerial photos, land status plans, supplemented by site inspections. They mainly include developed high rise residential buildings, educational institution of a few storeys high and hotels etc..

5.3.2.3 Planned/committed ASRs are identified by making reference to Tseung Kwan O Outline Zoning Plans (OZP) S/TKO/20, Outline Development Plans, Layout Plans and other published plans in the vicinity of the alignment.

5.3.2.4 The locations of the representative ASRs for air quality assessment are illustrated in **Drawing no. 209506/EIA/AIR/001**, and are summarised in **Table 5.3** below.

Table 5.3 Representative ASRs

ASR ID	Description	Land use [1]	No. of Storey	Affected during Construction Phase	Affected during Operational Phase	Separation distance (m)
Existing ASRs						
A1	Lohas Park Phase II – Le Prestige Tower 1	R	49	✓	✓	60
A2	Lohas Park Phase II – Le Prestige Tower 3	R	54	✓	✓	100
A6	Lohas Park Phase I – The Capitol Tower 1	R	54	✓	✓	330
A7	Chiaphua-Shinko Centre	I	2	✓	✓	410
A8	Metrix Manufacturing (HK) Ltd	I	3	✓	✓	90
A9	HSBC Office	C	4	✓	✓	320
A10	Hong Kong Oxygen Acetylene Co. Ltd	I	4	✓	✓	450
Planned ASRs						
A3	Lohas Park (Planned Development in Area 86, Package 3; Stage 2)	R	55	×	✓	50
A4	Lohas Park (Planned Development in Area 86, Package 3; Stage 2)	R	57	×	✓	250
A5	Lohas Park (Planned Development in Area 86, Package 3; Stage 2)	R	53	×	✓	380
A11	Lohas Park Stage 1 (Planned Development in Area 86, Package 6)	R	46	✓	✓	20
A12	Lohas Park Stage 1 (Planned Development in Area 86, Package 6)	R	55	✓	✓	70
A13	Lohas Park (Planned Development in Area 86, Package 5; Stage 1)	R	55	✓	✓	10
A14	Lohas Park (Planned Development in Area 86, Package 5; Stage 1)	R	57	✓	✓	50
A15	Lohas Park Stage 3 (Planned Development in Area 86,Package 11)	R	56	✓	✓	20
A16	Lohas Park Stage 3 (Planned Development in Area 86,Package 11)	R	52	✓	✓	10

ASR ID	Description	Land use [1]	No. of Storey	Affected during Construction Phase	Affected during Operational Phase	Separation distance (m)
A17	Lohas Park Stage 3 (Planned Development in Area 86,Package 11)	R	49	✓	✓	20
A18	Lohas Park Stage 3 (Planned Development in Area 86,Package 10)	R	55	✓	✓	30
A19	Tung Wah Group of Hospitals Aided Primary School & Secondary School	E	-	✓	✓	40
A20	Planned Primary and Secondary Schools	E	-	✓	✓	160
A21	The Beaumount (Under Construction)	R	-	✓	✓	540
A22	RTHK Broadcasting House (Planned)	GIC	-	✓	✓	70
A23	Data Centre (Planned)	C	-	✓	✓	150

Notes:
[1] R – Residential ; E – Educational ; I – Industrial ; C – Commercial

5.3.3 Pollution Sources

Construction Phase

5.3.3.1 Most sections of the CBL are located above Junk Bay and adverse fugitive dust impact from the marine-based construction is considered unlikely. However, the construction of the at-grade section of Road D9 would inevitably generate fugitive dust with potential impacts on neighbouring sensitive receivers from various construction activities, including excavation, backfilling, transportation of materials, and wind erosion. Apart from these activities, a temporary stockpiling / works area is proposed on an area earmarked for GIC on the south side of Road D9, near the junction with Wan Po Road. Stockpiling area is also proposed in the public fill in TKO Area 137 for the excavated material from the construction of Road D9. However, in consideration of its existing condition and daily load/unloading activities in the area, potential dust emission from the operation of the proposed stockpile in TKO Area 137 is considered insignificant.

5.3.3.2 Barging facilities would also be operated near the proposed site compound during the construction stage, however, only precast concrete and other non-dusty construction material would be handled at the barging point, no associated dust impact is anticipated.

Operational Phase

5.3.3.3 Upon completion of the Project, additional traffic would likely be generated and carried by the CBL. The associated air quality impact from vehicular emission via the CBL and induced traffic would be unavoidable.

5.4 Potential Concurrent Projects / Sources

5.4.1 General

5.4.1.1 The tentative commencement year for the construction of CBL is 2017, and would take approximately 4 years for completion. All concurrent projects, which may have cumulative environmental impacts during the construction period, have been identified and summarised in **Table 5.4** below.

Table 5.4 Key Concurrent Projects for Air Quality Assessment

Key Concurrent Projects	Tentative Construction Programme
Tseung Kwan O-Lam Tin Tunnel and Associated Works	End 2020
Tseung Kwan O Area 86 Development	2005-2020 (under construction)
Hong Kong Offshore Wind Farm in Sourtheastern Waters	2017

5.4.2 TKO-LT Tunnel

5.4.2.1 With reference to the Project Profile and the EIA Study Brief (ESB-195/2008) on TKO-LT Tunnel, the project is to construct a dual two-lane highway connecting TKO at Po Yap Road in the east with Trunk Road T2 in Kai Tak Development in the west and Lei Yue Mun Road Underpass. The project involves a 4.8km long highway with about 3km of the highway in tunnel. The TKO-LT Tunnel will connect with CBL to form a new external road link to meet the anticipated traffic flow associated with the further population intake and development in TKO New Town. The construction sites associated with TKO-LT Tunnel are located more than 1000m away from the existing receiver in TKO Area 86, hence cumulative air quality impact during construction stage is not anticipated.

5.4.2.2 During operational phase, vehicular emission due to the induced traffic, road network, ventilation building and tunnel portals associated with TKO-LT Tunnel would likely have cumulative air quality impact on the identified ASRs. Latest information is therefore obtained from the project proponent and is included in the operational air quality assessment.

5.4.3 TKO Area 86 Development

5.4.3.1 Area 86 is under construction. Potential emission sources include site excavation, trucks movement and wind erosion. The latest development schedule from MTRC has been obtained and the associated cumulative impact included in the construction dust assessment.

5.4.3.2 Vehicular emission due to the induced traffic from the TKO Area 86 Development would also have cumulative air quality impact on nearby ASRs. As such, induced traffic has been considered in the operational air quality assessment.

5.4.4 Hong Kong Offshore Wind Farm in Southeastern Waters

5.4.4.1 With reference to the approved EIA Study "*Hong Kong Offshore Wind Farm in Southeastern Waters*" (AEIAR-140/2009), the project is to construct and operate a wind farm in the southeastern waters of Hong Kong. The project includes installation of up to 67 wind turbines, an offshore transformer platform, sub-sea collection and transmission cables, and Research Mast. There will be a landing cable area and proposed cable at the west of Junk Bay connecting the collection cables from the turbines and the CLP existing grid connection network. According to the latest information provided by CLP, the tentative construction programme indicates that the construction of the offshore wind farm project may overlap with the CCL construction programme during 2017. However, based on the ASRs identified above, it is anticipated that the distances from the proposed cable landing area and cable route in Junk Bay, to the identified ASRs for CBL project, are greater than 500m. Impact arising from the construction work for landing cable area and laying of cable route in Junk Bay to the ASRs for CBL is not expected. As such, the cumulative air impact during construction is unlikely and therefore is not included in the assessment. In addition, the operation of the offshore wind farm would unlikely to generate air emission. Hence, cumulative air quality impact during operational phase is not anticipated.

5.4.5 Other Concurrent Sources

5.4.5.1 Other than the emission sources associated with the abovementioned planned/ committed concurrent projects, existing industrial and marine emission sources have also been identified in the vicinity of the Tseung Kwan O Industrial Estate (TKOIE), which is within 500m study area. Cumulative air quality impacts from these concurrent sources are anticipated during the operational phase of the Project. Detailed discussions are given in **Section 5.6**.

5.5 Construction Dust Assessment

5.5.1 Identification of Pollution Sources and Representative Pollutants

5.5.1.1 A review on the construction methodology has been conducted. Construction of the project would inevitably generate fugitive dust with potential impacts on neighbouring existing sensitive receivers. In general, construction dust, as the representative pollutants, will be potentially generated mainly from the land-based at-grade construction works including the following activities. According to HKAQO, the 1-hour, 24-hour and annual concentration would need to be considered.

- Soil excavation;
- Backfilling;
- Stockpiling of dusty material;
- Transportation of the excavated materials; and
- Wind erosion of all open sites.

5.5.1.2 According to Section 13.2.4.3 of USEPA AP-42, most of the particles in fugitive dust have an aerodynamic diameter of <30 µm. Hence, it is appropriate to adopt Total Suspended Particulates (TSP) (with aerodynamic diameter ≦30 µm) as the representative pollutant for construction phase. According to EPD's Air Quality Report 2011, the major sources for Respirable Suspended Particulates (RSP) include power generation, road transport, etc. Non-combustion sources only constitute about 14%. Since construction dust is only one of the sources from non-combustion sources. It is unlikely that RSP is a representative pollutant for construction dust.

5.5.2 Emission Inventory

5.5.2.1 Potential air quality impact is therefore anticipated during the construction of the Project and has been assessed based on the following conservative assumptions of the general construction activities:

- Heavy construction activities including site clearance, ground excavation, construction of the associated facilities, haul road etc;
- Wind erosion of all active open sites;
- All construction activities at all work sites would be undertaken concurrently in order to assess the worst-case situation;
- Construction working periods of 26 days a month and 12 hours a day from 7:00am to 7:00pm, except Sundays and public holidays.

5.5.2.2 The prediction of dust emissions is based on typical values and emission factors from United States Environmental Protection Agency (USEPA) Compilation of Air Pollution Emission Factors (AP-42), 5th Edition. References of the calculations of dust emission factors for different dust generating activities are listed in **Table 5.5**. Detailed calculations of emission factors are given in **Appendix 5.1**.

Table 5.5 Key Concurrent Projects for Air Quality Assessment

Activities	Reference	Operating Sites	Equations & Assumptions
Heavy construction activities including land clearance, ground excavation, cut and fill operations, construction of the facilities, haul road, etc	USEPA AP42 S.13.2.3.3	All construction and excavation sites	E = 1.2 tons/acre/month of activity or = 2.69Mg/hectare/month of activity
Loading/Unloading at any stockpile	USEPA AP42, S13.2.4	Stockpiling area	$E = k(0.0016)\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}(kg/megagram)$ k is particle size multiplier U is average wind speed M is material moisture content

Activities	Reference	Operating Sites	Equations & Assumptions
Wind Erosion	USEPA AP42 S.11.9, Table 11.9.4	All construction sites, any stockpile areas, barging area (all open sites)	E = 0.85 Mg/hectare/yr (24 hour emission)

5.5.2.3 Dust emission from construction vehicle movement will generally be limited within the confined worksites area and the heavy construction emission factor given in AP-42 S.13.2.3.3 has taken this factor into account. Watering facilities will be provided at every designated vehicular exit point. Haul roads within the work sites would be paved and water spraying would be provided to keep them in wet condition. Since all vehicles will be washed at exit points and vehicle loaded with the dusty materials will be covered entirely by clean impervious sheeting before leaving the construction site, dust nuisance from construction vehicle movement outside the worksites is unlikely to be significant. Locations and details of emission sources are illustrated in **Appendix 5.1.**

5.5.2.4 In addition, construction activities associated with the development in TKO Area 86 have been considered in this assessment to assess cumulative dust impact. However, it should be noted that the construction activities on top of the MTR Depot would only involve superstructure and hence are not considered dusty. As such, ground level construction activities only included in this assessment.

5.5.3 Assessment Methodology

5.5.3.1 Dust impact assessment has been undertaken using the EPD approved Fugitive Dust Model (FDM). It is a well-known Gaussian Plume model designed for computing air dispersion for fugitive dust sources. Modelling parameters including dust emission factors, particles size distributions, surface roughness, etc are referred to EPD's "Guideline on choice of models and model parameters" and USEPA AP-42. The density of dust is assumed to be 2.5g/cm^3. The 5-year annual averaged TSP concentration of 73µg/m^3 is taken as the background concentrations of this study. A surface roughness of 100 cm is assumed in the model to represent the terrain.

5.5.3.2 During daytime working hours (7am to 7pm), it is assumed that dust emissions would be generated from all dust generating activities and site erosion. During night-time non-working hours (7pm to 7am of the next day), Sunday and public holidays, dust emission source would include site erosion as construction activities during these hours will be ceased.

5.5.3.3 The worst-case 1-hour, worst-case 24-hour average and annual TSP concentrations were calculated based on real meteorological data, including wind direction, wind speed and stability, collected from the Kai Tak meteorological station in Year 2011. The mixing height and temperature data from the King's Park Station in Year 2011 were adopted.

5.5.3.4 Fugitive dust modelling was conducted at the 1.5m, 5m and 10m above ground. Since all the dust generating sources associated with this Project are at ground level only, these assessment levels would therefore represent the worst-case scenario. Both the unmitigated and mitigated scenarios for the project are presented. A 100x100m grid has also been used to investigate the pollutant dispersion.

5.5.3.5 A summary of modelling parameters adopted in the construction dust assessment are given in the table below:

Table 5.6 Modelling Parameters

Parameters	Input	Remark
Particle size distribution	1.25um = 7% 3.75um = 20% 7.5um = 20% 12.5um = 18% 22.5um = 35%	Reference from S13.2.4.3 of USEPA AP-42
Background Concentration	73µg/m^3	5-year annual averaged value recorded at Kwun Tong Station
Modeling mode	Flatted terrain	-
Meteorological data	Data recorded in 2011 at Kai Tak and King's Park Meteorological Stations	-
Anemometer Height	13m	Elevation of anemometer : +16mPD Ground level of anemometer : +3mPD
Surface Roughness	100cm	-

Parameters	Input	Remark
Emission period	General construction activities during daytime working hours (7 am to 7 pm) Wind erosion during both day-time (7am to 7pm) and night-time (7pm to 7am of the next day)	-
Assessment height	1.5m, 5m and 10m	-

5.5.3.6 It is understood that construction activities will not take place at all locations over the entire work sites at the same time, but to be undertaken at moving multiple work fronts spread across the work sites. The active areas on each work site were best estimated from the construction method, construction programme and number of operating plants. Based on the engineering information presented in the **Appendix 5.2**, it is estimated that the hourly percentage of active area is 7.4%, while the annual percentage of active areas is 4.1%. As a conservative assessment, it is assumed that the hourly and annual percentage active areas are 30% and 6% respectively.

5.5.3.7 For short-term 1-hour and 24-hour assessment, construction and plant activity would neither take place on the entire work site/work area at the same time, nor be concentrated in certain areas of the site close to ASRs at anytime during the construction period. Notwithstanding this, a conservative initial screening test, namely "Tier 1 Screening Test" was undertaken. The Tier 1 screening test is conservative and represented the worst case situation, whereby all the worksites would be active (i.e. 100%). The purpose of the Tier 1 screening test is to identify the potentially affected areas where construction dust may accumulate.

5.5.3.8 For the long-term annual concentration assessment, as mentioned above, all the active construction activities would likely be moving at work fronts spreading across the whole works site. On this basis, it was assumed that the dust emissions will be distributed across the whole area of each site to reasonably represent this mode of construction works (i.e. a correction factor of 0.06 is applied to the total dust emission rate for prediction of annual concentration).

5.5.3.9 Cumulative construction dust impact from the concurrent project (i.e. TKO Area 86 Development) has also been taken into account. Details of the construction schedule of Area 86 were unavailable during the preparation of this assessment, but construction of TKO Area 86 Development is generally programmed to finish in Year 2020. As a conservative assumption, the active area for the short-term assessment (i.e. Tier 1) was assumed as 100%. However, given that construction activities would be undertaken at moving multiple work fronts across the site, 6% active area is assumed for the long-term (i.e. annual) TSP assessment.

5.5.3.10 In addition, in order to determine the worst case scenario impact to TKO Area 86 from the construction of the CBL project, it is assumed that the ASRs A11-A19 would exist during the construction of Road D9.

5.5.4 Assessment Result – Unmitigated Scenario

5.5.4.1 The maximum unmitigated 1-hour, 24-hour and annual cumulative TSP concentrations at each existing representative ASR have been assessed and are presented in **Table 5.7** and **Table 5.8** below. **Drawing no. 209506/EIA/AIR/002-004** shows the contours of unmitigated 1-hour (Tier 1), 24-hour (Tier 1) and annual cumulative TSP concentrations at 1.5m height above ground level. Exceedances of the relevant criteria are predicted at most of the ASRs. Hence, mitigation measures are therefore required to reduce the dust impact.

Table 5.7 Predicted Cumulative Unmitigated 1-hour (Tier 1) and 24-hour (Tier 1) TSP Concentrations at ASRs (including background concentration)

ASR ID	Description	1-hour TSP Concentrations at Various Height (μg/m^3)			24-hour TSP Concentrations at Various Height (μg/m^3)		
		1.5m	5m	10m	1.5m	5m	10m
A1	Lohas Park Phase II – Le Prestige Tower 1	**2020**	**1414**	**831**	**348**	244	185
A2	Lohas Park Phase II – Le Prestige Tower 3	**1488**	**1100**	**774**	**262**	223	160
A3	Lohas Park (Planned Development in Area 86, Package 3; Stage 2)	Note [1]	Note [1]	Note [1]	Note [1]	Note [1]	Note [1]
A4	Lohas Park (Planned Development in Area 86, Package 3; Stage 2)	Note [1]	Note [1]	Note [1]	Note [1]	Note [1]	Note [1]

ASR ID	**Description**	**1-hour TSP Concentrations at Various Height (μg/m^3)**			**24-hour TSP Concentrations at Various Height (μg/m^3)**		
		1.5m	**5m**	**10m**	**1.5m**	**5m**	**10m**
A5	Lohas Park (Planned Development in Area 86, Package 3; Stage 2)	Note [1]	Note [1]	Note [1]	Note [1]	Note [1]	Note [1]
A6	Lohas Park Phase I – The Capitol Tower 1	**1687**	**1560**	**1046**	**340**	**325**	254
A7	Chiaphua-Shinko Centre	**1262**	**1260**	**1019**	194	192	167
A8	Metrix Manufacturing (HK) Ltd	**2335**	**1817**	**932**	**299**	**280**	217
A9	HSBC Office	**830**	**829**	**700**	142	145	139
A10	Hong Kong Oxygen Acetylene Co. Ltd	**859**	**884**	**767**	141	144	136
A11	Lohas Park Stage 1 (Planned Development in Area 86, Package 6)	**4879**	**1855**	**980**	**660**	**379**	241
A12	Lohas Park Stage 1 (Planned Development in Area 86, Package 6)	**2013**	**1258**	**776**	**339**	**273**	187
A13	Lohas Park (Planned Development in Area 86, Package 5; Stage 1)	**4920**	**2110**	**948**	**557**	**355**	231
A14	Lohas Park (Planned Development in Area 86, Package 5; Stage 1)	**2511**	**1394**	**909**	**438**	**317**	217
A15	Lohas Park Stage 3 (Planned Development in Area 86,Package 11)	**4605**	**1741**	**1055**	**768**	**406**	238
A16	Lohas Park Stage 3 (Planned Development in Area 86,Package 11)	**4154**	**2037**	**1160**	**552**	**357**	239
A17	Lohas Park Stage 3 (Planned Development in Area 86,Package 11)	**2781**	**2131**	**1310**	**361**	**318**	250
A18	Lohas Park Stage 3 (Planned Development in Area 86,Package 10)	**2997**	**2462**	**1256**	**375**	**343**	257

ASR ID	Description	1-hour TSP Concentrations at Various Height (µg/m^3)			24-hour TSP Concentrations at Various Height (µg/m^3)		
		1.5m	5m	10m	1.5m	5m	10m
A19	Tung Wah Group of Hospitals Aided Primary School & Secondary School	**3004**	**1425**	**866**	**427**	**329**	211
A20	Planned Primary and Secondary Schools	**2257**	**1894**	**1001**	**347**	**322**	240
A21	The Beaumount (Under Construction)	**1403**	**1411**	**1152**	134	135	124
A22	RTHK Broadcasting House (Planned)	**2294**	**1416**	**929**	**312**	250	179
A23	Data Centre (Planned)	**1145**	**898**	**686**	175	174	156

Notes: Bold values mean exceedance of relevant criteria.
[1] Not considered as an ASR during construction phase as it is assumed that the site is under construction to account for cumulative impact.

Table 5.8 Predicted Cumulative Unmitigated Annual TSP Concentrations at ASRs (including background concentration)

ASR ID	Description	Annual TSP Concentrations at Various Height (µg/m^3)		
		1.5m	5m	10m
A1	Lohas Park Phase II – Le Prestige Tower 1	76.9	76.0	74.9
A2	Lohas Park Phase II – Le Prestige Tower 3	76.5	76.1	75.1
A3	Lohas Park (Planned Development in Area 86, Package 3; Stage 2)	Note [1]	Note [1]	Note [1]
A4	Lohas Park (Planned Development in Area 86, Package 3; Stage 2)	Note [1]	Note [1]	Note [1]
A5	Lohas Park (Planned Development in Area 86, Package 3; Stage 2)	Note [1]	Note [1]	Note [1]
A6	Lohas Park Phase I – The Capitol Tower 1	75.0	75.0	74.7
A7	Chiaphua-Shinko Centre	74.0	74.0	73.9
A8	Metrix Manufacturing (HK) Ltd	74.6	74.5	74.1
A9	HSBC Office	73.5	73.5	73.5
A10	Hong Kong Oxygen Acetylene Co. Ltd	73.5	73.6	73.5

ASR ID	Description	Annual TSP Concentrations at Various Height ($\mu g/m^3$)		
		1.5m	5m	10m
A11	Lohas Park Stage 1 (Planned Development in Area 86, Package 6)	**86.4**	**81.3**	77.5
A12	Lohas Park Stage 1 (Planned Development in Area 86, Package 6)	**80.1**	78.9	76.8
A13	Lohas Park (Planned Development in Area 86, Package 5; Stage 1)	**87.0**	**82.9**	78.5
A14	Lohas Park (Planned Development in Area 86, Package 5; Stage 1)	**83.0**	**80.8**	77.8
A15	Lohas Park Stage 3 (Planned Development in Area 86,Package 11)	**89.5**	**83.1**	78.4
A16	Lohas Park Stage 3 (Planned Development in Area 86,Package 11)	**86.2**	**82.7**	78.7
A17	Lohas Park Stage 3 (Planned Development in Area 86,Package 11)	**81.9**	79.7	77.5
A18	Lohas Park Stage 3 (Planned Development in Area 86,Package 10)	**80.7**	79.2	77.2
A19	Tung Wah Group of Hospitals Aided Primary School & Secondary School	**82.2**	79.9	76.8
A20	Planned Primary and Secondary Schools	78.2	77.9	76.7
A21	The Beaumount (Under Construction)	73.8	73.8	73.7
A22	RTHK Broadcasting House (Planned)	75.6	75.2	74.5
A23	Data Centre (Planned)	74.6	74.5	74.2

Notes: Bold values mean exceedance of relevant criteria.
[1] Not considered as an ASR during construction phase as it is assumed that the site is under construction to account for cumulative impact.

5.5.5 Mitigation Measures

5.5.5.1 In order to reduce the dust emission from the Project and achieve compliance with the TSP criteria at ASRs, mitigation measures in form of regular watering under a good site practice should be adopted. In accordance with the "Control of Open Fugitive Dust Sources" (USEPA AP-42), watering once per hour on exposed worksites and haul road is recommended to achieve dust removal efficiency of 91.7%. **Appendix 5.2** presents the calculation of the dust removal efficiency. The dust suppression efficiency is derived based on the average haul road traffic of 20 vehicle/hour, average evaporation rate and an assumed application intensity of 0.5 L/m^2 for the respective watering frequencies. Any potential dust impact and watering mitigation would be subject to the actual site conditions. For example, a construction activity that produces inherently wet conditions or in cases during rainy weather, the above water application intensity may not be unreservedly applied. While the above watering frequency is to be followed, the extent of watering may vary depending on actual site conditions but should be sufficient to maintain an equivalent intensity of no less than 0.5 L/m^2 to achieve the respective dust removal efficiencies. The dust levels would be monitored and managed under an EM&A programme as specified in the EM&A Manual.

5.5.5.2 In addition to the watering and required intensity, the Contractor will also be obliged to follow the procedures and requirements given in the Air Pollution Control (Construction Dust) Regulation. This stipulates the construction dust control requirements for both Notifiable (e.g. site formation) and Regulatory (e.g. road opening) Works to be carried out by the Contractor.

5.5.5.3 In accordance with the Air Pollution Control (Construction Dust) Regulation, the following dust suppression measures should also be incorporated by the Contractor to control the potential for dust nuisance throughout the construction phase:

- Any excavated or stockpile of dusty material should be covered entirely by impervious sheeting or sprayed with water to maintain the entire surface wet and then removed or backfilled or reinstated where practicable within 24 hours of the excavation or unloading;
- Any dusty materials remaining after a stockpile is removed should be wetted with water and cleared from the surface of roads;

- A stockpile of dusty material should not extend beyond the pedestrian barriers, fencing or traffic cones;
- The load of dusty materials on a vehicle leaving a construction site should be covered entirely by impervious sheeting to ensure that the dusty materials do not leak from the vehicle;
- Where practicable, vehicle washing facilities with high pressure water jet should be provided at every discernible or designated vehicle exit point. The area where vehicle washing takes place and the road section between the washing facilities and the exit point should be paved with concrete, bituminous materials or hardcores;
- When there are open excavation and reinstatement works, hoarding of not less than 2.4m high should be provided as far as practicable along the site boundary with provision for public crossing. Good site practice shall also be adopted by the Contractor to ensure the conditions of the hoardings are properly maintained throughout the construction period;
- The portion of any road leading only to construction site that is within 30m of a vehicle entrance or exit should be kept clear of dusty materials;
- Surfaces where any pneumatic or power-driven drilling, cutting, polishing or other mechanical breaking operation takes place should be sprayed with water or a dust suppression chemical continuously;
- Any area that involves demolition activities should be sprayed with water or a dust suppression chemical immediately prior to, during and immediately after the activities so as to maintain the entire surface wet;
- Where a scaffolding is erected around the perimeter of a building under construction, effective dust screens, sheeting or netting should be provided to enclose the scaffolding from the ground floor level of the building, or a canopy should be provided from the first floor level up to the highest level of the scaffolding;
- Any skip hoist for material transport should be totally enclosed by impervious sheeting;
- Exposed earth should be properly treated by compaction, turfing, hydroseeding, vegetation planting or sealing with latex, vinyl, bitumen, shortcrete or other suitable surface stabiliser within six months after the last construction activity on the construction site or part of the construction site where the exposed earth lies.

5.5.5.4 For the barging facilities proposed at the site compound, the following good site practice is required:

- All road surfaces within the barging facilities should be paved.

- Vehicles should pass through designated wheel wash facilities.
- Continuous water spray should be installed at the loading point.

5.5.5.5 The above requirements should be incorporated into the Contract Specification for the civil work. In addition, an audit and monitoring programme during the construction phase should be implemented by the Contractor to ensure that the construction dust impacts are controlled to within the HKAQO. Detailed requirements for the audit and monitoring programme are given separately in the EM&A manual.

5.5.6 Assessment Result – Mitigated Scenario

5.5.6.1 With the implementation of the abovementioned mitigation measures, the maximum mitigated 1-hour (Tier 1), 24-hour (Tier 1) and annual cumulative TSP concentrations at each representative ASRs have been assessed and are presented in **Table 5.9** and **Table 5.10** below. In general, it is predicted that, with the recommended mitigation measures adopted, the TSP concentrations at all ASRs would comply with their respective criteria.

Table 5.9 Predicted Cumulative Mitigated 1-hour (Tier 1) and 24-hour (Tier 1) TSP Concentrations at ASRs (including background concentration)

ASR ID	Description	1-hour TSP Concentrations at Various Height (μg/m^3)			24-hour TSP Concentrations at Various Height (μg/m^3)		
		1.5m	5m	10m	1.5m	5m	10m
A1	Lohas Park Phase II – Le Prestige Tower 1	255	184	136	98	91	84
A2	Lohas Park Phase II – Le Prestige Tower 3	190	158	131	91	87	81
A3	Lohas Park (Planned Development in Area 86, Package 3; Stage 2)	Note [1]	Note [1]	Note [1]	Note [1]	Note [1]	Note [1]
A4	Lohas Park (Planned Development in Area 86, Package 3; Stage 2)	Note [1]	Note [1]	Note [1]	Note [1]	Note [1]	Note [1]
A5	Lohas Park (Planned Development in Area 86, Package 3; Stage 2)	Note [1]	Note [1]	Note [1]	Note [1]	Note [1]	Note [1]
A6	Lohas Park Phase I – The Capitol Tower 1	207	196	154	96	94	88

ASR ID	Description	1-hour TSP Concentrations at Various Height (µg/m^3)			24-hour TSP Concentrations at Various Height (µg/m^3)		
		1.5m	5m	10m	1.5m	5m	10m
A7	Chiaphua-Shinko Centre	172	171	152	83	83	81
A8	Metrix Manufacturing (HK) Ltd	263	219	145	94	92	86
A9	HSBC Office	139	139	127	80	80	80
A10	Hong Kong Oxygen Acetylene Co. Ltd	138	140	131	79	79	79
A11	Lohas Park Stage 1 (Planned Development in Area 86, Package 6)	472	221	148	131	101	88
A12	Lohas Park Stage 1 (Planned Development in Area 86, Package 6)	240	171	131	99	92	84
A13	Lohas Park (Planned Development in Area 86, Package 5; Stage 1)	475	242	148	124	100	87
A14	Lohas Park (Planned Development in Area 86, Package 5; Stage 1)	275	183	142	106	95	86
A15	Lohas Park Stage 3 (Planned Development in Area 86,Package 11)	449	211	154	137	103	87
A16	Lohas Park Stage 3 (Planned Development in Area 86,Package 11)	412	239	163	120	99	88
A17	Lohas Park Stage 3 (Planned Development in Area 86,Package 11)	298	244	176	101	96	89
A18	Lohas Park Stage 3 (Planned Development in Area 86,Package 10)	316	271	171	101	99	91
A19	Tung Wah Group of Hospitals Aided Primary School & Secondary School	316	186	139	106	96	85
A20	Planned Primary and Secondary Schools	254	224	150	99	97	89
A21	The Beaumount (Under Construction)	183	184	163	79	79	78

ASR ID	Description	1-hour TSP Concentrations at Various Height (μg/m^3)			24-hour TSP Concentrations at Various Height (μg/m^3)		
		1.5m	5m	10m	1.5m	5m	10m
A22	RTHK Broadcasting House (Planned)	273	197	144	100	93	84
A23	Data Centre (Planned)	169	147	124	84	83	81

Notes:
[1] Not considered as an ASR during construction phase as it is assumed that the site is under construction to account for cumulative impact.

Table 5.10 Predicted Cumulative Mitigated Annual TSP Concentrations at ASRs (including background concentration)

ASR ID	Description	Annual TSP Concentrations at Various Height (μg/m^3)		
		1.5m	5m	10m
A1	Lohas Park Phase II – Le Prestige Tower 1	74.6	74.1	73.5
A2	Lohas Park Phase II – Le Prestige Tower 3	74.5	74.2	73.7
A3	Lohas Park (Planned Development in Area 86, Package 3; Stage 2)	Note [1]	Note [1]	Note [1]
A4	Lohas Park (Planned Development in Area 86, Package 3; Stage 2)	Note [1]	Note [1]	Note [1]
A5	Lohas Park (Planned Development in Area 86, Package 3; Stage 2)	Note [1]	Note [1]	Note [1]
A6	Lohas Park Phase I – The Capitol Tower 1	73.8	73.8	73.6
A7	Chiaphua-Shinko Centre	73.4	73.4	73.3
A8	Metrix Manufacturing (HK) Ltd	73.7	73.6	73.4
A9	HSBC Office	73.2	73.2	73.2
A10	Hong Kong Oxygen Acetylene Co. Ltd	73.2	73.2	73.2
A11	Lohas Park Stage 1 (Planned Development in Area 86, Package 6)	78.5	75.8	74.3
A12	Lohas Park Stage 1 (Planned Development in Area 86, Package 6)	76.0	75.3	74.2

ASR ID	Description	Annual TSP Concentrations at Various Height ($\mu g/m^3$)		
		1.5m	5m	10m
A13	Lohas Park (Planned Development in Area 86, Package 5; Stage 1)	78.6	76.3	74.5
A14	Lohas Park (Planned Development in Area 86, Package 5; Stage 1)	77.0	75.7	74.3
A15	Lohas Park Stage 3 (Planned Development in Area 86,Package 11)	79.3	75.9	74.4
A16	Lohas Park Stage 3 (Planned Development in Area 86,Package 11)	78.1	76.1	74.5
A17	Lohas Park Stage 3 (Planned Development in Area 86,Package 11)	76.4	75.2	74.3
A18	Lohas Park Stage 3 (Planned Development in Area 86,Package 10)	76.0	75.2	74.3
A19	Tung Wah Group of Hospitals Aided Primary School & Secondary School	76.9	75.5	74.0
A20	Planned Primary and Secondary Schools	75.1	74.9	74.2
A21	The Beaumount (Under Construction)	73.3	73.3	73.3
A22	RTHK Broadcasting House (Planned)	74.2	73.9	73.5
A23	Data Centre (Planned)	73.7	73.6	73.4

Notes:
[1] Not considered as an ASR during construction phase as it is assumed that the site is under construction to account for cumulative impact.

5.5.6.2 It can also be seen from **Table 5.9** and **Table 5.10** that the predicted 1-hour, 24-hour and annual TSP concentrations would in general decrease with increasing elevations from ground level to 10m above ground. In respect of potential construction dust impact to the nearest ASRs in TKO Area 86 (i.e. ASR A1-A2, A6, A11-A18 and A20), the air sensitive uses as well as the fresh air intake are generally located at least 5m above ground. Fugitive dust impact generated from the construction of the at-grade section of this Project on ground level would not have significant dust impact on the ASRs at high elevation.

As shown in **Table 5.9** and **Table 5.10**, the TSP concentrations at ASR A1-A2, A6, A11-A18 and A20 at 5m and 10m above ground are far below their respective criteria.

5.5.6.3 **Drawing no. 209506/EIA/AIR/005-007** shows the contours of mitigated 1-hour (Tier 1), 24-hour (Tier 1) and annual cumulative TSP concentrations at the worst affected level (i.e. 1.5m above ground). For 1-hour and 24-hour TSP concentration, there are no air sensitive uses identified within the area of exceedance. Adverse short-term dust impact is therefore not anticipated.

5.5.6.4 For annual TSP concentrations, exceedance is observed at the basketball court of the ASR A19 Tung Wah Group of Hospitals Aided Primary School & Secondary School. However, it is considered that there is no long-term air sensitive use at the basketball court as the school will be closed after school hours, whereas the basketball court will be vacant during non-school hours (i.e. no air sensitive use). In addition, it is assumed in this construction dust assessment that the proposed stockpiling area located opposite to the basketball court will be uncovered throughout the entire year to represent the very conservative scenario, which will not occur in reality. As a general site practice, any stockpiling of dusty material would be covered entirely by impervious sheeting within 24 hours of the excavation or unloading. With the stockpiling area covered, dust emission due to open site erosion will then be minimal and will reduce the long-term dust impact in practice.

5.5.6.5 As such, since the predicted exceedance of annual TSP concentrations is based on the very conservative assumption mentioned above and there is no long-term air sensitive use at the basketball court of the ASR A19 Tung Wah Group of Hospitals Aided Primary School & Secondary School, adverse long-term dust impact is therefore not anticipated.

5.6 Operational Air Quality Assessment

5.6.1 Identification of Key/Representative Air Pollutions of Vehicular Emissions Open Road

5.6.1.1 Vehicular emission comprises a number of pollutants, including Nitrogen Oxides (NO_x), Respirable Suspended Particulates (RSP), Sulphur Dioxides (SO_2), Carbon Monoxide (CO), Lead (Pb), Toxic

Air Pollutants (TAPs) etc. Accordingly to "An Overview on Air Quality and Air Pollution Control in Hong Kong" published by EPD, motor vehicles are the main causes of high concentrations of respirable suspended particulates (RSP) and nitrogen oxides (NO_x) at street level in Hong Kong and are considered as key air quality pollutants for road projects. For other pollutants, due to the low concentration in vehicular emission, they are not considered as key pollutants for the purpose of this study.

(i) Nitrogen Dioxide (NO_2)

5.6.1.2 Nitrogen oxides (NOx) is a major pollutant from fossil fuel combustion. According to the Emission Inventory for 2010 published on EPD's website [1], navigation is the dominant contributor to NOx generation in Hong Kong, accounted for 32% of NOx emission in 2010. Road transport is the second largest NOx contributor which accounted for 30% of the total in the same year.

5.6.1.3 In the presence of O_3 and VOC, NOx would be converted to NO_2. Increasing traffic flow would inevitably increase the NOx emission and subsequently the roadside NO_2 concentration. Hence, NO_2 is one of the key pollutants for the operational air quality assessment of the Project. 1-hour, 24-hour and annual averaged NO_2 concentrations at each identified ASRs would be assessed and compared with the relevant AQO to determine the compliance.

(ii) Respirable Suspended Particulates (RSP)

5.6.1.4 Respirable Suspended Particulates (RSP) refers to suspended particulates with a nominal aerodynamic diameter of 10um or less. According to the Emission Inventory for 2010 published on EPD's website, navigation is the dominant contributor to RSP generation in Hong Kong, accounted for 36% of RSP emission in 2010. Road transport is the second largest RSP contributor which accounted for 21% of the total in the same year. Increasing traffic flow would inevitably increase the roadside RSP concentration. Hence, RSP is also one of the key pollutants for the operational air quality assessment of the Project. The 24-hour and annual averaged RSP concentrations at each identified ASRs would be

[1] http://www.epd.gov.hk/epd/english/environmentinhk/air/data/emission_inve.html

assessed and compared with the relevant AQO to determine the compliance.

(iii) Sulphur Dioxide (SO_2)

5.6.1.5 Sulphur dioxide (SO_2) is formed primarily from the combustion of sulphur-containing fossil fuels. In Hong Kong, power stations and marine vessels are the major sources of SO_2, followed by fuel combustion equipment and motor vehicles [2]. SO_2 emission from vehicular exhaust is due to the sulphur content in diesel oil. According to EPD's "Cleaning the Air at Street Level" [3],ultra low sulphur diesel (ULSD) with a sulphur content of only 0.005% has been adopted as the statutory minimum requirement for motor vehicle diesel since April 2002, which is 3 years ahead of the European Union. With the use of ULSD, according to the Emission Inventory for 2010 published on EPD's website, road transport is the smallest share of SO_2 emission sources in 2010 and only constitutes less than 1% of the total SO_2 emission. From 1 July 2010, EPD has tightened the statutory motor vehicle diesel and unleaded petrol specifications to Euro V level, which further tightens the cap on sulphur content from 0.005% to 0.001%.

5.6.1.6 In addition, the measured 1-hr average, daily average and annual average SO_2 concentration at all EPD air monitoring stations are all less than 40% of the respective AQO. In view that road transport only contributes a very small amount of SO_2 emission, relatively low measured concentrations and the adoption of low-sulphur and ultra-low-sulphur fuel under the existing government policy, SO_2 would not be a critical air pollutant of concern.

(iv) Carbon Monoxide (CO)

5.6.1.7 Carbon Monoxide (CO) is a typical pollutant emitted from fossil fuel combustion and comes mainly from vehicular emissions. With reference to the "Air Quality in Hong Kong 2011", measured the highest 1-hour average (4030μg/m^3) and the highest 8-hour average (3309 μg/m^3) were both recorded at the Causeway Bay roadside station; these values were around one seventh and one third of the respective AQO limits. In view that there is still a large margin to the AQO, CO would not be a critical air pollutant of concern.

[2] Air Quality in Hong Kong 2011
[3] http://www.epd.gov.hk/epd/english/environmentinhk/air/prob_solutions/cleaning_air_atroad.html

(v) Ozone (O_3)

5.6.1.8 Ozone (O_3) is produced from photochemical reaction between NOx and VOCs in the presence of sunlight, which will not be generated by this project. Concentration of O_3 is governed by both precursors and atmospheric transport from other areas. When precursors transport along under favorable meteorological conditions and sunlight, ozone will be produced. This explains why higher ozone levels are generally not produced in the urban core or industrial area but rather at some distance downwind after photochemical reactions have taken place. In the presence of large amounts of NOx in the roadside environment, O_3 reacts with NO to give NO_2 and thus results in O_3 removal. O_3 is therefore not considered as a key air pollutant for the operational air quality assessment of a road project.

(vi) Lead (Pb)

5.6.1.9 The sale of leaded petrol has been banned in Hong Kong since April 1999. According to the "Air Quality in Hong Kong 2011", the measured ambient lead concentrations were ranging from 20ng/m^3 to 104 ng/m^3. The measured concentrations were well below the AQO limits. Therefore, lead is not considered as a critical air pollutant of concern.

(vii) Toxic Air Pollutants (TAPs)

5.6.1.10 Vehicular exhaust is one of the emission sources of Toxic Air Pollutants (TAPs), which are known or suspected to cause cancer or other serious health and environmental effects. With reference to EPD's Assessment of Toxic Air Pollutant Measurements in Hong Kong Final Report, monitored TAPs in Hong Kong include diesel particulate matters (DPM), toxic elemental species, dioxins, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), carbonyls, and volatile organic compounds (VOCs). According to the results of Assessment of Toxic Air Pollutant Measurements in Hong Kong Final Report and Sources of PCB emissions , vehicular emission is not considered as primary source of dioxins, PCBs, carbonyls and most toxic elemental species in Hong Kong. Therefore, these pollutants are not considered as key pollutants for quantitative assessment for the operation phase of a road project.

(viii) Diesel Particulate Matters (DPM)

5.6.1.11 Diesel Particulate Matters (DPM), as part of the overall Respirable Suspended Particulates (RSP), is one of the most important parameter contributing to the overall health risk of the population. Local vehicular emission is one of the major sources of DPM.

5.6.1.12 EPD has embarked on the following three key programmes to reduce the diesel particulate level at the roadside : (a) the LPG taxi and light bus program; (b) the introduction of an advanced test to check diesel vehicle smoke emission; and (c) the retrofit of pre-Euro diesel commercial vehicles with diesel oxidation Catalysts (DOCs). According to EPD's website, franchised bus companies have also retrofitted their Euro I buses with diesel oxidation catalysts (DOCs) and Euro II and III buses with diesel particulate filters (DPFs). A DPF can reduce particulate emissions from diesel vehicles by over 80%.

5.6.1.13 As recommended by EPD's Assessment of Toxic Air Pollutant Measurements in Hong Kong Final Report, elemental carbon (EC) is used as a surrogate for DPM, and with reference to Measurements and Validation for the 2008/2009 Particulate Matter Study in Hong Kong, EC showed a significant decrease in concentration from 2001 to 2009 in Hong Kong, i.e. -47.5%, -30.0% and -28.3% at Mong Kok, Tsuen Wan and Hok Tsui Monitoring Sites, respectively. With the continual efforts by EPD to reduce particulate emission from the vehicular fleet, a discernible decreasing trend is noted in the level of particulate matter. Therefore, DPM is not selected as representative pollutant for quantitative assessment for this Project.

(ix) Polycyclic Aromatic Hydrocarbons (PAHs)

5.6.1.14 Polycyclic Aromatic Hydrocarbons (PAHs) are organic compounds of two or more fused benzene rings, in liner, angular or cluster conformations. Local vehicular traffic is also an important source of PAHs. For this group, the most important TAP is Benzo[a]pyrene, and it is often selected as a marker for the PAHs. The EU Air Quality Standards for PAHs (expressed as concentration of Benzo[a]pyrene) is 1 ng/m^3 for annual average . With reference to "Air Quality in Hong Kong 2011", annual average concentrations of PAHs (Benzo[a]pyrene) measured at EPD's TAP monitoring stations (Tsuen Wan and Central/Western) were 0.22ng/m^3, which is far below the EU Standards. Thus, PAHs are not considered as key pollutants for quantitative assessment for this Project.

(x) Volatile Organic Compounds (VOCs)

5.6.1.15 Volatile Organic Compounds (VOCs) are of great concern due to the important role played by them in a range of health and environmental problems. The US EPA has designated many VOC, including those typically found in vehicular emission, as air toxic. According to Assessment of Toxic Air Pollutant Measurements in Hong Kong Final Report, among the VOC compounds, benzene and 1,3-butadiene are the most significant ones for Hong Kong. The UK Air Quality Standards for benzene and 1,3-butadiene are 5.0µg/m^3 and 2.25 µg/m^3 respectively. Accordingly to "Air Quality in Hong Kong 2011", annual average concentrations of benzene and 1,3-butadiene at EPD's TAP monitoring stations (Tsuen Wan and Central/Western) were 1.53 - 1.62 µg/m^3 and 0.13 µg/m^3, respectively, which is far below the UK Standards. Thus, VOCs are not considered as key pollutants for quantitative assessment for this Project.

5.6.2 Emission Inventory

Vehicular Emission from Open Road and Tunnel Portals

5.6.2.1 As discussed in **Section 5.6.1** above, for a road project, nitrogen dioxide (NO_2) and respirable suspended particulates (RSP) are the air pollutants of primary concern during operational phase of the Project and hence are assessed in the study.

5.6.2.2 In assessing the operational air quality impact to air sensitive receivers, contribution from the following classes of emission sources will be considered:

- Contributions induced by the project itself;
- Vehicle emission of other existing roads within study area; and
- Portal emission from Landscape deck of Road P2 and TKO-LT Tunnel within study area.

5.6.2.3 Upon commencement of the CBL operation, vehicular emissions will be generated from the additional road network in the study area. Additional traffic flow would also be induced on the existing roads and therefore a corresponding increase in vehicular emissions is anticipated. Major roads in the vicinity of the study area include Wan Po Road, Chun Yat Street etc. **Drawing no. 209506/EIA/AIR/010** illustrates the locations of open roads and portals included in this assessment.

Industrial Emission

5.6.2.4 Chimney survey and desktop study have been conducted to identify/ verify the industrial emissions within 500m of the site boundary and inside Tseung Kwan O Industrial Estate (TKOIE). Chimney data were requested from each industrial premise, however, only few premises responded. According to further information provided by the Hong Kong Science & Technology Parks Corporation (HKSTPC), who manages the TKOIE, the following assumptions are applicable:

- The daily diesel consumption allocation available for tenants (besides Hong Kong Aero Engine Services Ltd) is 52.6 m^3/day.

5.6.2.5 To assess the potential cumulative air quality impact due to other minor emission sources, reference has been made to the approved EIA Study "*Fill Bank at TKO Area 137*" (AEIAR-060/2002) for the stack height, diameter, exit velocity and temperature. These chimney information adopted in this approved EIA are considered as the best available information and are adopted in this operational air quality assessment. Emission factors for the industries are calculated based on the emission limits stated in the Air Pollution Control (Fuel Restriction) Regulation. Detailed calculations are given in **Appendix 5.3**.

5.6.2.6 References have also been made to the approved EIA Studies for "*Development of a Biodiesel Plant at Tseung Kwan O Industrial Estate*" (AEIAR-131/2009) for the planned Biodiesel Plant in TKOIE, and the "*Further Development of Tseung Kwan O Feasibility Study*" (AEIAR-092/2005) for the landfill gas flaring plants. For the emission from the aircraft engine testing at Hong Kong Aero Engine Service Ltd (HAESL), a sensitivity test, which has taken into account different aircraft engine model mounted on the various large aircrafts commonly available in the market, has been conducted to determine the emissions from the engine test that might be undertaken at the HAESL. Estimation of emission from aircraft engine test has been referenced from the approved EIA study "*Environmental Impact Assessment HAECO/HAESL Facilities at Tseung Kwan O*" (EIA-147/BC), latest EDMS v5.1.3 developed by the Federal Aviation Administration (FAA) for determination of airport emission which includes aircraft engine emission, and the Air Quality Manual published by International Civil Aviation Organization (ICAO). Detailed calculations are given in **Appendix 5.3**. The highest estimated emissions from the sensitivity test have been taken for conservative operational air quality assessment.

5.6.2.7 The locations of industrial chimneys included in this assessment are shown in **Drawing no. 209506/EIA/AIR/010**. Their emission characteristics are presented in **Appendix 5.3**. The table below lists the chimneys that are included in the operational air quality assessment.

Table 5.11 Chimneys included in the Operational Air Quality Assessment

Source ID	Description
E1 – E2	Fuel oil and biogas combustion at the planned Biodiesel Plant
E4	Aircraft engine testing at HAESL
E6 – E21	Fuel oil combustion inside the TKOIE
EP1 – EP9	Fuel oil combustion at Television Broadcasts Ltd.
FS1	Sai Tso Wan Landfill gas flaring plant
TO1 – TO2	TKO Stage I & Stage II/III Landfill gas flaring plant

Marine Emission

5.6.2.8 Site survey and desktop study have been conducted to identify the potential marine emissions within the 500m study area. With reference to the "Study on Marine Vessels Emission Inventory, Final Report" published by EPD in February 2012, NO_x and RSP emissions from large vessels (including Fully Cellular Container Vessel, Ocean Going Vessel, River Trade Vessel, Cruise and Ferry) are not identified within 500m from the identified ASRs identified. The only potential marine emission source located within 500m from the ASRs will be the barges associated with the Hong Kong Oxygen Acetylene Co. Ltd, which is about 150m away from its administration building (ASR A10) and is about 400m away from the resident development in TKO Area 86 (e.g. ASR A13 Lohas Park (Planned Development in Area 86, Package 5; Stage 1)).

5.6.2.9 Liaison with the operator has been made to collect the latest information on the usage rate of barge, engine power and exhaust dimensions. According to the information provided by the operator, it is found that the use of vessel is infrequent (about once a week) and the vessel would only stay for a short period of time (about 30 minutes). And the engine powers of the vessel are also found to be relatively small as compared to those of typical barges stated in EPD's "Study on Marine Vessels Emission Inventory, Final Report". As such, it is considered that the potential air quality impact will only be transient and negligible. (i.e. significant cumulative air quality impact from this vessel during operational phase is therefore not anticipated)

5.6.2.10 In addition, it is understood that the marine emission has already been taken into account in the PATH model, in which the hourly concentration data predicted by the PATH model is taken as the background. More detailed discussion is given in **Section 5.6.3**.

5.6.3 Assessment Methodology

Vehicular Emission

Determination of the Assessment Year

5.6.3.1 According to Clause 3.4.1.4 (iv) (b) of the EIA Study Brief for CBL, the air pollution impacts of future road traffic should be calculated based on the highest emission strength from vehicles within the next 15 years upon commencement of operation of the proposed project. The selected assessment year should therefore represent the highest emission scenario for the roads within the 500m study boundary.

5.6.3.2 Vehicular tailpipe emissions from open roads are calculated based on the EPD EMFAC-HK model v2.1 at the time of assessment (end 2012). However, the latest model version EMFAC-HK v2.5 is just released by EPD in early January 2013. As concluded in the "Outline of Changes in January 2013 Release of EMFAC-HK" in EPD website, the overall effects on emission estimates are insignificant. There are only some changes in the output file formats due to items removal as comparing with v2.1. Besides, one output file name is also changed and the format for input files is changed from VKT to VMT to ensure the consistency in units used in input files (US units). The above format changes would not impose a change in the emission rate. Therefore, the vehicular tailpipe emissions generated from v2.1 are still adopted in this assessment. As NO_2 is the pollutant of primary concern for a road project, the assessment year was determined based on the highest total NOx emission from the roads in the study area using the EMFAC-HK model. **Appendix 5.4** presents the methodology and assumptions (prepared by the EIA consultant team of TKO-LT Tunnel) adopted in estimating the emission factors and the calculated results. **Table 5.12** below summarise the total emission of NO_x and RSP (in ton/year) for different road types among Year 2021, 2029 and 2036.

Table 5.12 Total Emission of NOx and RSP (in ton/year) for different Road Types among Year 2021, 2029 and 2036

Year	Total NOx Emission (ton/year)			Total RSP Emission (ton/year)		
	Local Road (50kph)	Trunk Road (70kph)	Express-way (80kph)	Local Road (50kph)	Trunk Road (70kph)	Express-way (80kph)
2021	77.1613	27.5650	56.6059	3.7967	1.6028	2.9677
2029	37.5575	12.2910	25.9166	2.3908	1.1432	1.9864
2036	27.8650	8.9417	19.0490	1.9282	0.9563	1.6170

5.6.3.3 As shown in **Table 5.12**, it was concluded that the highest vehicular emissions will be found in Year 2021. Therefore, Year 2021 was selected as the assessment year for the operational phase air quality impact assessment. The hourly emissions of NOx and RSP in Year 2021 were divided by the number of vehicles and the distance travelled to obtain the emission factors in gram per miles per vehicle. The calculated 24-hour emission factors of 16 vehicle classes for the different road types in Year 2021 adopted in this air quality impact assessment are presented in **Appendix 5.4**.

Background Pollutant Concentrations – PATH Model

5.6.3.4 PATH model was used to quantify the background air quality during the operational phase of the Project. The emission sources including those in Pearl River Delta Economic Zone, roads, marine, airport, power plants and industries within Hong Kong were all considered in the PATH model. The hourly concentration data of background concentration predicted by the PATH model provided by EPD were for Year 2020. As presented in **Sections 5.6.3.3**, Year 2021 was selected as the assessment year for the operation phase air quality impact assessment. Therefore, as a conservative assumption, Year 2020 background concentration were adopted in the calculation of the cumulative results. The PATH background concentrations for the concerned grids for Year 2020 and the graphical plots are presented in **Appendix 5.5**.

Vehicle Emissions from Open Roads – CALINE4

5.6.3.5 The USEPA approved line source air dispersion model, CALINE4 developed by the California Department of Transport was used to assess vehicular emissions impact from existing and planned road network.

5.6.3.6 The dispersion modelling was conducted based on the meteorological data extracted from the PATH model. The grid cells used for extraction of meteorological data and background pollutant concentration are summarized in **Table 5.13**. Surface roughness coefficients as shown in **Table 5.13** were used in the CALINE4 model.

Table 5.13 PATH Model Grid Cells for Extraction of Meteorological Data and Background Pollutant Concentrations

Grid Cells	Surface Roughness (cm)
35_26	100
35_27	100
36_26	100
36_27	100

5.6.3.7 The surface roughness height is closely related to the land use characteristics, and the surface roughness is estimated as 10 percent of the average height of physical structures within 1km study area. The wind standard deviation is estimated in accordance with the "Guideline on Air Quality Models (Revised), 1986" based on the surface roughness shown in the above table, as summarized in the below

Stability Class	Wind Standard Deviation
A	32.9
B	32.9
C	25.6
D	18.3
E	11.0
F	5.6

5.6.3.8 Ozone Limiting Method (OLM) was adopted for conversion of NOx to NO_2 based on the predicted O_3 level from PATH. A tailpipe emission NO_2/NOx ratio of 7.5% based on the EPD's "Guidelines on Choice of Models and Model Parameters" has been assumed. The NO_2/NOX conversion was calculated as follows:

$$[NO_2]pred = 0.075x[NO_X]pred + MIN \{0.925x[NO_X]pred, or (46/48)x [O_3]bkgd\}$$

where

$[NO_2]pred$ is the predicted NO_2 concentration

$[NO_X]pred$ is the predicted NO_X concentration

MIN means the minimum of the two values within the brackets

$[O_3]bkgd$ is the representative O_3 background concentration

(46/48) is the molecular weight of NO_2 divided by the molecular weight of O_3

5.6.3.9 Secondary air quality impacts arising from the implementation of roadside noise mitigation measures, namely, semi-enclosures were incorporated into the air quality model. It was assumed that dispersion of traffic pollutants will in effect be similar to physically shifting the mitigated road section towards the central divider: the traffic pollutants were therefore assumed to emit from the top of the canopies. In the CALINE4 model, the alignment of the mitigated road section was shifted by a distance equal to the covered extent, the elevation of the mitigated road section was set to the elevation of the barrier top and road type set to 'fill'. No correction or adjustment to the receiver heights was made in the model. In addition, owing to the constraint of the CALINE4 model in modelling elevated roads higher than 10m, the road heights of elevated road sections in excess of 10m high above local ground or water surface are set to 10m in the model as the worst-case assumption.

5.6.3.10 The location of open road emission sources, 24-hour traffic flows and composite emission factors for each road link are presented in **Appendix 5.6**.

Portal Emission

5.6.3.11 The EPD approved dispersion model, the Industrial Source Complex Short Term (ISCST3) model, was used to predict the portal emission from Road P2 and TKO-LT Tunnel within the study area.

5.6.3.12 According to the information provided by the TKO-LTT EIA Study, 60% of the emissions from TKO-LTT were assumed to be emitted from ventilation building (outside the study area) and 40% from the portal; and, 50% of the emissions from the decked section of Road P2 were assumed to be emitted from the southbound portal within the study area. A summary for the mentioned portals emissions within 500m study area of CBL Project are presented in **Table 5.14**.

Table 5.14 Summary of Portals Emissions within 500m Study Area

Location	Daily Emission Rates in gram/second	
	Portal	
	NOx	RSP
Landscape Deck at Road P2 (Portal Name: B)	0.2280	0.0107
TKO-LT Tunnel Eastbound Main Line (Portal Name: C)	3.6960	0.1930
	40% Emission from Portal	

5.6.3.13 Portal emissions were modelled in accordance with the Permanent International Association of Road Congress Report (PIARC, 1991). Pollutants were assumed to eject from the portal as a portal jet such that 2/3 of the total emissions are dispersed within the first 50 m of the portal and 1/3 of the total emissions within the second 50 m. The calculation and emission inventory for portal emissions are presented in **Appendix 5.7**.

5.6.3.14 Meteorological data extracted from the PATH model from different grid cells as listed in **Table 5.13** were employed for the model run. NO_x concentrations from the open roads and the portals were firstly added together and OLM as mentioned in **Section 5.6.3.7** was subsequently applied. The rural dispersion mode in the ISCST3 model was selected depending on the land uses where the ASRs are located.

Industrial Emission

5.6.3.15 The potential air quality impact associated with the industrial emissions in the study area was assessed by the EPD approved dispersion model, ISCST3. It was assumed that all chimneys operate over a 24 hour period. Meteorological data extracted from the PATH model from different grid cells as listed in **Table 5.13** was employed for the model run. Ozone Limiting Method (OLM) was adopted for the conversion of NO_X to NO_2 based on the predicted O_3 level from PATH. The rural dispersion mode in ISCST3 model was selected depending on the land uses where the ASRs are located. The NO_2/NO_X conversion is calculated as follows:

$$[NO_2]pred = 0.1x[NO_X]pred + MIN \{0.9x[NO_X]pred, \text{ or } (46/48)x[O_3]bkgd\}$$

where

$[NO_2]$pred is the predicted NO_2 concentration

$[NO_X]$pred is the predicted NO_X concentration

MIN means the minimum of the two values within the brackets

$[O_3]$bkgd is the representative O_3 background concentration

(46/48) is the molecular weight of NO_2 divided by the molecular weight of O_3

Cumulative Impact of Criteria Air Pollutants

5.6.3.16 The PATH model outputs based on Year 2020 emission inventories were added to the sum of the CALINE4 and ISCST3 model results sequentially on an hour-by-hour basis to derive the short-term and long-term cumulative impacts at each receptor. The highest pollutant concentration predicted at a receptor amongst the 8760 hours was taken as the worst predicted hourly pollutant concentration for that receptor. The maximum 24-hour average pollutant concentration at a receptor amongst the 365 days will be the highest predicted daily average concentration. The annual average pollutant concentration at a receptor will be the average of 8760 hourly concentrations. Since all the vehicular emissions associated with the Project are from ground level only, the maximum predicted 1-hour, 24-hour and annual NO_2 and RSP concentrations at each ASR at 5 levels (including 1.5m, 5m, 10m, 15m and 20m) will therefore represent the worst-case scenario and are then compared with the respective AQOs.

5.6.4 Assessment Result

5.6.4.1 The maximum cumulative 1-hour, 24-hour and annual NO_2 and/or RSP concentrations at each representative ASRs have been assessed and the results are presented in **Table 5.15** and **Table 5.16** below and detailed in **Appendix 5.8**. No exceedances of the relevant AQOs are predicted at all representative ASRs. In addition, as shown in **Appendix 5.8**, the worst affected level of each ASRs is at 1.5m above ground. Contours of 1-hour, 24-hour and annual NO_2, and 24-hour and annual RSP concentrations at 1.5m above ground are therefore plotted in **Drawing no. 209506/EIA/AIR/011-015**. The contour results show that no exceedance zone is predicted within the study area of CBL Project Area. Hence, adverse cumulative air quality impact during the operational phase is not anticipated.

Table 5.15 Predicted Cumulative 1-hour, 24-hour and Annual NO_2 Concentrations at ASRs

ASR ID	Description	Maximum NO_2 Concentrations ($\mu g/m^3$)		
		1-hour (AQO = 300)	24-hour (AQO = 150)	Annual (AQO = 80)
A1	Lohas Park Phase II – Le Prestige Tower 1	241	68	19.3

ASR ID	Description	Maximum NO_2 Concentrations (µg/m^3)		
		1-hour (AQO = 300)	24-hour (AQO = 150)	Annual (AQO = 80)
A2	Lohas Park Phase II – Le Prestige Tower 3	241	66	16.7
A3	Lohas Park (Planned Development in Area 86, Package 3; Stage 2)	252	73	16.5
A4	Lohas Park (Planned Development in Area 86, Package 3; Stage 2)	246	73	16.6
A5	Lohas Park (Planned Development in Area 86, Package 3; Stage 2)	204	62	14.6
A6	Lohas Park Phase I – The Capitol Tower 1	240	64	14.9
A7	Chiaphua-Shinko Centre	244	65	15.7
A8	Metrix Manufacturing (HK) Ltd	260	74	18.8
A9	HSBC Office	250	72	23.2
A10	Hong Kong Oxygen Acetylene Co. Ltd	237	65	18.0
A11	Lohas Park Stage 1 (Planned Development in Area 86, Package 6)	241	66	18.6
A12	Lohas Park Stage 1 (Planned Development in Area 86, Package 6)	241	65	16.6
A13	Lohas Park (Planned Development in Area 86, Package 5; Stage 1)	243	67	19.1
A14	Lohas Park (Planned Development in Area 86, Package 5; Stage 1)	244	66	17.3
A15	Lohas Park Stage 3 (Planned Development in Area 86,Package 11)	241	66	18.5
A16	Lohas Park Stage 3 (Planned Development in Area 86,Package 11)	250	76	20.5

ASR ID	Description	Maximum NO_2 Concentrations (μg/m^3)		
		1-hour (AQO = 300)	24-hour (AQO = 150)	Annual (AQO = 80)
A17	Lohas Park Stage 3 (Planned Development in Area 86,Package 11)	250	74	18.1
A18	Lohas Park Stage 3 (Planned Development in Area 86,Package 10)	249	73	17.2
A19	Tung Wah Group of Hospitals Aided Primary School & Secondary School	241	66	17.7
A20	Planned Primary and Secondary Schools	241	65	15.5
A21	The Beaumount (Under Construction)	204	61	14.2
A22	RTHK Broadcasting House (Planned)	248	70	18.0
A23	Data Centre (Planned)	248	69	17.2

Table 5.16 Predicted Cumulative 24-hour and Annual RSP Concentrations at ASRs

ASR ID	Description	Maximum RSP Concentrations (μg/m^3)	
		24-hour (AQO = 180)	Annual (AQO = 55)
A1	Lohas Park Phase II – Le Prestige Tower 1	100	38.0
A2	Lohas Park Phase II – Le Prestige Tower 3	100	37.9
A3	Lohas Park (Planned Development in Area 86, Package 3; Stage 2)	102	38.2
A4	Lohas Park (Planned Development in Area 86, Package 3; Stage 2)	102	38.2
A5	Lohas Park (Planned Development in Area 86, Package 3; Stage 2)	101	37.3
A6	Lohas Park Phase I – The Capitol Tower 1	100	37.8
A7	Chiaphua-Shinko Centre	100	37.8
A8	Metrix Manufacturing (HK) Ltd	101	38.0

ASR ID	Description	Maximum RSP Concentrations (µg/m³)	
		24-hour (AQO = 180)	Annual (AQO = 55)
A9	HSBC Office	101	38.3
A10	Hong Kong Oxygen Acetylene Co. Ltd	100	37.9
A11	Lohas Park Stage 1 (Planned Development in Area 86, Package 6)	100	38.0
A12	Lohas Park Stage 1 (Planned Development in Area 86, Package 6)	100	37.9
A13	Lohas Park (Planned Development in Area 86, Package 5; Stage 1)	101	38.0
A14	Lohas Park (Planned Development in Area 86, Package 5; Stage 1)	100	37.9
A15	Lohas Park Stage 3 (Planned Development in Area 86,Package 11)	100	38.0
A16	Lohas Park Stage 3 (Planned Development in Area 86,Package 11)	102	38.4
A17	Lohas Park Stage 3 (Planned Development in Area 86,Package 11)	102	38.3
A18	Lohas Park Stage 3 (Planned Development in Area 86,Package 10)	102	38.2
A19	Tung Wah Group of Hospitals Aided Primary School & Secondary School	100	37.9
A20	Planned Primary and Secondary Schools	100	37.8
A21	The Beaumount (Under Construction)	101	37.3
A22	RTHK Broadcasting House (Planned)	101	38.0
A23	Data Centre (Planned)	101	37.9

5.7 Residual Environmental Impacts

5.7.1 Construction Phase

5.7.1.1 With the implementation of the recommended mitigation measures and the dust suppression measures stipulated in Air Pollution Control (Construction Dust) Regulation, no adverse residual air quality impact is anticipated during construction phase.

5.7.2 Operational Phase

5.7.2.1 No adverse residual air quality impact is anticipated during operational phase.

5.8 Conclusion

5.8.1 Construction Phase

5.8.1.1 Potential dust impact would be generated from the soil excavation activities, backfilling, site erosion, storage of spoil on site, and transportation of soil during the construction phase. Quantitative fugitive dust assessments have therefore been conducted for the construction of CBL in accordance with Annex 12, Guidelines for Air Quality Assessment, of the TM-EIAO. The assessment result concluded that watering once per hour on all exposed worksites during working hours (7am – 7pm) will be required to control the fugitive dust impact. With the implementation of recommended mitigation measures, no exceedance of criteria provided by Annex 4, Criteria for Air Quality Assessment, of the TM-EIAO is anticipated during the construction phase.

5.8.2 Operational Phase

5.8.2.1 Cumulative air quality impact arising from the vehicular emissions from the open roads, tunnel portals and the chimney emissions from various industries in the TKOIE has been assessed according to Annex, 12, Guidelines for Air Quality Assessment of the TM-EIAO. The assessment results concluded that all the predicted cumulative 1-hour, 24-hour and annual NO2 and RSP concentrations would comply with the relevant AQOs and Annex 4, Criteria for Air Quality Assessment, of the TM-EIAO during the operational phase.

6 Noise Impact

6.1 Legislation and Standards

6.1.1 General

6.1.1.1 The relevant legislation and associated guidance applicable to present the study for the assessment of noise impacts include:

- Noise Control Ordinance (NCO) (Cap. 400);
- Environmental Impact Assessment Ordinance (EIAO) (Cap. 499);
- Technical Memorandum (TM) on Noise from Construction Work other than Percussive Piling (TM-GW);
- TM on Noise from Percussive Piling (TM-PP); and
- TM on Noise on Construction Work in Designated Areas (TM-DA).

6.1.2 Construction Noise

6.1.2.1 The NCO provides the statutory framework for noise control in Hong Kong. Assessment procedures and standards are set out in the respective TM promulgated under the NCO.

6.1.2.2 To ensure a better environment, the TM-EIAO promulgated under the EIAO has imposed more stringent criteria. For construction, there is no statutory limit on daytime construction noise under the NCO and related TMs. Nevertheless, the TM-EIAO stipulates criteria of 65 - 75dB(A) for daytime construction activities, as shown in **Table 6.1**.

Table 6.1: Noise standards for construction activities

Uses	Noise Standards [1], L_{eq} (30 mins) dB(A)
	0700 to 1900 hours on any day not being a Sunday or general holiday
All domestic premises including temporary housing accommodation	75
Hotels and hostels	75
Educational institutions including kindergartens, nurseries and all others where unaided voice communication is required	70 65 (During examinations)

Notes:

[1] The above standards apply to uses that rely on opened windows for ventilation.

Construction During Normal Restricted Hours

6.1.2.3 The NCO also provides statutory control on general construction works during restricted hours (ie 1900 to 0700 hours (of the next day) from Monday to Saturday and at any time on Sundays or public holidays). The use of Powered Mechanical Equipment (PME) for construction works during restricted hours would require a Construction Noise Permit (CNP). The TM-GW details the procedures adopted by EPD for assessing a CNP application. The granting of a CNP is subject to conditions stated in the CNP and it may be revoked at any time for failure to comply with the permit conditions.

6.1.2.4 In addition to the general controls on the use of PME during restricted hours, the use of Specified Powered Mechanical Equipment (SPME) and the undertaking of Prescribed Construction Work (PCW) during the restricted hours in a designated area are controlled by the TM-DA. Construction plant or equipment classified as SPME under the TM-DA includes hand-held breakers, bulldozers, concrete mixer lorries, dump trucks and poker vibrators. The PCW includes the erection or dismantling of formwork or scaffolding, hammering, handling of rubble, wooden boards, steel bars, or scaffolding material, and the disposal of rubble through plastic chutes.

6.1.2.5 The TM-DA details the procedures that should generally be adopted by the Noise Control Authority for assessing the use of SPME during restricted hours and for determining whether a CNP would be issued.

6.1.2.6 Maximum noise levels from construction activities during restricted hours at affected Noise Sensitive Receivers (NSRs) are controlled under the TMs and shall not exceed the specified Acceptable Noise Levels (ANLs). These ANLs are stipulated in accordance with the Area Sensitivity Ratings (ASR) established for the NSRs. The ANLs for construction works in Designated Areas are more stringent than those given in the TM-GW and are summarised in **Table 6.2**.

Table 6.2: ANLs for construction during restricted hours

Time Period	Acceptable Noise Levels for Area Sensitivity Ratings, dB(A)		
	A	B	C
All weekdays during the evening (1900 to 2300 hours), and general holidays (including Sundays) during the day and evening (0700 to 2300 hours)	60 (45)	65 (50)	70 (55)
All days during the night-time (2300 to 0700 hours)	45 (30)	50 (35)	55 (40)

Note: Figures in brackets are ANLs for SPME construction work in designated areas

6.1.2.7 Despite any description made in the report, there is no guarantee that a CNP will be issued for the project construction. The Noise Control Authority will consider a well-justified CNP application, once filed, for construction works within restricted hours as guided by the relevant TMs issued under the NCO. The Noise Control Authority will take into account contemporary conditions / situations of adjoining land uses and any previous complaints against construction activities at the site before making a decision in granting a CNP. Nothing in the report shall bind the Noise Control Authority in making a decision. If a CNP is to be issued, the Noise Control Authority shall include any conditions it may demand. Failure to comply with any such conditions will lead to cancellation of the CNP and prosecution under the NCO.

Percussive Pilling

6.1.2.8 Under the TM-PP, CNPs are also required for percussive piling involving the use of diesel, pneumatic and / or steam hammer. This TM specifies the permitted hours and other conditions for percussive piling. **Table 6.3** lists the acceptable percussive piling noise levels for various types of NSR.

Table 6.3: ANLs for percussive piling

NSR Window Type or Means of Ventilation	ANL, dB(A)
(i) NSR (or part of NSR) with no window or other opening	100
(ii) NSR with central air conditioning system.	90
(iii) NSR with windows or other openings but without central air conditioning system	85

6.1.2.9 Depending on the number and type of piling machines and the separation distance from NSRs, percussive piling may be restricted to

12, 5 or 3 hours per day. For NSRs that are particularly sensitive to noise, such as hospitals, medical clinics, educational institutions and courts of law, a further reduction of 10 dB(A) shall be applied to the above ANLs.

6.1.2.10 To minimize the construction noise impact, alternative construction methods to replace percussive piling and blasting shall be proposed as far as practicable.

6.1.3 Operational Noise

6.1.3.1 The TM-EIAO stipulates the noise standards for road traffic noise source as shown in **Table 6.4**.

Table 6.4: Noise standards for operational phase

Common Uses	**Noise Standards [1]**
	Road Traffic Noise $L_{10\ (1hour)}$ dB(A)
All domestic premises including temporary housing accommodation	70
Hotels and hostels	70
Offices	70
Educational institutions including kindergartens, nurseries and all others where unaided voice communication is required	65
Places of public worship and courts of law	65
Hospitals, clinics, convalescences and homes for the aged, diagnostic rooms, wards	55

Notes:
[1] The above standards apply to uses that rely on opened windows for ventilation.

6.2 Description of Existing Environment

6.2.1.1 Representative NSRs in the vicinity are within the TKO Area 86 development. Hence, the existing ambient noise climate is dominated by road traffic from the nearby Wan Po Road and Wan O Road.

6.3 Noise Sensitive Receivers & Pollution Sources

6.3.1 Sensitive Receivers

6.3.1.1 With reference to Annex 13 of the TM-EIAO, the potential NSRs could be, but not limited to the following: residential uses (all domestic premises including temporary housing), institutional uses (educational institutions including kindergarten and nurseries, hospitals, medical clinics, homes for the aged, convalescent homes, places of public worship, libraries, courts of law, performing arts centres, auditoria and amphitheatres), and others (country parks and hostels).

6.3.1.2 Representative NSRs within the assessment area (a distance of 300m from the project boundary) have been identified. The first layer NSRs have been selected for assessment. These NSRs include both the existing and planned sensitive receivers.

6.3.1.3 The existing NSRs have been identified by means of topographic maps, aerial photos, land status plans and several site surveys. Planned / committed NSRs have been identified by making reference to relevant Outline Zoning Plans, Outline Development Plans, Layout Plans and other relevant published land use plans, including plans and drawings published by Lands Department and any land use and development applications approved by the Town Planning Board.

6.3.1.4 The representative existing and planned NSRs in the vicinity are summarized in **Table 6.5**. The locations of NSRs are illustrated in **Drawing no. 209506/EIA/NS/001**.

6.3.1.5 According to "MTR Tseung Kwan O Line, Tseung Kwan O LOHAS Park CDA – Class B Amendments To The Approved Master Layout Plan", the TKO Area 86 development will include three stages: Stage 1 (2005-2018); Stage 2 (2008-2019) and Stage 3 (2011-2020). Please refer to **Drawing no. 209506/EIA/NS/001** for the demarcation.

Table 6.5: Locations of representative noise sensitive receivers

NSR No.	Description	Landuse	No. of Storeys	Type of Assessment	
				Construction	Operation
Existing					
R2	Lohas Park, Le Prestige, Tower 1 (South facade)	Residential	49	√	√

NSR No.	Description	Landuse	No. of Storeys	Type of Assessment	
				Construction	Operation
R3	Lohas Park, Le Prestige, Tower 2 (Southwest facade)	Residential	54	- [2]	√
Planned					
R1	Lohas Park Stage 1(Planned Development in Area 86, Package 2) (South facade)	Residential	55	√	- [2]
R6	Lohas Park Stage 1 (Planned Development in Area 86, Package 6) (Southeast facade)	Residential	46	√	√
R7	Lohas Park Stage 1 (Planned Development in Area 86, Package 6) (Southwest facade)	Residential	46	- [2]	√
R8	Lohas Park Stage 1 (Planned Development in Area 86, Package 6) (South facade)	Residential	46	√	√
R9	Lohas Park Stage 1 (Planned Development in Area 86, Package 6) (South facade)	Residential	49	√	√
R10	Lohas Park Stage 1 (Planned Development in Area 86, Package 6) (South facade)	Residential	55	√	√
R12	Lohas Park Stage 1(Planned Development in Area 86, Package 5) (Southeast facade)	Residential	55	√	√
R13	Lohas Park Stage 1 (Planned Development in Area 86, Package 5) (Southwest facade)	Residential	55	- [2]	√
R14	Lohas Park Stage 1 (Planned Development in Area 86, Package 5) (Southeast	Residential	55	√	√

NSR No.	Description	Landuse	No. of Storeys	Type of Assessment	
				Construction	Operation
	facade)				
R15	Lohas Park Stage 1 (Planned Development in Area 86, Package 5) (Southwest facade)	Residential	55	- [2]	√
R16	Lohas Park Stage 1 (Planned Development in Area 86, Package 5) (South facade)	Residential	57	√	√
R17	Lohas Park Stage 1 (Planned Development in Area 86, Package 5) (Southwest facade)	Residential	57	- [2]	√
R18	Lohas Park Stage 1 (Planned Development in Area 86, Package 5) (Southwest facade)	Residential	57	√	√
R22	Lohas Park Stage 3 (Planned Development in Area 86,Package 11) (Southeast facade)	Residential	56	√	√
R23	Lohas Park Stage 3 (Planned Development in Area 86,Package 11) (Southeast facade)	Residential	56	√	√
R24	Lohas Park Stage 3 (Planned Development in Area 86,Package 11) (Southeast facade)	Residential	56	√	√
R25	Lohas Park Stage 3 (Planned Development in Area 86,Package 11) (Southeast facade)	Residential	52	√	√
R26	Lohas Park Stage 3 (Planned Development in Area 86,Package 11) (Southwest facade)	Residential	49	- [2]	√

NSR No.	Description	Landuse	No. of Storeys	Type of Assessment	
				Construction	Operation
R27	Lohas Park Stage 3 (Planned Development in Area 86,Package 11) (West facade)	Residential	49	√	√
R28	Lohas Park Stage 3 (Planned Development in Area 86,Package 11) (Northwest facade)	Residential	49	- [2]	√
R29	Lohas Park Stage 3 (Planned Development in Area 86,Package 10) (Southwest facade)	Residential	55	√	√
R30	Lohas Park Stage 3 (Planned Development in Area 86,Package 10) (Southwest facade)	Residential	55	- [2]	√
R31	Lohas Park Stage 3 (Planned Development in Area 86,Package 10) (Southwest facade)	Residential	49	- [2]	√
R32	Lohas Park Stage 3 (Planned Development in Area 86,Package 10) (West facade)	Residential	55	√	√
R33	Planned Primary School & Secondary School near Wan Po Road (Southwest facade)	Educational	5[1]	√	√
R34	Planned Primary and Secondary Schools (South facade)	Educational	5[1]	√	- [2]

Note: [1] All planned schools are assumed to have 5 storeys.
[2] Representative sensitive receivers have been selected. Hence, they are not selected for the assessment.

6.3.1.6 The residential premises of Lohas Park of TKO Area 86 have previously been assessed in the “MTR Tseung Kwan O Line, Tseung Kwan O Area 86 CDA, Class B Amendments to the Approved Master Layout Plan Submission under Section 16A of the Town Planning

Ordinance – Revision 5" submitted in March 2006. Building orientation and mitigation measures such as fixed glazing, bay window to reduce the angle of view and balcony for those NSRs were included in the approved scheme by the Area 86 development proponent.

6.3.1.7 These at receiver mitigation measures were proposed for noise sensitive receivers that face the junction of Road R5 and Road D9. It was recognized at the time of planning of Lohas Park that a discontinuity in noise barriers to be provided alongside Road D9 would be unavoidable due to the road junction.

6.3.1.8 It was assumed at the time of planning Lohas Park that the Road D9 noise barriers would be cantilevered structures beside the carriage ways.

6.3.1.9 Inevitably, the location of noise barriers alongside Road D9 would have to accommodate traffic engineering and sight line requirements in order for the road junctions to operate safely for pedestrians and road users. Accordingly, the CBL project would need to provide the same or equivalent performing noise mitigation measures to those assumed by the Area 86 Lohas Park proponent.

6.4 Potential Concurrent Projects

6.4.1.1 The potential concurrent projects in the vicinity of the CBL project and their program are shown in **Table 6.6**.

Table 6.6: Potential concurrent projects and their program

Concurrent Project	Construction Program
TKO-LT Tunnel	2017 - 2020
Hong Kong Offshore Wind Farm in Southeastern Waters	Early of 2017 – Late of 2017
TKO Area 86 Development	
Stage 1	Early of 2005 – End of 2018
Stage 2	Mid of 2008 – End of 2019
Stage 3	Late of 2011 – End of 2020
TKO Area 85 Residential Development	[1]
RTHK Development of New Broadcasting House	[2]

Note:

[1] The distance from the site boundary of CBL to TKO Area 85 is greater than 300m. Hence the cumulative impact is not taken into account.
[2] The project is undergoing the procedure of application and has not been approved yet.

6.4.1.2 The distances from the closest work sites of TKO-LT Tunnel and HK Offshore Wind Farm in Southeastern Waters to the representative NSRs are 1000m and 750m respectively. Hence, their cumulative impacts have not been taken into account. However, cumulative impact due to the construction of TKO Area 86 Lohas Park Development has been included.

6.4.1.3 The TKO Area 85 Residential Development is still undergoing the procedures of Broad Development Parameters of the Applied Use /Development. The distances from the centre of the site to the CBL will be more than 300m. Therefore, the cumulative noise impact is not anticipated.

6.4.1.4 Area 137 and a presently vacant site on the southern side of Road D9, adjacent to Wan Po Road, will be used as temporary work sites for temporary material stockpiling. As Area 137 is 300m away from the NSRs and there is no evening and night-time work due to CBL construction, the construction noise impact from area 137 is not included in the construction noise assessment.

6.4.1.5 The New Broadcasting House of RTHK is presently undergoing the technical feasibility study. The location and construction programme of the site are not yet approved. Hence, the construction noise impact from RTHK Development is not included in the construction noise assessment. Furthermore, according to Architectural Services Department, centralized air conditioning system will be provided to the building, and therefore the building would not be noise sensitive during the operational phase of CBL. Since the New Broadcasting House will be equipped with centralized air conditioning system, no further actions are required by the CBL project proponent.

6.5 Assessment Methodology

6.5.1 Construction Phase

6.5.1.1 Assessment Procedures

6.5.1.2 Construction noise assessment will be conducted based on the following procedures:

- Determine the assessment area;
- Identify and locate representative NSRs that may be affected by the works;
- Identify the construction method and work sequence for the construction period;
- Identify the construction plant inventory for each corresponding construction work sequence;
- Determine the sound power levels of the plant items according to the information stated in the TM-GW or other recognised sources of reference, where appropriate;
- Apply corrections for facade, distance, barrier attenuation, acoustic reflection where applicable;
- Predict construction noise levels at the NSRs;
- Quantify the level of impact at the NSRs, in accordance with TM-GW; and
- Predict the cumulative noise impacts for any concurrent construction works in the vicinity of the proposed work.

6.5.1.3 Noise Assessment Tool

6.5.1.4 An in-house program has been used for construction noise calculations. Initially, program runs were conducted without mitigation measures (i.e. the "Unmitigated Scenario"). Should exceedence be identified, further runs would be made with mitigation measures incorporated (i.e. the "Mitigated Scenario).

6.5.2 Operational Phase

6.5.2.1 Road Traffic Noise

6.5.2.2 Road traffic noise calculation is based on the method of UK Department of Transport "Calculation of Road Traffic Noise (CRTN)". The predicted noise levels at the sensitive receivers include 2.5dB(A) facade reflection and correction factors of effects due to gradient, distance, view angle, road surface and barriers.

6.5.2.3 The computer programme, RoadNoise 2000, has been used to model traffic noise from road networks. It complies with the Calculation of Road Traffic Noise (CRTN) developed by the UK Department of Transport.

6.5.2.4 According to the EIA Study Brief, calculations of future road traffic noise will be based on the peak hourly flow for the maximum traffic projected within a 15 years period upon commencement of operation. The traffic projection will take into account the induced traffic due to the operation of other planned roads and committed projects. Since the commencement year for CBL is Year 2021, the assessment year for road traffic noise is taken at Year 2036.

6.6 Construction Noise Assessment

6.6.1 Tentative Construction Programme

6.6.1.1 The tentative construction programmes showing the construction period of CBL and road D9 are shown in **Appendix 4.1**.

6.6.2 Construction Noise Source

6.6.2.1 The major construction works for CBL would include the following activities:

- Install piles by marine piling rigs;
- Erect cofferdam;
- Build pile caps;
- Build piers
- Erect concrete deck segments of the approach; and
- Install main bridge & side spans.

6.6.2.2 The major construction works for Road D9 would include the following activities:

- Install sheet piles along the sea wall and pump out the water;
- Excavate the soil behind the seawall;
- Strengthen/expand the existing seawall;
- Backfill the excavated soil;
- Ground improvement by compaction grouting;
- Piling for noise barrier; and
- Noise barrier erection

6.6.2.3 These construction activities will involve the use of Powered Mechanical Equipment (PME) including air compressor, excavators, lorries, mobile cranes, concrete lorry mixers, pokers, rollers, etc. The types of PME adopted are listed in **Table 6.7** and **Appendix 6.2**.

6.6.2.4 The utilization rates, which have been reviewed by the Project Engineer, are also presented in **Table 6.7** and **Appendix 6.2**. In practice, the PME will not be operating at all times within a work site. However, the following construction noise assessment will demonstrate a worst case scenario. The construction plant inventory used in the assessment has been confirmed to be representative of the works by the project proponent.

Table 6.7: PMEs and their utilization rates

PME	Typical Utilisation Rate (%)
Air Compressor (CNP003)	100%
Asphalt Paver (CNP004)	100%
Bar Bender and Cutter (CNP021)	100%
Hand-held breaker (CNP026)	100%
Break (Pneumatic) (CNP027)	100%
Breaker, Excavator Mounted (Hydraulic) (CNP028)	100%
Bulldozer (CNP030)	100%
Concrete Mixer (CNP045)	70%
Concrete Lorry Mixer (CNP044)	70%
Concrete Pump (CNP047)	100%
Crane Mobile (CNP048)	100%
Tower Crane (CNP050)	100%
Compactor, vibratory (CNP050)	100%
Cutter, Circular, Steel (CNP056)	100%
Crane Barge (CNP061)	100%
Dump Barge (CNP061)	100%
Derrick Barge (CNP061)	100%
Grab dredger (CNP063)	100%
Dump Truck (CNP067)	70%
Drill, Hand-Held (Battery) (CNP071)	100%
Excavator/Loader, Wheeled/Tracker (CNP081)	100%
Backactor (CNP081)	100%
Mini Backhoe (CNP082)	100%
Generator, silenced (CNP103)	100%
Grout Pump (CNP106)	100%

PME	Typical Utilisation Rate (%)
Welder/Generator, portable (CNP107)	100%
Lorry (CNP141)	70%
Paint Line Marker (CNP161)	100%
Piling, Large Diameter Bored, Grab and Chisel (CNP164)	100%
Piling, Large Diameter Bored, reverse circulation drill (CNP166)	100%
Piling rig and drilling rig (CNP167)	100%
Poker, Vibratory, Hand-held (CNP170)	100%
Piling, Vibrating Hammer (CNP172)	100%
Roller (CNP185)	100%
Tug boat (CNP221)	100%
Water Pump (CNP281)	100%
Crane Truck (CNP144)	100%

6.6.3 Assessment Results (Unmitigated Scenario)

6.6.3.1 According to the latest engineering design, construction works would mainly comprise the activities as described in **Section 6.6.2**. The corresponding SWLs of these activities have been predicted according to the SWLs of the PME and the assessment methodology listed in TM-GW. **Appendix 6.3** lists the plant inventory adopted for each workfront and **Appendix 6.4** illustrates the distances between the notional sources and the NSRs.

6.6.3.2 **Appendix 6.5** presents the monthly unmitigated noise level contributed by different workfronts of CBL during construction period at the representative NSRs and **Appendix 6.6** presents the calculated construction noise impacts. The predicted construction noise impacts of CBL at the NSRs under unmitigated scenario are summarised in **Table 6.8** below.

Table 6.8: Predicted construction noise impact at NSRs under unmitigated scenario

NSR No.	Description	Landuse	Criterion, dB(A) [1]	Unmitigated Noise Level dB(A) [2]	Exceedance, dB(A)
Existing					
R2	Lohas Park, Le Prestige, Tower 1 (South facade)	Residential	75	**77**	2

NSR No.	Description	Landuse	Criterion, dB(A) [1]	Unmitigated Noise Level dB(A) [2]	Exceedance, dB(A)
Planned					
R1	Lohas Park Stage 1(Planned Development in Area 86, Package 2) (South facade)	Residential	75	68	-
R6	Lohas Park Stage 1 (Planned Development in Area 86, Package 6) (Southeast facade)	Residential	75	**82**	7
R8	Lohas Park Stage 1 (Planned Development in Area 86, Package 6) (South facade)	Residential	75	**81**	6
R9	Lohas Park Stage 1 (Planned Development in Area 86, Package 6) (South facade)	Residential	75	**82**	7
R10	Lohas Park Stage 1 (Planned Development in Area 86, Package 6) (South facade)	Residential	75	**83**	8
R12	Lohas Park Stage 1(Planned Development in Area 86, Package 5) (Southeast facade)	Residential	75	**89**	14
R14	Lohas Park Stage 1 (Planned Development in Area 86, Package 5) (Southeast facade)	Residential	75	**91**	16

NSR No.	Description	Landuse	Criterion, dB(A) [1]	Unmitigated Noise Level dB(A) [2]	Exceedance, dB(A)
R16	Lohas Park Stage 1 (Planned Development in Area 86, Package 5) (South facade)	Residential	75	**88**	13
R18	Lohas Park Stage 1 (Planned Development in Area 86, Package 5) (Southwest facade)	Residential	75	**85**	10
R22	Lohas Park Stage 3 (Planned Development in Area 86,Package 11) (Southeast facade)	Residential	75	**82**	7
R23	Lohas Park Stage 3 (Planned Development in Area 86,Package 11) (Southeast facade)	Residential	75	**85**	10
R24	Lohas Park Stage 3 (Planned Development in Area 86,Package 11) (Southeast facade)	Residential	75	**88**	13
R25	Lohas Park Stage 3 (Planned Development in Area 86,Package 11) (Southeast facade)	Residential	75	**89**	14
R27	Lohas Park Stage 3 (Planned Development in Area 86,Package 11) (West facade)	Residential	75	**89**	14

NSR No.	Description	Landuse	Criterion, dB(A) [1]	Unmitigated Noise Level dB(A) [2]	Exceedance, dB(A)
R29	Lohas Park Stage 3 (Planned Development in Area 86,Package 10) (Southwest facade)	Residential	75	**87**	12
R32	Lohas Park Stage 3 (Planned Development in Area 86,Package 10) (West facade)	Residential	75	**78**	3
R33	Planned Primary School & Secondary School near Wan Po Road (Southwest facade)	Educational	70 (65) [1]	**79**	9(14)
R34	Planned Primary and Secondary Schools (South facade)	Educational	70 (65) [1]	**77**	7 (12)

Note:
[1] Values in parentheses indicate the noise criterion during examination period of educational institution.
[2] Bolded values mean exceedence of the noise criteria

6.6.3.3 As shown in above table, the predicted unmitigated construction noise levels at most residential receivers, except Lohas Park Stage 1 (R1), will exceed the noise criteria by 2-16 dB(A) and in the range of 68 – 91 dB(A).

6.6.3.4 For educational institutions, the predicted unmitigated construction noise levels will exceed the normal period noise criterion and examination period noise criterion by 7-9 dB(A) and 12-14 dB(A) respectively and in the range of 77 – 79 dB(A).

6.6.4 Mitigation Measures

6.6.4.1 Unmitigated construction noise would exceed the daytime noise criteria. Mitigation measures are therefore required. The following mitigation measures have been considered:

- Good site practices to limit noise emissions at the source;
- Use of quiet plant and working methods;
- Use of site hoarding as noise barrier to screen noise at ground level of NSRs;
- Use of shrouds / temporary noise barriers to screen noise from relatively static PMEs;
- Scheduling of construction works outside school examination periods in critical area; and
- Alternative use of plant items within one worksite, wherever practicable.

6.6.4.2 Detailed descriptions of these mitigation measures are given in the following sections.

<u>Good Site Practice and Noise Management techniques</u>

6.6.4.3 Good site practice and noise management techniques could considerably reduce the noise impact from construction site activities on nearby NSRs. The following measures should be followed during each phase of construction:

- Only well-maintained plant should be operated on-site and the plant should be serviced regularly during the construction programme;
- Machines and plant (such as trucks, cranes) that are in intermittent use should be shut down between work periods or should be throttled down to a minimum;
- Plant known to emit noise strongly in one direction, where possible, should be orientated so that the noise is directed away from nearby NSRs;
- Silencers or mufflers on construction equipment should be properly fitted and maintained during the construction works;
- Mobile plant should be sited as far away from NSRs as possible and practicable; and
- Material stockpiles, site office and other structures should be effectively utilised, where practicable, to screen noise from on-site construction activities.

6.6.4.4 The benefits of these techniques can vary according to specific site conditions and operations. The environmental noise climate would certainly be improved through these control practices, although the improvement can only be quantified during implementation when specific site parameters are known. The assessment has therefore not taken into account the effectiveness of Good Site Practices and Noise Management Techniques.

Quiet Plant and Working Methods

6.6.4.5 The use of quiet plant is a feasible solution to tackle adverse noise impacts associated with construction works. It is generally known (supported by field measurement) that particular models of construction equipment are quieter than standard types given in the TM-GW. Whilst it is generally considered too restrictive to specify that the Contractor has to use specific models or items of plant, it is reasonable and practicable to set plant noise performance specifications for specific PME so that more flexibility is allowed. A pragmatic approach would be to request that the Contractor should independently verify the noise level of the plant proposed to be used and demonstrate through furnishing of these results, that the plant proposed to be used on the site meets the requirements.

6.6.4.6 The use of quiet plant associated with the construction works is prescribed in British Standard “Noise Control on Construction and Open Sites, BS5228: Part 1: 2009” which contains the SWLs for specific quiet PME.

Use of site hoarding

6.6.4.7 Purposed built temporary noise barriers (approx 2.4m high) located at the site boundaries between noisy construction activities and NSRs could generally reduce noise levels at lower height NSRs through partial screening. In general, this would provide a minimum 5 dB(A) attenuation for the low level receivers. It would be possible for the Contractor to provide these in the form of site hoardings to achieve this attenuation effect, provided that the hoardings have no openings or gaps and have a superficial surface density of at least $14kg/m^2$. Good site practice shall also be adopted by the Contractor to ensure that the conditions of the hoardings are properly maintained throughout the construction period. As a conservative approach, however, site hoarding has not been taken into consideration in the construction noise assessment.

<u>Use of Temporary or Movable Noise Barriers and Full Enclosure for Relatively Fixed Plant source</u>

6.6.4.8 Movable temporary noise barriers that can be located close to noisy plant and be moved concurrently with the plant along a worksite can be very effective for screening noise from NSRs. A typical design which has been used locally is a wooden framed barrier with a small-cantilevered upper portion of superficial density no less than 14kg/m^2 on a skid footing with 25mm thick internal sound absorptive lining. This measure is particularly effective for low level zone of NSRs. A cantilevered top cover would be required to achieve screening benefits at upper floors of NSRs.

6.6.4.9 Movable barriers will be used for some PME (e.g. pipe pile rigs, auger). It is anticipated that suitably designed barriers could achieve at least 5dB(A) reduction for movable plant and 10dB(A) for stationary plant.

6.6.4.10 The use of standard enclosure has been considered in this assessment to shelter relatively fixed plant including air compressor, generator, etc. These standard enclosures can provide about 15dB(A) noise reduction. For horizontal jack, movable noise barriers of 5dB(A) attenuation have been assumed.

6.6.4.11 A summary of the barriers and standard enclosures adopted for various PMEs and the indicative drawings are shown in **Appendix 6.7**. Their associated noise reductions are given in **Appendix 6.2**.

6.6.5 Assessment Results (Mitigated Scenario)

6.6.5.1 With the implementation of the above mentioned mitigation measures, the predicted mitigated construction noise levels at representative NSRs are presented in **Table 6.9**. **Appendix 6.8** presents the monthly mitigated noise contribution from different work fronts during the construction period and **Appendix 6.9** presents the combined mitigated construction noise impacts on representative NSRs.

Table 6.9: Predicted construction noise impact on NSRs under mitigated scenario

NSR No.	Description	Landuse	Criteria, dB(A) [1]	Mitigated Noise Level dB(A)	Exceedance, dB(A)
Existing					
R2	Lohas Park, Le Prestige, Tower 1 (South facade)	Residential	75	63	-
Planned					
R1	Lohas Park Stage 1(Planned Development in Area 86, Package 2) (South facade)	Residential	75	54	-
R6	Lohas Park Stage 1 (Planned Development in Area 86, Package 6) (Southeast facade)	Residential	75	67	-
R8	Lohas Park Stage 1 (Planned Development in Area 86, Package 6) (South facade)	Residential	75	65	-
R9	Lohas Park Stage 1 (Planned Development in Area 86, Package 6) (South facade)	Residential	75	66	-
R10	Lohas Park Stage 1 (Planned Development in Area 86, Package 6) (South facade)	Residential	75	67	-
R12	Lohas Park Stage 1(Planned Development in Area 86, Package 5) (Southeast facade)	Residential	75	73	-
R14	Lohas Park Stage 1 (Planned Development in	Residential	75	74	-

NSR No.	Description	Landuse	Criteria, dB(A) [1]	Mitigated Noise Level dB(A)	Exceedance, dB(A)
	Area 86, Package 5) (Southeast facade)				
R16	Lohas Park Stage 1 (Planned Development in Area 86, Package 5) (South facade)	Residential	75	72	-
R18	Lohas Park Stage 1 (Planned Development in Area 86, Package 5) (Southwest facade)	Residential	75	69	-
R22	Lohas Park Stage 3 (Planned Development in Area 86,Package 11) (Southeast facade)	Residential	75	66	-
R23	Lohas Park Stage 3 (Planned Development in Area 86,Package 11) (Southeast facade)	Residential	75	69	-
R24	Lohas Park Stage 3 (Planned Development in Area 86,Package 11) (Southeast facade)	Residential	75	72	-
R25	Lohas Park Stage 3 (Planned Development in Area 86,Package 11) (Southeast facade)	Residential	75	73	-
R27	Lohas Park Stage 3 (Planned	Residential	75	73	-

NSR No.	Description	Landuse	Criteria, dB(A) [1]	Mitigated Noise Level dB(A)	Exceedance, dB(A)
	Development in Area 86,Package 11) (West facade)				
R29	Lohas Park Stage 3 (Planned Development in Area 86,Package 10) (Southwest facade)	Residential	75	71	-
R32	Lohas Park Stage 3 (Planned Development in Area 86,Package 10) (West facade)	Residential	75	62	-
R33	Planned Primary School & Secondary School near Wan Po Road (Southwest facade)	Educational	70 (65)[1]	65	-
R34	Planned Primary and Secondary Schools (South facade)	Educational	70 (65)[1]	62	-

Note:
[1] Values in parentheses indicate the noise criterion during examination period of educational institution.

6.6.5.2 As shown in above table, the predicted mitigated construction noise levels at all the residential NSRs would comply with the criterion of 75 dB(A) and in the range of 54 – 74dB(A).

6.6.5.3 For educational institution, the predicted mitigated construction noise levels would comply with the criterion during normal period and examination period respectively. The predicted noise levels at the educational institutions would be in the range of 62 – 65 dB(A).

6.6.6 Cumulative Impacts

6.6.6.1 Potential concurrent projects will include the TKO Area 86 development. For the development programme of TKO Area 86

Development, reference was made to "MTR Tseung Kwan O Line, Tseung Kwan O LOHAS Park CDA – Amendments To The Approved Master Layout Plan". As the construction plant inventory for TKO Area 86 Development was not available, the plant inventory was determined according to EIA-144/2008 "Proposed Comprehensive Development at Wo Shang Wai, Yuen Long". The plant inventory for the substructure and superstructure construction activities in that study have been adopted as a reasonable similar prediction of noise impacts due the construction of TKO Area 86 Development. **Table 6.10** summarises the predicted cumulative noise level at representative NSRs. **Appendix 6.10** presents the monthly mitigated noise contribution from different work fronts and concurrent projects on representative NSRs. **Appendix 6.11** presents the predicted cumulative construction noise impacts. A sample calculation of the predicted sound pressure level at an NSR on a monthly basis is presented in **Appendix 6.12**.

Table 6.10: Cumulative noise impact on representative NSRs

NSR No.	Description	Construction Noise Contribution dB(A)				Criteria [1] dB(A)	Total [2] dB(A)	Exceedance dB(A)	Duration of Exceedence Months
		LOHAS Park			CBL				
		Stage 1 (S10)	Stage 2 (S11)	Stage 3 (S12)					
Existing									
R2	Lohas Park, Le Prestige, Tower 1 (South facade)	65	- [4]	- [3]	63	75	67	-	-
Planned									
R1	Lohas Park Stage 1 (Planned Development in Area 86, Package 2) (South facade)	59	58	- [3]	54	75	62	-	-
R6	Lohas Park Stage 1 (Planned Development in Area 86, Package 6) (Southeast facade)	- [5]	- [4]	- [3]	67	75	67	-	-
R8	Lohas Park Stage 1 (Planned Development in Area 86, Package 6) (South facade)	- [5]	- [4]	55	65	75	65	-	-
R9	Lohas Park Stage 1 (Planned Development in Area 86,	- [5]	- [4]	- [4]	66	75	66	-	-

NSR No.	Description	Construction Noise Contribution dB(A)				Criteria [1] dB(A)	Total [2] dB(A)	Exceedance dB(A)	Duration of Exceedence Months
		LOHAS Park			CBL				
		Stage 1 (S10)	Stage 2 (S11)	Stage 3 (S12)					
	Package 6) (South facade)								
R10	Lohas Park Stage 1 (Planned Development in Area 86, Package 6) (South facade)	- [5]	- [4]	- [4]	67	75	67	-	-
R12	Lohas Park Stage 1(Planned Development in Area 86, Package 5) (Southeast facade)	- [5]	- [4]	- [4]	73	75	73	-	-
R14	Lohas Park Stage 1 (Planned Development in Area 86, Package 5) (Southeast facade)	- [5]	- [4]	- [4]	74	75	74	-	-
R16	Lohas Park Stage 1 (Planned Development in Area 86, Package 5) (South facade)	- [5]	- [4]	- [4]	72	75	72	-	-
R18	Lohas Park Stage 1 (Planned Development in Area 86, Package 5) (Southwest facade)	- [5]	- [4]	- [4]	69	75	69	-	-
R22	Lohas Park Stage 3 (Planned Development in Area 86,Package 11) (Southeast facade)	68	- [4]	- [5]	66	75	69	-	-
R23	Lohas Park Stage 3 (Planned Development in Area 86,Package 11) (Southeast facade)	68	- [4]	- [5]	69	75	71	-	-
R24	Lohas Park Stage 3 (Planned Development in Area 86,Package 11) (Southeast facade)	66	- [4]	- [5]	72	75	72	-	-

NSR No.	Description	Construction Noise Contribution dB(A)				Criteria [1] dB(A)	Total [2] dB(A)	Exceedance dB(A)	Duration of Exceedence Months
		LOHAS Park			CBL				
		Stage 1 (S10)	Stage 2 (S11)	Stage 3 (S12)					
R25	Lohas Park Stage 3 (Planned Development in Area 86,Package 11) (Southeast facade)	62	- [4]	- [5]	73	75	74	-	-
R27	Lohas Park Stage 3 (Planned Development in Area 86,Package 11) (West facade)	- [5]	- [4]	- [5]	73	75	73	-	-
R29	Lohas Park Stage 3 (Planned Development in Area 86,Package 10) (Southwest facade)	- [4]	- [4]	- [5]	71	75	71	-	-
R32	Lohas Park Stage 3 (Planned Development in Area 86,Package 10) (West facade)	- [3]	- [4]	- [5]	62	75	62	-	-
R33	Planned Primary School & Secondary School near Wan Po Road (Southwest facade)	- [5]	- [4]	- [4]	65	70 (65) [1]	66	- (1)	0(4)
R34	Planned Primary and Secondary Schools (South facade)	66	- [4]	- [5]	62	70 (65) [1]	67	- (2)	0(46)

Notes:
[1] Values in parentheses indicate the exceedence during examination period of educational institution.
[2] Cumulative impacts arisen from TKO Area 86 Development and CBL are included.
[3] The notional source is out of 300m of the assessment area.
[4] The notional source is located behind of the assessment point.
[5] Buildings have been erected and no construction in this area.

6.6.6.2 As shown in the above table, the predicted noise levels at all the residential NSRs would comply with the criterion of 75 dB(A) and in the range of 62 – 74dB(A).

6.6.6.3 For educational institutions, the predicted noise levels would comply with the criterion of 70 dB(A) during normal period and in the range of 66 – 67dB(A). However, 1 – 2 dB(A) exceedence of the 65 dB(A) criterion and the duration of exceedences ranges from 4 – 46 months during examination period is predicted at the Planned Primary and Secondary School (R33 & R34). Typical examination period includes May, June, November and December, so the anticipated duration is approximately 16 months. In addition, examination period should only last for 2 weeks. The intake year for the Planned Primary and Secondary School (R33 & R34) and the construction programme for Lohas Park Stage 1, Stage 2 and Stage 3 are not yet confirmed. The predicted exceedance and duration of exccedance is a conservative estimate as the current cumulative assessment has assumed the construction period of Lohas Park will be continuous throughout the construction of CBL.

6.6.6.4 The contractor will be required further confirm the construction programme of R33 & R34 at the commencement of the construction of CBL work. The CBL construction work at Road D9 will be scheduled to avoid the examination period at the Planned Primary and Secondary Schools if they are open (R33 & R34) during CBL construction work.

6.7 Road Traffic Noise Assessment

6.7.1 Traffic Flow

6.7.1.1 Major roads in the vicinity of the Study Boundary include CBL, D9 Road, Wan Po Road and Road R5 within the Lohas Park Area 86 development. The general layout plan and Study Boundary are shown in the **Drawing no. 209506/EIA/IN/001**. The traffic data have been approved by Transport Department in 2012 and 2013 (**Appendix 6.13a**). Computer plots of the road scheme and key to traffic flow ID are shown in **Appendix 6.13b. Table 6.11** shows the traffic data in 2036.

Table 6.11: Peak hour traffic flow data in 2036

ID[1]	Road Section	Peak Hour Flow (veh/h)	% Heavy Vehicle	Design Speed (km/h)
11	Wan Po Road (NB)	853	58.4	70
12	Wan Po Road (SB)	1381	37.5	70
13	Road D9 (EB)	1137	34.6	50
14	Road D9 (WB)	871	35.1	50

ID[1]	Road Section	Peak Hour Flow (veh/h)	% Heavy Vehicle	Design Speed (km/h)
15	Wan Po Road (NB)	336	55.8	70
16	Wan Po Road (SB)	598	38.6	70
18	Road D9 (WB)	1846	29.4	80
19	Road D9 (EB)	1394	33.9	50
20	Road D9 (WB)	1846	29.4	50
115	CBL (EB)	1394	33.9	80
116	CBL (WB)	1846	29.4	80
243	Road R5 (NB)	202	5.0	50
244	Road R5 (SB)	269	5.0	50

Notes:
[1] No ID17 in the flow ID

6.7.2 Assessment Results (Unmitigated Scenario)

6.7.2.1 The predicted road traffic noise levels at the representative NSRs and the road traffic noise levels during the without project scenario are summarized in **Table 6.12**. Detailed noise impacts of unmitigated scenario and without CBL scenario (at Year 2036, 15 years after opening and at Year 2015, before the commencement of works to construct the road) on different levels of the NSRs are given in **Appendix 6.14** and **Appendix 6.15**. Sample calculation is given in **Appendix 6.16a**.

Table 6.12: Predicted road traffic noise impact on representative NSRs (Year 2036)

NSR No.	Landuse	Max Noise Level, dB(A)	Criterion, dB(A)	Compliance (Y/N)	Without CBL Noise Impact, dB(A)
Existing					
R2	Residential	73	70	**N**	72
R3	Residential	71	70	**N**	69
Planned					
R6	Residential	74	70	**N**	69
R7	Residential	74	70	**N**	65
R8	Residential	69	70	**Y**	50
R9	Residential	69	70	**Y**	60
R10	Residential	68	70	**Y**	61
R12	Residential	75	70	**N**	63
R13	Residential	75	70	**N**	-[1]

NSR No.	Landuse	Max Noise Level, dB(A)	Criterion, dB(A)	Compliance (Y/N)	Without CBL Noise Impact, dB(A)
R14	Residential	75	70	**N**	56
R15	Residential	74	70	**N**	-[1]
R16	Residential	74	70	**N**	52
R17	Residential	72	70	**N**	-[1]
R18	Residential	72	70	**N**	26
R22	Residential	70	70	**N**	46
R23	Residential	75	70	**N**	33
R24	Residential	76	70	**N**	43
R25	Residential	78	70	**N**	-[1]
R26	Residential	75	70	**N**	-[1]
R27	Residential	74	70	**N**	-[1]
R28	Residential	73	70	**N**	-[1]
R29	Residential	70	70	**Y**	-[1]
R30	Residential	69	70	**Y**	-[1]
R31	Residential	68	70	**Y**	-[1]
R32	Residential	62	70	**Y**	-[1]
R33	Educational	68	65	**N**	58

Notes:
[1] NSRs are not affected by road traffic noise in the without project scenario.

6.7.2.2 As shown in **Table 6.12**, exceedences in road noise criterion on most NSRs are predicted in the range of 1 – 8dB(A). Mitigation measures are, thus, required.

6.7.3 Mitigated Scenario

6.7.3.1 Direct mitigation measures including noise screening and low noise road surface have been considered in terms of noise reduction effectiveness, engineering and traffic safety.

6.7.3.2 Cantilevered noise barriers beside both the eastbound and westbound carriageway of Road D9 were envisaged during the planning of Lohas Park and were assumed by the developer to be provided upon opening of CBL. These have been replaced with semi enclosure, which provides more effective screening of traffic on Road D9. As known during the planning of Lohas Park, noise barriers could not be provided at the junction of Road D9 and Road R5. While further consideration has been given to extending the semi noise enclosure, traffic sight line and visibility requirements would be compromised at ground level by an extension of the enclosure panels and from columns that would be needed to support decking over the junction area itself.

6.7.3.3 Low noise road surface can further reduce road traffic at source and this has been proposed for Road D9 from Wan Po Road and extending onto the CBL bridge. The use of low noise road surface at the junction of Road D9 and Road R5 is considered to be the best practicable mitigation in view of the constraints preventing noise enclosure being provided in this location.

6.7.3.4 The locations and extent of the proposed mitigation measures are shown in **Drawing no. 209506/EIA/NS/002**. Section drawing for the proposed semi-enclosure is shown in **Appendix 6.16**. A summary of these mitigation measures to be provided for the operation of CBL is shown in **Table 6.12a** below.

Table 6.12a: Summary of noise mitigation measures

No.	Mitigation Measures	NSRs to be Protected	Noise Reduction, dB(A)
N1	Approx. 300m long low noise surfacing	R2, R3, R6-R10, R12 – R18, R22 – R33	1 – 17
N2	Approx. 960m long low noise surfacing		
N3	Approx. 220m long 6m height + 17m width semi-enclosure		
N4	Approx. 245m long 6m height + 10.5m width semi-enclosure		
N5	Approx. 22m long 6m height + 13.2m width semi-enclosure		
N6	Approx. 33m long 6m height + 17.4m width semi-enclosure		
N7	Approx. 90m long 6m height + 13.5m width semi-enclosure		
N8	Approx. 55m long low noise surfacing		

6.7.3.5 Mitigated noise levels at the representative NSRs are summarized in **Table 6.13**. **Appendix 6.17** shows the detailed noise levels at various levels of the NSRs.

Table 6.13: Predicted road traffic noise impact on representative NSRs (Year 2036)

NSR No.	Landuse	CBL, dB(A)	Other Roads, dB(A)	Overall Noise Level, dB(A)	Criterion, dB(A)	Compliance (Y/N)
Existing						
R2	Residential	64	69	70	70	**Y**
R3	Residential	60	67	68	70	**Y**
Planned						
R6	Residential	64	66	68	70	**Y**
R7	Residential	65	63	67	70	**Y**
R8	Residential	61	35	61	70	**Y**
R9	Residential	60	59	62	70	**Y**
R10	Residential	58	60	62	70	**Y**
R12	Residential	66	62	67	70	**Y**
R13	Residential	66	44	66	70	**Y**
R14	Residential	66	56	67	70	**Y**
R15	Residential	66	50	66	70	**Y**
R16	Residential	66	54	66	70	**Y**
R17	Residential	65	57	65	70	**Y**
R18	Residential	64	56	65	70	**Y**
R22	Residential	62	63	66	70	**Y**
R23	Residential	66	57	67	70	**Y**
R24	Residential	68	55	68	70	**Y**
R25	Residential	70	48	70	70	**Y**
R26	Residential	68	-[1]	68	70	**Y**
R27	Residential	68	-[1]	68	70	**Y**
R28	Residential	67	-[1]	67	70	**Y**
R29	Residential	66	-[1]	66	70	**Y**
R30	Residential	65	-[1]	65	70	**Y**
R31	Residential	64	-[1]	64	70	**Y**
R32	Residential	59	-[1]	59	70	**Y**
R33	Educational	45	50	51	65	**Y**

Notes:
[1] NSRs are not affected by other roads.

6.7.3.6 With the implementation of the proposed mitigation measures as shown in **Appendix 6.16**, CBL will not contribute to an exceedance of the noise criteria. All the residential premises and educational institutions will be within the respective noise criterion of 70 dB(A) and 65 dB(A) respectively.

6.7.3.7 To study the noise performance of the project, traffic noise levels at the residential properties and schools which have a direct line of sight to the Project have been predicted. The numbers of dwellings and classrooms that would benefit from and be protected by the provision of noise mitigation measures have been calculated. The definition of "exposed", "benefited" and "protected" noise sensitive uses are defined as follow:

- Exposed – Noise sensitive elements with unmitigated noise level greater than relevant noise criteria
- Benefited – Exposed noise sensitive elements with a noise reduction of 1.0 dB(A) or greater in overall noise level with the noise mitigation measures in place
- Protected – Exposed noise sensitive elements with an overall noise level not greater than relevant noise criteria with the noise mitigation measures in place

6.7.3.8 The number of dwellings that would benefit from and be protected by the provision of noise mitigation measures will be identified for existing residential premises and planned noise sensitive uses. The results for existing and planned noise sensitive uses are presented in **Table 6.14** below.

Table 6.14: Summary of protected and benefitted land uses

NSE[1]	Total No. of NSE	Unmitigated Scenario	Mitigated Scenario		
		No. of Exposed NSE	No. of Exposed NSE	Protected NSE	Benefitted NSE
Existing					
Dwellings	206	70	0	70	206
Planned					
Dwellings[2]	4856	2280	0	2280	4848
Classroom[3]	36	36	0	36	36

Notes:

[1] NSE – Noise sensitive element

[2] As the layout details showing rooms is not presently available, four dwellings will be assumed for each floor.

[3] As the layout details showing classrooms is not presently available, six classrooms will be assumed for each floor.

6.7.4 Consideration of Indirect Technical Remedies

6.7.4.1 According to Section 6.2, Annex 3 of the TM-EIAO, it states that upon exhaust of direct mitigation measures, indirect mitigation measure in form of window insulation and air-conditioning is often the "last resort" in an attempt to ameliorate the residual impact. As all the direct mitigation measures have been exhausted, the eligibility of the affected premises for indirect technical remedies is determined with reference to the following three criteria:

- the predicted overall noise level must be above a specified noise level (e.g. 70 dB(A) for domestic premises and 65 dB(A) for education institutions, all in $L_{10,1hr}$);
- the predicted overall noise level is at least 1.0 dB(A) more than the prevailing traffic noise level, i.e. the total traffic noise level existing before the works to construct the road were commenced; and
- the contribution to the increase in the predicted overall noise level from the road project must be at least 1.0dB(A).

6.7.4.2 The premises are eligible for ITR only if all the three criteria are met. Since none of the receivers (shown in **Tables 6.12**) has met all three criteria, ITR is not required.

6.8 Assessment of Side Effects and Constraints

6.8.1.1 The adopted mitigation measures have been designed to balance between feasibility and effectiveness. The scheme has avoided blockage to the entrance way of the existing and planned premises. The induced impacts from noise barrier will be separately discussed in Air Quality and LVIA chapters.

6.9 Evaluation of Constraints on Planned Noise Sensitive Developments/Land Uses

6.9.1.1 Adverse constraints on the planned noise sensitive development/land uses are not anticipated. Therefore, no additional measures within the planned noise sensitive uses are required.

6.10 Residual Environmental Impacts

6.10.1.1 It is expected that there will be no noise exceedance during construction and operational phases of the CBL and Road D9 with proposed mitigation measures implemented.

6.11 Conclusion

6.11.1.1 Construction noise assessment has been conducted. With the implementation of mitigation measures and rescheduling the construction work outside examination period, construction noise exceedance is not anticipated at NSRs.

6.11.1.2 For the operational phase, practicable mitigation measures have been proposed for Road D9 and CBL to ensure that traffic noise from these roads will be well within the noise criterion. Semi-enclosures on Road D9 and low noise road surface on Road D9 and CBL to protect the nearest noise sensitive receivers of Lohas Park Area 86 development, which was previously planned on the assumption of similar mitigation measures being provided in the CBL project.

6.11.1.3 The mitigated noise levels at all noise sensitive receivers would meet the relevant noise criteria and no indirect technical remedies are required.

6.11.1.4 The noise assessment has been conducted accordingly to the criteria and guidelines for evaluating and assessing noise impacts as stated in Annexes 5 and 13 of the TM.

7 Sediment Quality Impact

7.1 Legislation and Standards

7.1.1 Relevant legislation and guidelines for the disposal of contaminated sediments at marine disposal sites are listed below.

- Annexes 7 and 15 of the TM-EIAO, Criteria and Guidelines for Evaluating and Assessing Waster Management Implications;
- Dumping at Sea Ordinance (DASO) (Cap.466);
- Environment, Transport and Works Bureau Technical Circular (Works) No. 34/2002 "Management of Dredged/Excavated Sediment" (ETWB TC(W) No. 34/2002); and
- Works Bureau Technical Circular (WBTC) No. 12/2000 Fill Management.

7.1.2 The DASO is the principal statutory legislation to control dumping of sediment at sea. It safeguards the water quality and ecology of Hong Kong waters.

7.1.3 ETWB TC(W) No. 34/2002 sets out the procedure for seeking approval to dredge/excavate sediment and the management framework for marine disposal of such sediment. It covers the approval of dredging/excavation proposals and marine disposal of dredged/excavated sediment. ETWB TC(W) No. 34/2002 also provides guidelines for the classification of sediment based on their contaminant levels. Sediment quality criteria for classification include:

- Metals (cadmium, chromium, copper, mercury, nickel, lead, silver and zinc);
- Metalloid (arsenic); and
- Organic micro-pollutants (PAHs, PCBs and TBT).

7.1.4 Based on the criteria, sediment is classified into Category L (low contamination level), Category M (medium contamination level) or Category H (high contamination level).

7.1.5 This technical circular also stipulates a three-tier screening for sediment assessment for determining the disposal options. Details of this three-tier approach are given in **Section 7.2.3 – 7.2.5**.

7.2 Methodology for Sediment Quality Assessment

7.2.1 The management framework of dredged/excavated sediment in Hong Kong is implemented under a three-tiered approach as illustrated in **Appendix 7.1** in accordance with the ETWBTC (Works) No. 34/2002. Sediment will be classified as 3 categories as follows:

Category L — Sediment with all contaminant levels not exceeding the Lower Chemical Exceedance Level (LCEL). The material must be dredged, transported and disposed of in a manner that minimises the loss of contaminants either into solution or by suspension.

Category M — Sediment with any one or more contaminant levels exceeding the Lower Chemical Exceedance Level (LCEL) and none exceeding the Upper Chemical Exceedance Level (UCEL). The material must be dredged and transported with care, and must be effectively isolated from the environment upon final disposal unless appropriate biological tests demonstrate that the material will not adversely affect the marine environment.

Category H — Sediment with any one or more contaminant levels exceeding the Upper Chemical Exceedance Level (UCEL). The material must be dredged and transported with great care, and must be effectively isolated from the environment upon final disposal.

7.2.2 **Table 7.1** summarises the guidelines for the assessment, sampling, testing and classification of sediment. Detailed description of the three-tier approach stipulated in the ETWB TC(W) No. 34/2002 is described below.

Table 7.1 Test endpoints and decision criteria for Tier III biological screening under ETWBTC (Works) No. 34/2002

Contaminants	Lower Chemical Exceedance Level (LCEL)	Upper Chemical Exceedance Level (UCEL)
Heavy Metal (mg/kg dry weight)		
Cadmium (Cd)	1.5	4
Chromium (Cr)	80	160
Copper (Cu)	65	110
Mercury (Hg)	0.5	1
Nickel (Ni)(1)	40	40
Lead (Pb)	75	110
Silver (Ag)	1	2

Zinc (Zn)	200	270
Metalloid (mg/kg dry weight)		
Arsenic	12	42
Organic-PAHs (µg/kg dry weight)		
PAHs (Low Molecular Weight)	550	3160
PAHs (High Molecular Weight)	1700	9600
Organic-non-PAHs (µg/kg dry weight)		
Total PCBs	23	180
Organometallics (µg-TBT L-1 in interstitial water)		
Tributyltin(1)	0.15	0.15

Note:

(1) The contaminant level is considered to have exceeded the UCEL if it is greater than the value shown.

Tier I Screening

7.2.3 Tier I screening is a desktop screening process to review the available information and determine whether the sediment of concern belongs to Category L material suitable for open sea disposal. If there is insufficient information to arrive at such a conclusion, Tier II chemical screening shall be proceeded directly.

Tier II Screening

7.2.4 Tier II screening is a chemical screening process to categorise sediment based on its chemical contaminant levels and to determine whether the sediment is suitable for open sea disposal without further testing. Upon Type II screening, the sediment shall be classified as Category L, M or H material. Category L material is suitable for Type 1 disposal - Open Sea Disposal, but Categories M and H will require Tier III screening to further determine the disposal option.

Tier III Screening

7.2.5 Tier III screening is a biological screening process for further analysis of Category M and certain Category H sediment (contaminant levels exceed 10 times Lower Chemical Exceedance Level). Sediment classified as Category M shall be subjected to the following three toxicity tests:

- A 10-day burrowing amphipod toxicity test;

- A 20-day burrowing polychaete toxicity test; and
- A 48-96 hour larvae (bivalve or echinoderm) toxicity test.

7.2.6 **Table 7.2** summarizes the details of the test endpoints and failure criteria of the three toxicity tests. Sediment classified as Category H and with one or more contaminant levels exceeding 10 times LCEL shall also be subjected to the above three toxicity tests but in a diluted manner (dilution test). If the Category M material passes the biological test (i.e. Mp material), Type 1 disposal - Open Sea Disposal (Dedicated Sites) is required. In case of failure of biological test on Category M material (i.e. Mf material), Type 2 disposal - Confined Marine Disposal shall be required. For Category H material which passes the biological test (i.e. Hp material), Type 2 disposal - Confined Marine Disposal shall be required. However, Type 3 disposal - Special Treatment/Disposal shall be required for Category H material if biological test is failed (i.e. Hf material).

Table 7.2 EPD sediment quality data between 2005 and 2009 at Junk Bay

Toxicity Test	Endpoints Measured	Test Methods	Failure Criteria
10-day amphipod	Survival	USEPA Standard Methods for Assessing the Toxicity of Sediment-associated Contaminants with Estuarine and Marine Amphipods	Mean survival in test sediment is significantly different ($p \leq 0.05$)(1) from mean survival in reference sediment and mean survival in test sediment <80% of mean survival in reference sediment.
20-day polychaete worm	Dry Weight(2)	PSEP Standard Recommended Guidelines for Conducting Laboratory Bioassays on the Pudget Sound Sediments – Juvenile Polychaete Sediment Bioassay, 1995	Mean dry weight in test sediment is significantly different ($p \leq 0.05$)(1) from mean dry weight in reference sediment and mean dry weight in test sediment <90% of mean dry weight in reference sediment.
48-96 hour larvae (bivalve or echinoderm)	Normality Survival(3)	PSEP Standard Recommended Guidelines for Conducting Laboratory Bioassays on the Pudget Sound Sediments – Bivalve Larvae Sediment Bioassay, 1995	Mean normality survival in test sediment is significantly different ($p \leq 0.05$)(1) from mean normality survival in reference sediment and mean normality survival in test sediment <80% of mean normality survival in reference sediment

Note:

(1) Statistically significant differences should be determined using appropriate two-sample comparisons (e.g. t-tests) at a probability of $p \leq 0.05$.

(2) Dry weight means total dry weight after deducting dead and missing worms.

(3) Normality survival integrates the normality and survival end points, and measures survival of only the normal larvae relative to the starting number.

7.3 Review of Previous Sediment Quality Data

EPD's Monitoring Data

7.3.1 EPD conducts routine monitoring of bottom sediment quality at 45 stations within the territory of Hong Kong waters, in which the nearest station is located at Junk Bay approximately 1km to the south of the proposed CBL.

7.3.2 **Table 7.3** summarizes the sediment contaminant levels (mean values of data collected between 2005 and 2009, data in brackets indicate ranges) and their classification. The measurement parameters include heavy metals (cadmium, chromium, copper, mercury, nickel, lead, silver, zinc, arsenic) and organic contaminants (PAHs and PCBs). Measurement of TBT was not provided. Based on the data, "Copper" and "Silver" exceeded the LCEL, and therefore the sediment shall be classified as Category M.

Table 7.3 EPD sediment quality data between 2005 and 2009 at Junk Bay

Contaminant	Unit	Mean Concentration (between 2005 and 2009)	Sediment Classification under ETWB TC(W) No. 34/2002
Silver (Ag)	mg/kg	2.0 (1.6 – 3.0)	Category M
Arsenic (As)	mg/kg	7.4 (6.7 – 8.5)	Category L
Cadmium (Cd)	mg/kg	0.2 (0.1 – 0.2)	Category L
Chromium (Cr)	mg/kg	46 (39 – 52)	Category L
Copper (Cu)	mg/kg	96 (73 – 120)	Category M
Nickel (Ni)	mg/kg	24 (19 – 31)	Category L
Lead (Pb)	mg/kg	50 (41 – 54)	Category L
Zinc (Zn)	mg/kg	150 (110 – 160)	Category L
Mercury (Hg)	mg/kg	0.26 (0.17 – 0.41)	Category L

Contaminant	Unit	Mean Concentration (between 2005 and 2009)	Sediment Classification under ETWB TC(W) No. 34/2002
Total PCB	µg/kg	18 (18 – 20)	Category L
Low Molecular Weight PAHs	µg/kg	97 (90 – 110)	Category L
High Molecular Weight PAHs	µg/kg	250 (90 – 420)	Category L

7.3.3 The elevated levels of heavy metals detected in the sediments of Junk Bay could often be attributed to previous industrial pollution sources in the 1960s to 1980s before pollution control legislation was introduced (EPD, 2009).

EIA for Further Development of TKO

7.3.4 Sediment sampling works for the EIA of Further Development of TKO were conducted in March 2003. Vibrocore samples were collected at 6 locations. In these 6 locations, 2 (i.e. VC5 and VC13) of them are lying on the proposed alignment of CBL. The locations of these 2 sediment samples are presented in **Drawing no. 209506/EIA/SQ/001**.

7.3.5 **Appendix 7.2** presents a summary of the measurement results at these 2 locations. All sub-samples of these 2 locations were classified as Category L, except the following:

- VC5, depth 0.12 – 0.9m, heavy metal "Copper" exceeded the LCEL and is therefore classified as Category M.
- VC13, depth 0.9 – 1.9m, heavy metal "Mercury" exceeded the LCEL and is therefore classified as Category M.

7.3.6 No sample was classified as Category H. The concentrations of PAH and TBT of both samples were reported to be very low. No Tier III Biological Screening Test was carried out for the Category M sediment samples.

7.4 Sample Collection and Laboratory Analysis

Objectives

7.4.1 The purpose of ground investigation for CBL is to obtain relevant information for the geo-chemical characteristics of the seabed sediment to be excavated from the Study Area through identification of the geological conditions, presence of contaminants and their levels, so that the subsequent decision for the sediment disposal arrangement could be made. The SI works were accomplished by collecting vibrocore, grabs sediment and in-situ samples for the subsequent laboratory analyses.

Sediment Sampling

7.4.2 The locations of the grab and vibrocore sediments were selected with a view to obtain information for the excavation works. A summary of these sampling locations is given below and illustrated in **Drawing no. 209506/EIA/SQ/002**. The sampling work was carried out between March and April 2010 by the Term Contractor of Geotechnical Engineering Office (GEO) of CEDD.

- Grab and Vibrocore sediment samples
  - 12 sampling Locations:
    - VB1 to VB9, VB11 and VB12 for three CBL alignment options
    - VB10 for the saltwater main partly submarine alignment
- Grab sample only
  - 1 sample at Reference Location in Port Shelter (PS6)

7.4.3 It should be noted that the proposed saltwater main has been excluded from the scope of this EIA Study (refer to **Section 1.3**). Therefore, the testing results of VB10 are not presented in this EIA Report.

7.4.4 Sediment samples were retrieved by vibrocoring in the marine deposit layer. Vibrocore of 100mm in diameter and 4m long was deployed from marine vessels. The sediment samples were collected at seabed level (i.e. grab sampling) and then at 0.9m, 1.9m, 2.9m below the seabed, thereafter 3m depth intervals. The depth of sediment sampling was terminated at base of marine deposits.

7.4.5 Grab samples of the upper deposits of seabed were collected for pore water testing at all vibrocore locations. Modified van Veen grab (or equivalent) of capacity ~2L was deployed from marine vessels and ~20L of sediment at each location was collected. All seawater trapped inside the grab during sampling was drained out carefully before any further process. After draining of seawater, individual grabs were composited on-site and split into portions for packing for laboratory pore water testing.

7.4.6 All sediment samples were kept at 4ºC during transportation and at the laboratory prior to testing. The sampling bottle and pre-treatment methods followed the recommendation stipulated in ETWB TC(W) No. 34/2002. Sediment samples were extracted in the laboratory and placed in the appropriate containers directly after the sampling. All samples were double bagged and labelled internally and externally with indelible ink. The sample holding time for chemical and biological testing was 2 weeks and 8 weeks respectively.

7.4.7 The sub-samples for biological testing were stored in the same manner as described above (including for ancillary parameters). The composite samples for biological testing (where required) comprised of up to 5 sub-samples of the same category (i.e. sediment classified under the ETWB TC(W) No. 34/2002 as Categories M or H), and continuous in a vertical or horizontal profile.

7.4.8 Marine water of ~5L was required for preparation of elutriate testing in the laboratory for each sediment sub-sample. Sufficient quantity of marine water was collected at one location during each day of vibrocoring. The sample holding time for elutriate samples was 1 week. Additional 10L of marine water was collected for each sampling location column for blank test. The locations for collecting water samples for the elutriate test and blank test were the same as the vibrocoring.

7.4.9 Reference sediment (surface grab) of ~30L was collected at Port Shelter (PS6, E850234, N820057). Modified Van Veen grab (or equivalent) of capacity ~2L was deployed from marine vessel and ~30L of sediment was collected. Individual grabs were composited on-site and split into portions for packing, of which ~4L for elutriate testing, ~20L for pore water testing, and ~6L for biological testing respectively. Sediment sample was stored at 4^{o}C during transportation and at the laboratory prior to testing. Marine water of

~5L was collected at the same time for preparation of elutriate samples.

Laboratory Testing

Testing for Sediment Quality Assessment

7.4.10 The sediment quality was assessed through laboratory analyses of sediment samples at all vibrocore locations (as in **Table 7.1**) for the chemical and/or biological parameters listed in ETWB TC(W) No. 34/2002. The reference sediment (clean sample) was also tested for comparison.

7.4.11 Chemical screening parameters include:

- 9 metals/metalloid: cadmium, chromium, copper, mercury, nickel, lead, silver, zinc and arsenic for all grab samples and vibrocore sub-samples; and
- 3 organic micro-pollutants: polyaromatic hydrocarbons (PAHs) (low and high molecular weights), polychlorinated biphenyls (PCBs) (total), tributyltin (TBT) (in pore water) for all grab samples and vibrocore sub-samples.

7.4.12 Biological screening parameters include:

- 10-day burrowing amphipod toxicity test,
- 20-day burrowing polychaete toxicity test, and
- 48-96 hours larvae (bivalve or echinoderm) toxicity test.

7.4.13 Based on the chemical test results, the necessity and arrangement of biological tests were concluded. For every sample which required biological test based on the chemical test results and subsequent classification in accordance with the ETWBTC (Works) No. 34/2002, biological test of each sample was conducted. All analytical methods were based on the U.S. Environmental Protection Agency (U.S. EPA) or equivalent.

7.4.14 Details of the chemical and biological testing parameters, methodology and reporting limits for sediment quality assessment are summarised in **Tables 7.4** and **7.5.** Ancillary testing parameters including moisture content, grain size (>2000µm, 63-2000µm, and <63µm), total organic carbon, ammonia (as mg N/L), and salinity in pore water were analysed for those samples undergoing biological testing.

Table 7.4 Chemical screening parameters for sediment quality

Parameters	Instrumentation	Analytical Method	Reporting Limit
Cadmium (Cd)	ICP-ES & ICP-MS	*ICP-ES* APHA 3030F 3b APHA 3120B ASTM D3976-92 *ICP-MS* APHA 3030F 3b APHA 3125 A & B ASTM D3976-92 USEPA 3005A USEPA 6020A	0.05 mg/kg
Chromium (Cr)	ICP-ES & ICP-MS		0.1 mg/kg
Copper (Cu)	ICP-ES & ICP-MS		0.2 mg/kg
Mercury (Hg)	ICP-MS		0.05 mg/kg
Nickel (Ni)	ICP-ES & ICP-MS		0.2 mg/kg
Lead (Pb)	ICP-ES & ICP-MS		0.1 mg/kg
Silver (Ag)	ICP-ES & ICP-MS		0.1 mg/kg
Zinc (Zn)	ICP-ES & ICP-MS		0.2 mg/kg
Arsenic (As)	ICP-ES & ICP-MS		0.1 mg/kg
Total PAHs (Low MW)	GC-MSD	USEPA 3546, 3660B, 8630C & 8270C	55 µg/kg(1)
Total PAHs (High MW)	GC-MSD		55 µg/kg(1)
Total PCBs	GC-MSD	USEPA 3546, 3660B, 3665A, 8082 & 8270C	2 µg/kg(2)
Tributyltin(3) (TBT)	GC-MSD	UNEP/IOC/IAEA	0.015 µg/L

Note:

(1) Reporting limit for each low and high molecular weight PAH.

(2) Reporting limit for each PCB.

(3) In interstitial water

Table 7.5 Biological screening(1) parameters for sediment quality

Toxicity Test	Test Method	Endpoints Measured	Failure Criteria
10-day amphipod	USEPA Standard Methods for Assessing the Toxicity of Sediment-associated Contaminants with Estuarine and Marine Amphipods	Survival	Mean survival in test sediment is significantly different ($p \leq 0.05$)(2) from mean survival in reference sediment and mean survival in test sediment < 80% of mean survival in reference sediment.
20-day polychaete worm	PSEP Standard Recommended Guidelines for Conducting Laboratory Bioassays on the Pudget Sound Sediments – Juvenile Polychaete Sediment Bioassay, 1995	Dry weight(3)	Mean dry weight in test sediment is significantly different ($p \leq 0.05$)(2) from mean dry weight in reference sediment and mean dry weight in test sediment <90% of mean dry weight in reference sediment.

Toxicity Test	Test Method	Endpoints Measured	Failure Criteria
48-96 hour larvae (bivalve or echinoderm)	PSEP Standard Recommended Guidelines for Conducting Laboratory Bioassays on the Pudget Sound Sediments – Bivalve Larvae Sediment Bioassay, 1995	Normality survival(4)	Mean normality survival in test sediment is significantly different ($p \leq 0.05$)(2) from mean normality survival in reference sediment and mean normality survival in test sediment <80% of mean normality survival in reference sediment.

Note:

(1) Ancillary testing parameters to be analysed for all sediment samples include moisture content, grain size (>2000µm, 63-2000µm, and <63µm), total organic carbon, ammonia (as mg N/L), and salinity in porewater.

(2) Statistically significantly differences should be determined using appropriate two-sample composite (e.g. t-tests) at a probability of $p \leq 0.05$.

(3) Dry weight means total dry weight after deducting dead and missing worms. \

(4) Normality survival integrates the normality and survival end points, and measures survival of only the normal larvae relative to the starting number.

Elutriate and Pore Water Testing for Water Quality Assessment

7.4.15 Preparation of elutriate for vibrocore sediment sub-samples was conducted in accordance with the Evaluation of Dredged Material proposed for Discharge in Waters of the US – Testing Manual (Inland Testing Manual), USEPA and USACE, 1998. The reference sediment and marine water samples were also tested for comparison.

7.4.16 Elutriate samples were prepared by sub-sampling approximately 1L of sediment sub-sample combined with unfiltered marine water collected on-site in a sediment-to-water ratio of 1:4 by volume in a pre-cleaned container in the laboratory. The mixture was stirred for 30 minutes on a platform shaker. After 30 minutes, the mixture was allowed for settling for 1 hour and the supernatant was then siphoned off without disturbing the settled material. The decanted solution was centrifuged to remove particulates prior to chemical analysis (approximately 2000rpm for 30 min, until visually clear). The elutriate testing parameters include:

- 9 metals/metalloid: cadmium, chromium, copper, mercury, nickel, lead, silver, zinc and arsenic;
- 3 organic micro-pollutants: PAHs (low and high molecular weights), total PCBs and TBT; and

- Ammonia, Nitrite, Nitrate, Total Kjeldahl Nitrogen, Total Phosphorus, Reactive Phosphorus and Chlorinated Pesticides.

7.4.17 Preparation of pore water from all grab sediment samples was conducted in accordance with "Methods for Collection, Storage and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual, USEPA 2001" (or equivalent). The reference sediment was also tested for comparison.

7.4.18 Pore water samples were prepared by sub-sampling approximately 1L of sediment in a pre-cleaned container in the laboratory and centrifuged at rotation speed at 3,000rpm for 10 minutes. After that, the supernatant was decanted without disturbing the sediment material. The pore water testing parameters and assessment criteria are the same as those for elutriate samples.

7.4.19 All analytical methods were based on U.S. EPA or equivalent. The details of elutriate and pore water testing parameters for water quality assessment are summarised in **Table 7.6** (including the reporting limits for the respective analytical methods).

Table 7.6 Chemical parameters for sediment elutriate and pore water testing

<table>
<tr><th>Parameters</th><th>Instrumentation</th><th>Analytical Method</th><th>Reporting Limit</th></tr>
<tr><td>Cadmium (Cd)</td><td>ICP-ES & ICP-MS</td><td rowspan="9"><u>ICP-ES</u>
APHA 3030F 3b
APHA 3120B
ASTM D3976-92
<u>ICP-MS</u>
APHA 3030F 3b
APHA 3125 A & B
USEPA 3005A
USEPA 6020A</td><td>0.1 μg/L</td></tr>
<tr><td>Chromium (Cr)</td><td>ICP-ES & ICP-MS</td><td>0.2 μg/L</td></tr>
<tr><td>Copper (Cu)</td><td>ICP-ES & ICP-MS</td><td>0.2 μg/L</td></tr>
<tr><td>Mercury (Hg)</td><td>ICP-MS</td><td>0.1 μg/L</td></tr>
<tr><td>Nickel (Ni)</td><td>ICP-ES & ICP-MS</td><td>0.2 μg/L</td></tr>
<tr><td>Lead (Pb)</td><td>ICP-ES & ICP-MS</td><td>0.2 μg/L</td></tr>
<tr><td>Silver (Ag)</td><td>ICP-ES & ICP-MS</td><td>0.2 μg/L</td></tr>
<tr><td>Zinc (Zn)</td><td>ICP-ES & ICP-MS</td><td>0.4 μg/L</td></tr>
<tr><td>Arsenic (As)</td><td>ICP-ES & ICP-MS</td><td>0.2 μg/L</td></tr>
<tr><td>PAHs</td><td>GC-MSD</td><td>USEPA 3546, 3660B, 8630C & 8270C</td><td>0.1 μg/L(1)</td></tr>
<tr><td>Total PCBs</td><td>GC-MSD</td><td>USEPA 8082 & 8270C</td><td>0.01 μg/L(2)</td></tr>
<tr><td>Tributyltin (TBT)</td><td>GC-MSD</td><td>UNEP/IOC/IAEA</td><td>0.015 μg TBT/L</td></tr>
<tr><td>Ammonia</td><td>FIA</td><td>APHA 4500-NH_3 H</td><td>0.01mg NH_3-N/L</td></tr>
<tr><td>Nitrite as N</td><td>FIA</td><td>APHA 4500-NO_2 B</td><td>0.01mg NO_2^--N/L</td></tr>
<tr><td>Nitrate as N</td><td>FIA</td><td>APHA 4500-NO_3 F</td><td>0.01 NO_3^--mg/L</td></tr>
<tr><td>TKN as N</td><td>FIA</td><td>APHA 4500-N_{org} A, B & D</td><td>0.5mg N/L</td></tr>
</table>

Parameters	Instrumentation	Analytical Method	Reporting Limit
Total Phosphorus	FIA	APHA 4500-P B, E, F & H	0.02 mg-P/L
Reactive Phosphorus	FIA	APHA 4500-P A, F & G	0.005 mg PO_4^{3-}-/L
Chlorinated Pesticides: Alpha-BHC Beta- BHC Gamma-BHC Delta-BHC Heptachlor Aldrin Heptachlor epoxide Endosulfan 1 p,p'-DDE p,p'-DDD p,p'-DDT Endosulfan sulphate	GC-MSD	USEPA 8270C	0.05 µg/L(3)

Note:

(1) Reporting limit for both low and high molecular weights PAHs.

(2) Reporting limit for each PCB.

(3) Reporting limit for each Chlorinated Pesticides.

QA/QC Requirements

7.4.20 Field logs and site diary were maintained for all on-site sampling works with date, equipment used, site activities and observations, undertaken as far as possible. Any deviation from the standard procedures and reasons were recorded in the logs.

7.4.21 Laboratory QA/QC requirements, including analyses by HOKLAS accredited laboratory, certified reference materials, spike recovery, blank samples, duplicate samples (for every 20 samples), negative/positive control for biological test, etc. were strictly followed.

7.5 Sediment Quality and Classification

Chemical screening test

7.5.1 There were in total 90 sub-samples from 11 vibrocore and 11 grab samples from each of the vibrocore sampling locations (i.e. the sampling location VB10 is excluded). The detailed results of chemical screening test of the sediment samples are summarised in **Table 7.7.**

7.5.2 The levels of cadmium, chromium, mercury, nickel, and silver were all below LCELs with concentration ranged from:

- Cadmium : <0.05 - 1.4 mg/kg,
- Chromium: 4.4 - 50 mg/kg,
- Mercury: <0.05 - 0.23 mg/kg,
- Nickel: 2.5 - 25 mg/kg,
- Silver: <0.1 - 0.1 mg/kg

7.5.3 The concentrations of PAHs, PCBs, TBT were all below the LCELs.

7.5.4 The levels of copper, lead, zinc, and arsenic have exceeded LCELs in some of the sub-samples including most of the grab samples. On the other hand, the level of zinc in 2 sub-samples VB3 (0.2-0.9m) and VB11 (1.9-2.9m) have exceeded the UCEL. The maximum concentrations of these metals were 106mg/kg for copper, 105mg/kg for lead, 400mg/kg for zinc and 15mg/kg for arsenic.

7.5.5 Based on the chemical test results, 78 vibrocore sub-samples with no exceedance of LCELs were classified as Category L, whilst the 2 sub-samples VB3 (0.2-0.9m) and VB11 (1.9-2.9m) which each have an exceedence of UCEL was classified as Category H. The remaining 10 sub-samples with levels of contaminants exceeded LCELs were classified as Category M and were further tested on the biological screening tests.

Table 7.7 Sediment Chemical Quality Data and Proposed Biological Tests

Sampling Location	Sampling Depth (meter below seabed level)	Metals and Metalloid (mg/kg in dry wt. basis)									Organics (µg/kg in dry wt. basis)			Organo-metallic (µg TBT/L)	Overall Classification under ETWB TC(W) No. 34/2002	Biological Test
		Cd	Cr	Cu	Hg	Ni	Pb	Ag	Zn	As	Total PCB	LMW PAHs	HMW PAHs	Tributyltin - Soluble		
VB1	Grab Sample	0.13	31	73	0.11	15	40	0.1	106	4.3	All PCB congeners are <2 µg/kg	<330	<550	<0.015	M	√
	0.0-0.9	0.28	32	85	0.11	13	61	<0.1	160	3.6		<330	<550	<0.015	M	√
	0.9-1.9	<0.05	37	57	0.14	19	41	<0.1	128	4.3		<330	<550	<0.015	L	-
	1.9-2.9	<0.05	24	4.8	0.15	18	14	<0.1	60	1.7		<330	<550	<0.015	L	-
	4.9-5.9	<0.05	26	6.3	0.09	18	18	<0.1	58	2.3		<330	<550	<0.015	L	-
	7.9-8.9	<0.05	28	7.9	<0.05	20	24	<0.1	64	3.8		<330	<550	<0.015	L	-
	10.9-11.9	<0.05	29	8.3	<0.05	21	31	<0.1	66	6.3		<330	<550	<0.015	L	-
	13.9-14.9	<0.05	9.2	4.6	<0.05	2.8	8.0	<0.1	11	2.6		<330	<550	IS	L	-
	16.3-17.3	<0.05	23	8.9	<0.05	16	23	<0.1	54	6.8		<330	<550	IS	L	-
VB2	Grab Sample	<0.05	28	58	0.08	15	34	<0.1	62	5.1	All PCB congeners are <2 µg/kg	<330	<550	<0.015	L	-
	0.1-0.9	<0.05	5.8	18	<0.05	8.1	21	<0.1	26	2.5		<330	<550	<0.015	L	-
	0.9-1.9	<0.05	7.8	3.9	<0.05	6.3	17	<0.1	22	2.1		<330	<550	<0.015	L	-
	1.9-2.9	<0.05	27	7.9	<0.05	21	21	<0.1	64	3.6		<330	<550	<0.015	L	-
	4.9-5.9	<0.05	29	8.4	<0.05	22	28	<0.1	64	2.8		<330	<550	<0.015	L	-
	7.9-8.9	<0.05	33	10	<0.05	25	30	<0.1	71	3.9		<330	<550	<0.015	L	-
	10.9-11.9	<0.05	25	8.2	<0.05	18	34	<0.1	58	7.4		<330	<550	<0.015	L	-
	12.0-13.0	<0.05	24	5.9	<0.05	8.7	18	<0.1	24	9.8		<330	<550	IS	L	-
VB3	Grab Sample	0.13	35	63	0.09	18	59	0.1	124	4.9	All PCB congeners are <2 µg/kg	<330	<550	<0.015	L	-
	0.2-0.9	1.4	50	106	0.13	17	105	<0.1	400	4.2		<330	<550	<0.015	*H*	-
	0.9-1.9	0.16	25	31	0.10	13	56	<0.1	84	2.7		<330	<550	<0.015	L	-
	1.9-2.9	<0.05	25	8.5	<0.05	19	20	<0.1	83	1.2		<330	<550	<0.015	L	-

Sampling Location	**Sampling Depth (meter below seabed level)**	**Metals and Metalloid (mg/kg in dry wt. basis)**									**Organics (µg/kg in dry wt. basis)**			**Organo-metallic (µg TBT/L)**	**Overall Classification under ETWB TC(W) No. 34/2002**	**Biological Test**
		Cd	**Cr**	**Cu**	**Hg**	**Ni**	**Pb**	**Ag**	**Zn**	**As**	**Total PCB**	**LMW PAHs**	**HMW PAHs**	**Tributyltin - Soluble**		
	4.9-5.9	<0.05	29	8.3	<0.05	21	20	<0.1	66	1.6		<330	<550	<0.015	L	-
	7.9-8.9	<0.05	29	10	<0.05	21	23	<0.1	70	2.6		<330	<550	<0.015	L	-
	10.9-11.9	<0.05	27	8.7	<0.05	20	29	<0.1	62	5.6		<330	<550	<0.015	L	-
	13.9-14.9	<0.05	5.2	2.8	<0.05	2.5	14	<0.1	22	2.6		<330	<550	IS	L	-
VB4	Grab Sample	0.17	40	86	0.17	19	49	0.1	126	5.3	All PCB congeners are <2 µg/kg	<330	<550	<0.015	M	√
	0.0-0.9	<0.05	29	58	0.23	13	41	<0.1	101	4.3		<330	<550	<0.015	L	-
	0.9-1.9	<0.05	24	13	0.21	17	32	<0.1	76	2.6		<330	<550	<0.015	L	-
	1.9-2.9	<0.05	24	5.5	0.20	18	15	<0.1	58	1.8		<330	<550	<0.015	L	-
	4.9-5.9	<0.05	24	6.5	0.20	17	17	<0.1	54	1.1		<330	<550	<0.015	L	-
	7.9-8.9	<0.05	28	7.4	0.10	19	21	<0.1	60	2.1		<330	<550	<0.015	L	-
	10.9-11.9	<0.05	28	8.5	<0.05	21	27	<0.1	64	5.6		<330	<550	<0.015	L	-
	13.9-14.9	<0.05	21	6.4	<0.05	6.7	22	<0.1	23	2.1		<330	<550	IS	L	-
	15.9-16.7	<0.05	34	8.2	<0.05	11	13	<0.1	28	9.6		<330	<550	IS	L	-
VB5	Grab Sample	0.18	29	76	<0.05	13	45	0.1	97	4.1	All PCB congeners are <2 µg/kg	<330	<550	<0.015	M	√
	01-0.9	0.21	16	35	0.10	11	74	<0.1	93	4.7		<330	<550	<0.015	L	-
	0.9-1.9	<0.05	41	44	<0.05	21	56	<0.1	119	5.6		<330	<550	<0.015	L	-
	1.9-2.9	<0.05	26	7.2	<0.05	20	19	<0.1	61	4.1		<330	<550	<0.015	L	-
	4.9-5.9	<0.05	24	7.2	<0.05	18	20	<0.1	56	2.3		<330	<550	<0.015	L	-
	7.9-8.9	0.05	25	8.5	<0.05	19	31	<0.1	53	3.0		<330	<550	<0.015	L	-
	10.9-11.9	<0.05	24	8.6	<0.05	19	32	<0.1	57	7.2		<330	<550	<0.015	L	-
	12.8-13.8	<0.05	10	6.1	<0.05	6.6	26	<0.1	36	7.6		<330	<550	IS	L	-

Sampling Location	Sampling Depth (meter below seabed level)	Metals and Metalloid (mg/kg in dry wt. basis)									Organics (µg/kg in dry wt. basis)			Organo-metallic (µg TBT/L)	Overall Classification under ETWB TC(W) No. 34/2002	Biological Test
		Cd	Cr	Cu	Hg	Ni	Pb	Ag	Zn	As	Total PCB	LMW PAHs	HMW PAHs	Tributyltin - Soluble		
VB6	Grab Sample	0.19	33	85	0.09	14	45	0.2	103	4.7	All PCB congeners are <2 µg/kg	<330	<550	<0.015	M	√
	0.1-0.9	<0.05	43	54	0.06	20	40	<0.1	114	3.9		<330	<550	<0.015	L	-
	0.9-1.9	<0.05	37	38	<0.05	18	48	<0.1	117	4.1		<330	<550	<0.015	L	-
	1.9-2.9	<0.05	22	5	<0.05	16	14	<0.1	55	2.0		<330	<550	<0.015	L	-
	4.9-5.9	<0.05	24	6.8	<0.05	18	19	<0.1	55	1.6		<330	<550	<0.015	L	-
	7.9-8.9	<0.05	29	8.5	<0.05	21	23	<0.1	62	1.7		<330	<550	<0.015	L	-
	10.9-11.9	<0.05	29	9.1	<0.05	21	27	<0.1	62	3.7		<330	<550	<0.015	L	-
	13.9-14.9	<0.05	24	8.1	<0.05	18	30	<0.1	55	7.0		<330	<550	IS	L	-
	14.9-15.7	<0.05	11	1.9	<0.05	3.7	39	<0.1	26	15		<330	<550	IS	M	√
	0.1-0.9	<0.05	23	8.5	0.16	16	17	<0.1	55	2.5		<330	<550	<0.015	L	-
VB7	Grab Sample	0.33	36	96	0.11	19	66	0.1	230	7.1	All PCB congeners are <2 µg/kg	<330	<550	<0.015	M	√
	0.9-1.9	<0.05	42	58	0.11	19	48	<0.1	121	5.5		<330	<550	<0.015	L	-
	1.9-2.9	<0.05	21	3.7	<0.05	16	14	<0.1	53	1.3		<330	<550	<0.015	L	-
	4.9-5.9	<0.05	22	5.3	<0.05	17	15	<0.1	53	1.7		<330	<550	<0.015	L	-
	7.9-8.9	<0.05	28	6.8	<0.05	20	22	<0.1	63	1.7		<330	<550	<0.015	L	-
	10.9-11.9	<0.05	29	7.7	<0.05	21	24	<0.1	64	2.8		<330	<550	<0.015	L	-
	13.9-14.9	<0.05	25	7.4	<0.05	18	29	<0.1	59	7.7		<330	<550	IS	L	-
VB8	Grab Sample	<0.05	25	54	0.09	11	34	<0.1	97	5.2	All PCB congeners are <2 µg/kg	<330	<550	<0.015	L	-
	0.2-0.9	<0.05	30	39	<0.05	16	41	<0.1	132	3.6		<330	<550	<0.015	L	-
	0.9-1.9	<0.05	23	6.2	<0.05	17	17	<0.1	59	2.1		<330	<550	<0.015	L	-
	1.9-2.9	<0.05	23	5.2	<0.05	17	15	<0.1	58	1.3		<330	<550	<0.015	L	-

Sampling Location	Sampling Depth (meter below seabed level)	Metals and Metalloid (mg/kg in dry wt. basis)									Organics (µg/kg in dry wt. basis)			Organo-metallic (µg TBT/L)	Overall Classification under ETWB TC(W) No. 34/2002	Biological Test
		Cd	Cr	Cu	Hg	Ni	Pb	Ag	Zn	As	Total PCB	LMW PAHs	HMW PAHs	Tributyltin - Soluble		
	4.9-5.9	<0.05	25	6.9	<0.05	18	18	<0.1	57	1.2		<330	<550	<0.015	L	-
	7.9-8.9	<0.05	27	7.9	<0.05	20	26	<0.1	60	3.2		<330	<550	<0.015	L	-
	10.9-11.9	<0.05	23	7.8	<0.05	17	34	<0.1	56	7.0		<330	<550	<0.015	L	-
	12.3-13.3	<0.05	7.9	3.8	<0.05	4	58	<0.1	26	3.2		<330	<550	IS	L	-
VB9	Grab Sample	0.15	34	73	0.10	16	55	0.1	192	5.0	All PCB congeners are <2 µg/kg	<330	<550	<0.015	M	√
	0.5-0.9	0.18	26	64	0.08	12	54	<0.1	119	4.0		<330	<550	IS	L	-
	0.9-1.9	<0.05	23	12	<0.05	17	25	<0.1	68	3.6		<330	<550	<0.015	L	-
	1.9-2.9	<0.05	24	6.8	<0.05	18	17	<0.1	60	2.6		<330	<550	<0.015	L	-
	4.9-5.9	<0.05	23	6.9	<0.05	17	19	<0.1	53	1.8		<330	<550	<0.015	L	-
	7.9-8.9	<0.05	29	8.5	<0.05	21	25	<0.1	62	3.4		<330	<550	<0.015	L	-
	10.9-11.9	<0.05	24	8.7	<0.05	18	36	<0.1	59	7.4		<330	<550	<0.015	L	-
	13.9-14.9	<0.05	5.3	2.8	<0.05	1.6	18	<0.1	7.9	5.2		<330	<550	IS	L	-
VB11	Grab Sample	0.20	37	73	0.17	19	70	0.1	159	5.5	All PCB congeners are <2 µg/kg	<330	<550	<0.015	M	√
	0.5-0.9	0.13	26	38	0.09	11	48	<0.1	85	3.0		<330	<550	IS	L	-
	0.9-1.9	0.47	45	90	0.21	16	67	<0.1	317	3.7		<330	<550	<0.015	*H*	-
	1.9-2.9	<0.05	31	18	<0.05	23	35	<0.1	93	4.3		<330	<550	<0.015	L	-
	4.9-5.9	<0.05	30	8.9	<0.05	23	24	<0.1	69	3.4		<330	<550	<0.015	L	-
	7.9-8.9	<0.05	30	11	<0.05	23	31	<0.1	68	4.5		<330	<550	<0.015	L	-
	10.9-11.9	<0.05	4.4	7.6	<0.05	2.9	38	<0.1	17	7.1		<330	<550	IS	L	-
VB12	Grab Sample	0.12	37	69	0.14	18	60	0.1	130	5.0	All PCB congeners	<330	<550	<0.015	M	√
	0.1-0.9	<0.05	17	16	<0.05	11	27	<0.1	58	7.2		<330	<550	<0.015	L	-

Sampling Location	Sampling Depth (meter below seabed level)	Metals and Metalloid (mg/kg in dry wt. basis)									Organics (µg/kg in dry wt. basis)			Organo-metallic (µg TBT/L)	Overall Classification under ETWB TC(W) No. 34/2002	Biological Test
		Cd	Cr	Cu	Hg	Ni	Pb	Ag	Zn	As	Total PCB	LMW PAHs	HMW PAHs	Tributyltin - Soluble		
	0.9-1.9	0.16	44	56	0.35	18	68	<0.1	124	4.7	are <2 µg/kg	<330	<550	<0.015	L	-
	1.9-2.9	<0.05	28	6.5	<0.05	23	20	<0.1	70	3.4		<330	<550	<0.015	L	-
	4.9-5.9	<0.05	28	8.4	<0.05	21	23	<0.1	64	3.5		<330	<550	<0.015	L	-
	7.9-8.9	<0.05	32	10	<0.05	25	33	<0.1	71	4.2		<330	<550	<0.015	L	-
	10.9-11.9	<0.05	27	9	<0.05	21	35	<0.1	64	11		<330	<550	<0.015	L	-
	12.6-13.6	<0.05	5.6	1.4	<0.05	2.5	21	<0.1	15	1.9		<330	<550	IS	L	-
Port Shelter	Grab Sample (Reference Sediment Sample)	<0.05	20	9.8	0.1	14	26	<0.1	59	5.6	All PCB congeners are <2 µg/kg	<330	<550	<0.015	- -	- -

Note:

1. IS: Insufficient interstitial water for TBT analysis
2. Bold value denotes contaminate level exceeds the Lower Chemical Exceedance Level (LCEL)
3. Italic value denotes contaminate level exceeds the Upper Chemical Exceedance Level (UCEL)
4. Low molecular weight PAHs includes naphthalene, acenaphthylene. acenaphthene, fluorene, phenanthrene and anthracene; high molecular weight PAHs include chrysene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, dibenzo(a.h.)anthracene, fluoranthene, indeno(1.2.3-cd)pyrene, pyrene and benzo(g.h.i)perylene; and
5. Total PCBs include 2,4' dichlorobiphenyl, 2,2',5 trichlorobiphenyl, 2,4',4 trichlorobiphenyl, 2,2',3,5 tetrachlrobiphenyl, 2,2',5,5' tetrachlrobiphenyl, 2,3',4,4' tetrachlrobiphenyl, 3,3',4,4' tetrachlrobiphenyl, 2,2',4,5,5' pentachlrobiphenyl, 2,3,3',4,4' pentachlrobiphenyl, 2,3',4,4',5' pentachlrobiphenyl, 3,3',4,4,5' pentachlrobiphenyl, 2,2',3,3',4,4' hexachlrobiphenyl, 2,2',3,4,4',5' hexachlrobiphenyl, 2,2',4,4',5,5' hexachlrobiphenyl, 3,3',4,4',5,5' hexachlrobiphenyl, 2,2',3,3',4,4',5 heptachlrobiphenyl, 2,2',3,4,4',5,5' heptachlrobiphenyl and 2,2'3,4',5,5',6 heptachlrobiphenyl.

Biological screening test

7.5.6 Biological screening tests are required for the 10 Category M sediments. **Table 7.8** summarises the samples requiring biological screening tests.

7.5.7 The results of 10-day burrowing amphipod toxicity test, 20-day burrowing polychaete toxicity test, and 48-hour bivalve larvae toxicity test are summarised in **Tables 7.9 – 7.11**. The results of ancillary parameters including grain size, moisture content, total organic carbon (TOC), ammonia, and salinity are summarised in **Table 7.12**.

7.5.8 The results showed that all the samples passed the biological tests except the Composite Sample VB1 (i.e. composited of VB1 Grab Sample & VB1 (0.0-0.9m)), VB6 Grab Sample and VB6 (14.9-15.7m) which failed in the 48-hour bivalve larvae test, as the mean normality survival percentage in these samples were more than 80% in relation to the reference and were significantly different from that of the reference sediment.

7.5.9 The levels of moisture content and TOC content ranged from 44 - 65% and from 0.13 - 0.45%, respectively. Levels of interstitial salinity were all found to be 32ppt except for VB6 (14.9-15.7m) and VB7 (grab sample) which were 31ppt. The levels of interstitial ammonia was between <0.05 and 0.06 mgNH3/L. The size spectrum of >2000 µm, 63-2000 µm, and <63 µm ranges from 0.6 - 2.3%, 13 - 24%, and 56 - 86.1%, respectively.

Table 7.8 Sediment samples requiring biological screening tests

Sampling Location	Sampling Depth (meter below seabed level)	Composite Sample
VB1	Composite of VB1 Grab Sample and VB1 (0.0-0.9m)	--
VB1	0.0-0.9	Yes
VB4	Grab Sample	
VB5	Grab Sample	--
VB6	Grab Sample	--
VB6	14.9-15.7	--
VB7	Grab Sample	--
VB9	Grab Sample	--
VB11	Grab Sample	--
VB12	Grab Sample	--

Table 7.9 Amphipod survival in relation to reference sediment

Sampling Location	Sampling Depth (meter below seabed level)	Mean Survival (%)	Survival in relation to reference (%)(1)	Results
Reference	-	92.0	-	-
VB1	Composite of VB1 Grab Sample and VB1 (0.0-0.9m)	93.0	101.1	Pass
VB4	Grab sample	91.0	98.9	Pass
VB5	Grab sample	87.0	94.6	Pass
VB6	Grab sample	88.0	95.7	Pass
VB6	14.9-15.7	89.0	96.7	Pass
VB7	Grab sample	89.0	96.7	Pass
VB9	Grab sample	85.0	92.4	Pass
VB11	Grab sample	85.0	92.4	Pass
VB12	Grab sample	92.0	100.0	Pass

Table 7.10 Total dry weight of polychaete in relation to reference sediment

Sampling Location	Sampling Depth (meter below seabed level)	Mean Total Dry Weight (mg)	Total dry weight in relation to reference (%)(1)	Results
Reference	-	86.9	-	-
VB1	Composite of VB1 Grab Sample and VB1 (0.0-0.9m)	96.7	111.3	Pass
VB4	Grab sample	99.5	114.5	Pass
VB5	Grab sample	87.8	101.0	Pass
VB6	Grab sample	88.9	102.3	Pass
VB6	14.9-15.7	101.5	116.8	Pass
VB7	Grab sample	107.9	124.2	Pass
VB9	Grab sample	100.5	115.7	Pass
VB11	Grab sample	90.8	104.5	Pass
VB12	Grab sample	88.2	101.5	Pass

Note:

(1) As the average total dry weight of polychaete for test sediment was greater than 90% of that of the reference sediment, statistical analysis was not required.

Table 7.11 Normality survival bivalve larvae in relation to reference sediment

Sampling Location	Sampling Depth (meter below seabed level)	Mean Normality Survival (%)	Normal survival in relation to reference (%)	Results
Reference	-	84.3	-	-
VB1	Composite of VB1 (0.0-0.9m) and grab sample	67.1	79.6 (1)	**Fail**
VB4	Grab sample	79.0	93.7	Pass
VB5	Grab sample	74.8	88.7	Pass
VB6	Grab sample	53.4	63.3 (1)	**Fail**
VB6	14.9-15.7	61.5	73.0 (1)	**Fail**
VB7	Grab sample	76.9	91.2	Pass
VB9	Grab sample	76.6	90.9	Pass
VB11	Grab sample	80.0	94.9	Pass
VB12	Grab sample	80.6	95.6	Pass

Note:

(1) Mean normality survival in test sediment is <80% in relation to reference sediment and is significantly different ($p<0.05$) from that in reference sediment

Table 7. 12 Ancillary test results

Sampling Location	Sampling Depth (meter below seabed level)	Interstitial Ammonia ($mgNH_3/L$)	Interstitial Salinity (ppt)	Size Spectrum (percentage of sand/silt/clay, >2000µm), %	Size Spectrum (63-2000µm), %	Size Spectrum (<63µm) ,%	Moisture Content (%)	Total Organic Carbon (%)
VB1	Composite of VB1 (0.0-0.9m) and grab sample	0.05	32	2.1	24	73.9	44	0.31
VB4	Grab Sample	0.06	32	1.2	16	82.8	55	0.45
VB5	Grab Sample	<0.05	32	0.9	13	86.1	55	0.44
VB6	Grab Sample	0.05	32	0.9	22	77.1	49	0.33
VB6	14.9-15.7	<0.05	31	11	33	56.0	24	0.13
VB7	Grab Sample	0.06	31	2.3	19	78.7	65	0.37
VB9	Grab Sample	0.05	32	0.6	19	80.4	65	0.45
VB11	Grab Sample	0.06	32	1.2	16	82.8	61	0.43
VB12	Grab Sample	0.05	32	1.3	21	77.7	61	0.34

Elutriate Samples

7.5.10 Elutriate tests were conducted for the purpose of water quality assessment (see **Section 8**) to test the extent of contaminant release when excavation activities take place. The testing parameters included heavy metals (cadmium, chromium, copper, mercury, nickel, lead, zinc and silver), metalloid (arsenic) and organic micro-pollutants (PCB, PAH and TBT), chlorinated pesticides and nutrients including NH_3-N, NO_2-H, NO_3-N, TKN, PO_4-P, and total phosphorus.

7.5.11 The elutriate test results are summarised in **Tables 7.3** and **7.14**. In general, the levels of PAHs, PCBs and TBT were all below the reporting limits.

Pore Water Samples

7.5.12 Pore water tests were conducted (i.e. for grab samples only) also for the purpose of water quality assessment (see **Section 8**) of the potential of contaminant release when filling activities take place. The testing parameters included heavy metals (cadmium, chromium, copper, mercury, nickel, lead, zinc and silver), metalloid (arsenic) and organic micro-pollutants (PCB, PAH and TBT), chlorinated pesticides and nutrients including NH_3-N, NO_2-H, NO_3-N, TKN, PO_4-P, and total phosphorus.

7.5.13 The pore water test results of this investigation are summarised in **Tables 7.15** and **7.16**. In general, the levels of PAHs, PCBs and TBT were all below the reporting limits.

Table 7.13 Elutriate test results (Metals, Metalloid and PAHs)

Sampling Location	Sampling Depth (meter below seabed level)	Metals (µg/L)								Metalloid (µg/L)	Organic-PAHs (µg/L)	
		Cd	Cr	Cu	Hg	Ni	Pb	Ag	Zn	As	LMW PAH	HMW PAH
VB1	Ambient water	<0.1	4.8	37	<0.1	2.3	33	<0.2	41	21	<0.1	<0.1
	0.0-0.9	<0.1	12.0	57	<0.1	4.6	41	<0.2	65	16	<0.1	<0.1
	0.9-1.9	<0.1	6.7	35	<0.1	2.7	38	<0.2	29	21	<0.1	<0.1
	1.9-2.9	<0.1	21	32	<0.1	12.0	31	<0.2	34	33	<0.1	<0.1
	4.9-5.9	<0.1	7.3	33	<0.1	3.0	35	<0.2	30	14	<0.1	<0.1
	7.9-8.9	<0.1	22	36	<0.1	13	32	<0.2	80	13	<0.1	<0.1
	10.9-11.9	<0.1	6.5	33	<0.1	3.1	35	<0.2	25	12	<0.1	<0.1
	13.9-14.9	<0.1	6.7	34	<0.1	1.2	28	<0.2	20	13	<0.1	<0.1
	16.3-17.3	<0.1	5.3	34	<0.1	2.4	38	<0.2	17	12	<0.1	<0.1
VB2	Ambient water	<0.1	2.8	43	<0.1	7.0	55	<0.2	7.2	34	<0.1	<0.1
	0.1-0.9	<0.1	1.5	43	<0.1	4.4	57	<0.2	7.8	40	<0.1	<0.1
	0.9-1.9	<0.1	1.3	42	<0.1	5.3	52	<0.2	7.0	41	<0.1	<0.1
	1.9-2.9	<0.1	2.0	42	<0.1	4.8	51	<0.2	6.4	35	<0.1	<0.1
	4.9-5.9	<0.1	2.0	43	<0.1	4.4	52	<0.2	6.2	33	<0.1	<0.1
	7.9-8.9	<0.1	1.8	44	<0.1	5.4	61	<0.2	6.5	36	<0.1	<0.1
	10.9-11.9	<0.1	1.3	44	<0.1	4.0	52	<0.2	8.1	31	<0.1	<0.1
	12.0-13.0	<0.1	1.7	43	<0.1	6.2	53	<0.2	8.7	32	<0.1	<0.1
VB3	Ambient water	<0.1	4.7	35	<0.1	0.4	32	<0.2	18	13	<0.1	<0.1
	0.2-0.9	<0.1	5.1	34	<0.1	3.7	34	<0.2	32	19	<0.1	<0.1
	0.9-1.9	<0.1	4.4	34	<0.1	2.3	33	<0.2	85	22	<0.1	<0.1
	1.9-2.9	<0.1	8.0	33	<0.1	2.9	37	<0.2	20	20	<0.1	<0.1
	4.9-5.9	<0.1	6.0	71	<0.1	2.4	32	<0.2	16	26	<0.1	<0.1
	7.9-8.9	<0.1	6.6	37	<0.1	2.6	36	<0.2	21	21	<0.1	<0.1

Sampling Location	Sampling Depth (meter below seabed level)	Metals (µg/L)								Metalloid (µg/L)	Organic-PAHs (µg/L)	
		Cd	Cr	Cu	Hg	Ni	Pb	Ag	Zn	As	LMW PAH	HMW PAH
	10.9-11.9	<0.1	8.6	36	<0.1	2.9	48	<0.2	35	6.9	<0.1	<0.1
	13.9-14.9	<0.1	6.2	34	<0.1	2.9	36	<0.2	17	18	<0.1	<0.1
VB4	Ambient water	<0.1	5.2	41	<0.1	1.6	32	<0.2	17	8.1	<0.1	<0.1
	0.0-0.9	<0.1	6.8	38	<0.1	2.9	38	<0.2	28	16	<0.1	<0.1
	0.9-1.9	<0.1	4.7	31	<0.1	1.2	34	<0.2	7.9	37	<0.1	<0.1
	1.9-2.9	<0.1	7.4	33	<0.1	3.3	35	<0.2	42	24	<0.1	<0.1
	4.9-5.9	<0.1	6.3	34	<0.1	1.9	35	<0.2	13	18	<0.1	<0.1
	7.9-8.9	<0.1	4.9	33	<0.1	1.8	29	<0.2	13	23	<0.1	<0.1
	10.9-11.9	<0.1	4.0	32	<0.1	0.8	34	<0.2	8.6	15	<0.1	<0.1
	13.9-14.9	<0.1	5.5	33	<0.1	0.5	37	<0.2	12	17	<0.1	<0.1
	15.9-16.7	<0.1	5.8	35	<0.1	1.8	36	<0.2	61	12	<0.1	<0.1
VB5	Ambient water	<0.1	1.0	40	<0.1	7.1	51	<0.2	0.8	33	<0.1	<0.1
	0.1-0.9	<0.1	1.4	39	<0.1	3.7	50	<0.2	0.8	36	<0.1	<0.1
	0.9-1.9	<0.1	2.1	38	<0.1	5.0	55	<0.2	1.3	32	<0.1	<0.1
	1.9-2.9	<0.1	2.0	39	<0.1	5.7	53	<0.2	2.4	36	<0.1	<0.1
	4.9-5.9	<0.1	2.4	39	<0.1	5.2	50	<0.2	2.4	38	<0.1	<0.1
	7.9-8.9	<0.1	2.1	39	<0.1	4.8	51	<0.2	2.5	36	<0.1	<0.1
	10.9-11.9	<0.1	2.2	42	<0.1	6.9	58	<0.2	8.4	36	<0.1	<0.1
	12.8-13.8	<0.1	1.3	43	<0.1	3.6	54	<0.2	2.8	29	<0.1	<0.1
VB6	Ambient water	<0.1	1.4	42	<0.1	5.3	58	<0.2	1.2	40	<0.1	<0.1
	0.1-0.9	<0.1	1.9	40	<0.1	6.1	51	<0.2	<0.4	34	<0.1	<0.1
	0.9-1.9	<0.1	1.3	40	<0.1	6.2	55	<0.2	<0.4	41	<0.1	<0.1
	1.9-2.9	<0.1	1.3	40	<0.1	4.1	57	<0.2	0.6	38	<0.1	<0.1

Sampling Location	Sampling Depth (meter below seabed level)	Metals (µg/L)								Metalloid (µg/L)	Organic-PAHs (µg/L)	
		Cd	Cr	Cu	Hg	Ni	Pb	Ag	Zn	As	LMW PAH	HMW PAH
	4.9-5.9	<0.1	1.7	41	<0.1	4.9	56	<0.2	0.5	39	<0.1	<0.1
	7.9-8.9	<0.1	1.8	41	<0.1	5.0	50	<0.2	0.9	36	<0.1	<0.1
	10.9-11.9	<0.1	2.1	43	<0.1	4.1	57	<0.2	1.6	30	<0.1	<0.1
	13.9-14.9	<0.1	2.7	42	<0.1	5.6	55	<0.2	0.4	39	<0.1	<0.1
	14.9-15.7	<0.1	2.1	42	<0.1	6.0	54	<0.2	2.1	43	<0.1	<0.1
VB7	Ambient water	<0.1	4.9	36	<0.1	1.2	33	<0.2	31	15	<0.1	<0.1
	0.1-0.9	<0.1	9.4	40	<0.1	3.1	39	<0.2	36	14	<0.1	<0.1
	0.9-1.9	<0.1	6.7	36	<0.1	2.6	35	<0.2	14	27	<0.1	<0.1
	1.9-2.9	<0.1	7.5	32	<0.1	3.1	34	<0.2	18	34	<0.1	<0.1
	4.9-5.9	<0.1	4.3	32	<0.1	1.1	34	<0.2	21	5.0	<0.1	<0.1
	7.9-8.9	<0.1	4.5	32	<0.1	0.5	35	<0.2	12	18	<0.1	<0.1
	10.9-11.9	<0.1	5.1	33	<0.1	3.3	38	<0.2	24	29	<0.1	<0.1
	13.9-14.9	<0.1	5.7	32	<0.1	1.6	33	<0.2	24	17	<0.1	<0.1
VB8	Ambient water	<0.1	1.9	40	<0.1	5.1	54	<0.2	1.6	31	<0.1	<0.1
	0.2-0.9	<0.1	2.5	41	<0.1	4.8	59	<0.2	3.2	26	<0.1	<0.1
	0.9-1.9	<0.1	2.4	42	<0.1	3.8	57	<0.2	3.4	34	<0.1	<0.1
	1.9-2.9	<0.1	1.6	41	<0.1	4.9	53	<0.2	0.2	26	<0.1	<0.1
	4.9-5.9	<0.1	1.6	40	<0.1	6.5	53	<0.2	0.8	38	<0.1	<0.1
	7.9-8.9	<0.1	2.8	42	<0.1	4.2	55	<0.2	2.0	29	<0.1	<0.1
	10.9-11.9	<0.1	2.8	40	<0.1	5.5	61	<0.2	0.9	48	<0.1	<0.1
	12.3-13.3	<0.1	2.6	40	<0.1	5.6	51	<0.2	<0.4	20	<0.1	<0.1
VB9	Ambient water	<0.1	1.3	38	<0.1	3.2	57	<0.2	1.7	42	<0.1	<0.1
	0.5-0.9	<0.1	1.9	42	<0.1	5.6	50	<0.2	2.6	34	<0.1	<0.1

Sampling Location	Sampling Depth (meter below seabed level)	Metals (µg/L)								Metalloid (µg/L)	Organic-PAHs (µg/L)	
		Cd	Cr	Cu	Hg	Ni	Pb	Ag	Zn	As	LMW PAH	HMW PAH
	0.9-1.9	<0.1	2.3	41	<0.1	4.5	54	<0.2	2.5	43	<0.1	<0.1
	1.9-2.9	<0.1	2.6	41	<0.1	4.3	54	<0.2	3.2	39	<0.1	<0.1
	4.9-5.9	<0.1	2.0	41	<0.1	6.3	56	<0.2	2.3	38	<0.1	<0.1
	7.9-8.9	<0.1	1.0	42	<0.1	4.3	57	<0.2	1.4	35	<0.1	<0.1
	10.9-11.9	<0.1	2.4	41	<0.1	5.7	50	<0.2	1.3	28	<0.1	<0.1
	13.9-14.9	<0.1	2.1	41	<0.1	4.9	56	<0.2	1.3	37	<0.1	<0.1
	0.5-0.9	<0.1	1.2	41	<0.1	4.9	57	<0.2	<0.4	44	<0.1	<0.1
VB11	Ambient water	<0.1	0.8	40	<0.1	5.6	55	<0.2	<0.4	28	<0.1	<0.1
	0.9-1.9	<0.1	1.8	40	<0.1	4.5	48	<0.2	<0.4	31	<0.1	<0.1
	1.9-2.9	<0.1	1.8	41	<0.1	4.5	54	<0.2	<0.4	32	<0.1	<0.1
	4.9-5.9	<0.1	1.8	41	<0.1	5.1	53	<0.2	<0.4	42	<0.1	<0.1
	7.9-8.9	<0.1	1.2	43	<0.1	4.6	52	<0.2	<0.4	24	<0.1	<0.1
	10.9-11.9	<0.1	1.8	45	<0.1	5.2	53	<0.2	<0.4	32	<0.1	<0.1
VB12	Ambient water	<0.1	1.9	40	<0.1	3.8	57	<0.2	2.0	32	<0.1	<0.1
	0.1-0.9	<0.1	1.1	42	<0.1	5.9	57	<0.2	2.7	28	<0.1	<0.1
	0.9-1.9	<0.1	1.2	44	<0.1	4.0	57	<0.2	3.4	35	<0.1	<0.1
	1.9-2.9	<0.1	0.8	43	<0.1	5.3	54	<0.2	2.9	29	<0.1	<0.1
	4.9-5.9	<0.1	1.5	42	<0.1	6.9	50	<0.2	1.2	39	<0.1	<0.1
	7.9-8.9	<0.1	1.7	41	<0.1	5.5	62	<0.2	1.0	29	<0.1	<0.1
	10.9-11.9	<0.1	1.4	40	<0.1	5.5	54	<0.2	0.9	43	<0.1	<0.1
	12.6-13.6	<0.1	2.8	41	<0.1	4.7	56	<0.2	1.8	37	<0.1	<0.1
Reference	Ambient water	<0.1	2.6	31	<0.1	3.1	27	<0.2	8.8	14	<0.1	<0.1

Table 7.14 Elutriate test results (PCBs, TBT, Chlorinated Pesticides and Nutrients)

Sampling Location	Sampling Depth (meter below seabed level)	Organic-non-PAHs (μg/L)	Organo-metallics (μg/L)	Chlorinated Pesticides (μg/L)	TKN (mg/L)	NH_3-N (mg/L)	NO_3-N (mg/L)	NO_2-N (mg/L)	Total P (mg/L)	Ortho-P (mg/L)
		Total PCBs	TBT							
VB1	Ambient water	<0.01	<0.015	<0.05	<0.5	0.15	0.08	0.01	0.17	0.036
	0.0-0.9	<0.01	<0.015	<0.05	1.5	1.2	0.49	0.01	0.39	0.029
	0.9-1.9	<0.01	<0.015	<0.05	2.2	1.3	1.3	0.02	0.34	0.11
	1.9-2.9	<0.01	<0.015	<0.05	1.5	1.3	0.07	0.02	0.26	0.094
	4.9-5.9	<0.01	<0.015	<0.05	1.2	1.1	0.15	0.02	0.32	0.088
	7.9-8.9	<0.01	<0.015	<0.05	0.6	0.5	0.19	0.02	0.21	0.072
	10.9-11.9	<0.01	<0.015	<0.05	2.2	1.3	0.08	0.01	0.33	0.048
	13.9-14.9	<0.01	<0.015	<0.05	2.4	1.7	0.7	0.02	0.23	0.022
	16.3-17.3	<0.01	<0.015	<0.05	4.1	3.8	0.26	0.01	0.25	0.02
VB2	Ambient water	<0.01	<0.015	<0.05	<0.5	0.08	0.03	0.03	0.23	0.026
	0.1-0.9	<0.01	<0.015	<0.05	<0.5	0.07	0.05	<0.01	0.21	0.026
	0.9-1.9	<0.01	<0.015	<0.05	<0.5	0.15	0.03	0.02	0.21	0.027
	1.9-2.9	<0.01	<0.015	<0.05	<0.5	0.09	0.03	0.02	0.22	0.026
	4.9-5.9	<0.01	<0.015	<0.05	<0.5	0.08	0.04	0.02	0.20	0.027
	7.9-8.9	<0.01	<0.015	<0.05	<0.5	0.11	0.04	0.02	0.20	0.028
	10.9-11.9	<0.01	<0.015	<0.05	<0.5	0.11	0.03	0.03	0.22	0.025
	12.0-13.0	<0.01	<0.015	<0.05	<0.5	0.07	0.04	0.02	0.23	0.028
VB3	Ambient water	<0.01	<0.015	<0.05	<0.5	0.08	0.19	0.02	0.14	0.036
	0.2-0.9	<0.01	<0.015	<0.05	0.8	0.7	0.05	0.02	0.24	0.041
	0.9-1.9	<0.01	<0.015	<0.05	2.1	2.1	0.03	0.02	0.33	0.055
	1.9-2.9	<0.01	<0.015	<0.05	0.8	0.76	0.09	0.02	0.31	0.038
	4.9-5.9	<0.01	<0.015	<0.05	2.1	2.0	0.08	0.02	0.33	0.061
	7.9-8.9	<0.01	<0.015	<0.05	2.0	2.0	0.08	0.02	0.34	0.068

Sampling Location	Sampling Depth (meter below seabed level)	Organic-non-PAHs (µg/L)	Organo-metallics (µg/L)	Chlorinated Pesticides (µg/L)	TKN (mg/L)	NH_3-N (mg/L)	NO_3-N (mg/L)	NO_2-N (mg/L)	Total P (mg/L)	Ortho-P (mg/L)
		Total PCBs	TBT							
	10.9-11.9	<0.01	<0.015	<0.05	2.2	1.7	0.1	0.02	0.30	0.037
	13.9-14.9	<0.01	<0.015	<0.05	1.6	1.4	0.07	0.02	0.31	0.04
VB4	Ambient water	<0.01	<0.015	<0.05	<0.5	0.12	0.09	0.02	0.38	0.037
	0.0-0.9	<0.01	<0.015	<0.05	1.2	1.0	0.13	0.02	0.22	0.11
	0.9-1.9	<0.01	<0.015	<0.05	1.3	1.2	0.11	0.02	0.20	0.074
	1.9-2.9	<0.01	<0.015	<0.05	0.7	0.67	0.21	0.01	0.32	0.048
	4.9-5.9	<0.01	<0.015	<0.05	1.2	1.1	0.13	0.02	0.31	0.061
	7.9-8.9	<0.01	<0.015	<0.05	1.6	1.5	0.1	0.01	0.21	0.071
	10.9-11.9	<0.01	<0.015	<0.05	3.6	2.7	0.09	0.02	0.15	0.059
	13.9-14.9	<0.01	<0.015	<0.05	2.5	2.3	0.09	0.01	0.13	0.029
	15.9-16.7	<0.01	<0.015	<0.05	1.7	1.4	0.18	0.01	0.13	0.035
VB5	Ambient water	<0.01	<0.015	<0.05	<0.5	0.07	0.04	0.03	0.20	0.028
	01-0.9	<0.01	<0.015	<0.05	<0.5	0.08	0.04	0.03	0.26	0.021
	0.9-1.9	<0.01	<0.015	<0.05	<0.5	0.1	0.04	0.03	0.25	0.027
	1.9-2.9	<0.01	<0.015	<0.05	<0.5	0.08	0.04	0.03	0.26	0.025
	4.9-5.9	<0.01	<0.015	<0.05	<0.5	0.12	0.03	0.02	0.24	0.023
	7.9-8.9	<0.01	<0.015	<0.05	<0.5	0.07	0.04	0.02	0.22	0.027
	10.9-11.9	<0.01	<0.015	<0.05	<0.5	0.1	0.03	0.02	0.26	0.026
	12.8-13.8	<0.01	<0.015	<0.05	<0.5	0.08	0.03	0.02	0.26	0.024
VB6	Ambient water	<0.01	<0.015	<0.05	<0.5	0.09	0.04	0.03	0.26	0.027
	0.1-0.9	<0.01	<0.015	<0.05	<0.5	0.08	0.04	0.02	0.25	0.028
	0.9-1.9	<0.01	<0.015	<0.05	<0.5	0.13	0.04	0.03	0.25	0.025
	1.9-2.9	<0.01	<0.015	<0.05	<0.5	0.09	0.03	0.03	0.24	0.024

Sampling Location	Sampling Depth (meter below seabed level)	Organic-non-PAHs (µg/L)	Organo-metallics (µg/L)	Chlorinated Pesticides (µg/L)	TKN (mg/L)	NH_3-N (mg/L)	NO_3-N (mg/L)	NO_2-N (mg/L)	Total P (mg/L)	Ortho-P (mg/L)
		Total PCBs	TBT							
	4.9-5.9	<0.01	<0.015	<0.05	<0.5	0.1	0.04	0.03	0.25	0.027
	7.9-8.9	<0.01	<0.015	<0.05	<0.5	0.08	0.06	0.03	0.26	0.023
	10.9-11.9	<0.01	<0.015	<0.05	<0.5	0.12	0.04	0.03	0.26	0.021
	13.9-14.9	<0.01	<0.015	<0.05	<0.5	0.1	0.03	0.02	0.33	0.022
	14.9-15.7	<0.01	<0.015	<0.05	<0.5	0.07	0.03	0.03	0.22	0.024
VB7	Ambient water	<0.01	<0.015	<0.05	<0.5	0.32	0.22	0.02	0.65	0.034
	0.1-0.9	<0.01	<0.015	<0.05	<0.5	0.37	0.75	0.04	0.14	0.11
	0.9-1.9	<0.01	<0.015	<0.05	1.3	1.3	0.17	0.02	0.3	0.12
	1.9-2.9	<0.01	<0.015	<0.05	0.8	0.71	0.08	0.02	0.26	0.09
	4.9-5.9	<0.01	<0.015	<0.05	<0.5	0.42	0.19	0.01	0.21	0.033
	7.9-8.9	<0.01	<0.015	<0.05	<0.5	0.11	0.77	0.01	0.12	0.034
	10.9-11.9	<0.01	<0.015	<0.05	3.8	3.7	0.08	0.02	0.27	0.13
	13.9-14.9	<0.01	<0.015	<0.05	4.1	4.1	0.15	0.04	0.21	0.078
VB8	Ambient water	<0.01	<0.015	<0.05	<0.5	0.08	0.03	0.03	0.26	0.023
	0.2-0.9	<0.01	<0.015	<0.05	<0.5	0.08	0.04	0.03	0.25	0.026
	0.9-1.9	<0.01	<0.015	<0.05	<0.5	0.07	0.04	0.03	0.26	0.023
	1.9-2.9	<0.01	<0.015	<0.05	<0.5	0.1	0.03	0.02	0.24	0.024
	4.9-5.9	<0.01	<0.015	<0.05	<0.5	0.1	0.04	0.02	0.26	0.024
	7.9-8.9	<0.01	<0.015	<0.05	<0.5	0.08	0.04	0.03	0.21	0.021
	10.9-11.9	<0.01	<0.015	<0.05	<0.5	0.06	0.03	0.03	0.26	0.022
	12.3-13.3	<0.01	<0.015	<0.05	<0.5	0.07	0.03	0.03	0.26	0.024
VB9	Ambient water	<0.01	<0.015	<0.05	<0.5	0.08	0.03	0.03	0.26	0.024
	0.5-0.9	<0.01	<0.015	<0.05	<0.5	0.06	0.04	0.03	0.24	0.026

Sampling Location	Sampling Depth (meter below seabed level)	Organic-non-PAHs (µg/L)	Organo-metallics (µg/L)	Chlorinated Pesticides (µg/L)	TKN (mg/L)	NH_3-N (mg/L)	NO_3-N (mg/L)	NO_2-N (mg/L)	Total P (mg/L)	Ortho-P (mg/L)
		Total PCBs	TBT							
	0.9-1.9	<0.01	<0.015	<0.05	<0.5	0.08	0.04	0.03	0.24	0.024
	1.9-2.9	<0.01	<0.015	<0.05	<0.5	0.08	0.13	0.03	0.24	0.022
	4.9-5.9	<0.01	<0.015	<0.05	<0.5	0.07	0.04	0.03	0.23	0.024
	7.9-8.9	<0.01	<0.015	<0.05	<0.5	0.09	0.04	0.03	0.21	0.02
	10.9-11.9	<0.01	<0.015	<0.05	<0.5	0.11	0.04	0.03	0.22	0.024
	13.9-14.9	<0.01	<0.015	<0.05	<0.5	0.08	0.03	0.03	0.22	0.025
VB11	Ambient water	<0.01	<0.015	<0.05	<0.5	0.16	0.03	0.03	0.54	0.024
VB11	0.5-0.9	<0.01	<0.015	<0.05	<0.5	0.13	0.04	0.03	0.48	0.025
	0.9-1.9	<0.01	<0.015	<0.05	<0.5	0.08	0.04	0.02	0.52	0.025
	1.9-2.9	<0.01	<0.015	<0.05	<0.5	0.22	0.03	0.02	0.53	0.025
	4.9-5.9	<0.01	<0.015	<0.05	<0.5	0.11	0.03	0.03	0.43	0.023
	7.9-8.9	<0.01	<0.015	<0.05	<0.5	0.12	0.04	0.03	0.42	0.026
	10.9-11.9	<0.01	<0.015	<0.05	<0.5	0.06	0.03	0.03	0.38	0.023
VB12	Ambient water	<0.01	<0.015	<0.05	<0.5	0.07	0.03	0.02	0.21	0.025
	0.1-0.9	<0.01	<0.015	<0.05	<0.5	0.1	0.03	0.02	0.22	0.022
	0.9-1.9	<0.01	<0.015	<0.05	<0.5	0.12	0.03	0.02	0.2	0.026
	1.9-2.9	<0.01	<0.015	<0.05	<0.5	0.08	0.03	0.02	0.41	0.027
	4.9-5.9	<0.01	<0.015	<0.05	<0.5	0.1	0.03	0.03	0.44	0.026
	7.9-8.9	<0.01	<0.015	<0.05	<0.5	0.13	0.04	0.02	0.57	0.026
	10.9-11.9	<0.01	<0.015	<0.05	<0.5	0.25	0.03	0.02	0.56	0.023
	12.6-13.6	<0.01	<0.015	<0.05	<0.5	0.1	0.03	0.02	0.56	0.024
Reference	Ambient water	<0.01	<0.015	<0.05	<0.5	0.06	0.03	<0.01	0.39	0.017

Table 7.15 Pore water test results for grab samples (Metals, Metalloid and PAHs)

Sampling Location	Metals (µg/L)								Metalloid (µg/L)	Organic-PAHs (µg/L)	
	Cd	Cr	Cu	Hg	Ni	Pb	Ag	Zn	As	LMW PAH	HMW PAH
VB1	<0.1	4.4	34	<0.1	0.6	40	<0.2	13.2	14	<0.1	<0.1
VB2	<0.1	2.1	47	<0.1	4.9	57	<0.2	9.8	26	<0.1	<0.1
VB3	<0.1	4.5	83	<0.1	0.2	36	<0.2	22.5	8	<0.1	<0.1
VB4	<0.1	4.8	42	<0.1	2.1	38	<0.2	34.3	19	<0.1	<0.1
VB5	<0.1	2.7	41	<0.1	5.8	50	<0.2	5.2	32	<0.1	<0.1
VB6	<0.1	1.4	40	<0.1	5.4	54	<0.2	0.5	38	<0.1	<0.1
VB7	<0.1	4.7	33	<0.1	1.4	34	<0.2	34.4	16	<0.1	<0.1
VB8	<0.1	1.1	42	<0.1	5.6	56	<0.2	3.4	26	<0.1	<0.1
VB9	<0.1	1.8	40	<0.1	3.9	57	<0.2	3.5	32	<0.1	<0.1
VB11	<0.1	1.3	40	<0.1	5.2	51	<0.2	<0.4	26	<0.1	<0.1
VB12	<0.1	2.1	40	<0.1	5.2	54	<0.2	3.1	35	<0.1	<0.1
Reference	<0.1	2.8	30	<0.1	2.1	25	<0.2	6.2	14	<0.1	<0.1

Table 7.16 Pore water test results for grab samples (PCBs, TBT, Chlorinated Pesticides and Nutrients)

Sampling Location	Organic-non-PAHs (µg/L)	Organo-metallics (µg/L)	Chlorinated Pesticides (µg/L)	TKN (mg/L)	NH_3-N (mg/L)	NO_3-N (mg/L)	NO_2-N (mg/L)	Total P (mg/L)	Ortho-P (mg/L)
	Total PCBs	TBT							
VB1	<0.01	<0.015	<0.05	<0.5	0.10	2.00	0.02	0.12	0.034
VB2	<0.01	<0.015	<0.05	<0.5	0.07	0.03	0.03	0.22	0.024
VB3	<0.01	<0.015	<0.05	<0.5	0.16	0.53	0.02	0.16	0.04
VB4	<0.01	<0.015	<0.05	<0.5	0.13	0.10	0.01	0.15	0.036
VB5	<0.01	<0.015	<0.05	<0.5	0.06	0.03	0.02	0.26	0.027
VB6	<0.01	<0.015	<0.05	<0.5	0.09	0.04	0.03	0.26	0.026
VB7	<0.01	<0.015	<0.05	<0.5	0.16	0.43	0.02	0.18	0.034
VB8	<0.01	<0.015	<0.05	<0.5	0.12	0.04	0.03	0.26	0.023
VB9	<0.01	<0.015	<0.05	<0.5	0.10	0.04	0.03	0.24	0.024
VB11	<0.01	<0.015	<0.05	<0.5	0.17	0.03	0.02	0.54	0.024
VB12	<0.01	<0.015	<0.05	<0.5	0.06	0.03	0.02	0.24	0.025
Reference	<0.01	<0.015	<0.05	<0.5	0.06	0.03	<0.01	0.38	0.026

7.6 Classification of Sediment

7.6.1 Based on the chemical and biological test results, the classification of samples according to ETWBTC (Works) No. 34/2002 is summarised in **Table 7.17**. 10 sediment samples were classified as Category M of which 6 were Category Mp (Type 1 open sea disposal at dedicated sites) and 4 were Category Mf (Type 2 confined marine disposal); 2 Category H sediments were also identified. All remaining sediment samples belong to Category L (Type 1 open sea disposal).

Table 7.17 Classification of sediment

Sampling Location	Sampling Depth (meter below seabed level)	Sediment Category				Proposed Disposal Option (according to ETWB TC(W) No. 34/2002)
		L	Mp	Mf	H	
VB1	Grab Sample			#		**Type 2 (Confined Marine Disposal)**
	0.0-0.9			#		**Type 2 (Confined Marine Disposal)**
	0.9-1.9	#				Type 1 (Open Sea Disposal)
	1.9-2.9	#				Type 1 (Open Sea Disposal)
	4.9-5.9	#				Type 1 (Open Sea Disposal)
	7.9-8.9	#				Type 1 (Open Sea Disposal)
	10.9-11.9	#				Type 1 (Open Sea Disposal)
	13.9-14.9	#				Type 1 (Open Sea Disposal)
	16.3-17.3	#				Type 1 (Open Sea Disposal)
VB2	Grab Sample	#				Type 1 (Open Sea Disposal)
	0.1-0.9	#				Type 1 (Open Sea Disposal)
	0.9-1.9	#				Type 1 (Open Sea Disposal)
	1.9-2.9	#				Type 1 (Open Sea Disposal)
	4.9-5.9	#				Type 1 (Open Sea Disposal)
	7.9-8.9	#				Type 1 (Open Sea Disposal)
	10.9-11.9	#				Type 1 (Open Sea Disposal)
	12.0-13.0	#				Type 1 (Open Sea Disposal)
VB3	Grab Sample	#				Type 1 (Open Sea Disposal)

Sampling Location	Sampling Depth (meter below seabed level)	Sediment Category				Proposed Disposal Option (according to ETWB TC(W) No. 34/2002)
		L	Mp	Mf	H	
	0.2-0.9				#	**Type 2 (Confined Marine Disposal)**
	0.9-1.9	#				Type 1 (Open Sea Disposal)
	1.9-2.9	#				Type 1 (Open Sea Disposal)
	4.9-5.9	#				Type 1 (Open Sea Disposal)
	7.9-8.9	#				Type 1 (Open Sea Disposal)
	10.9-11.9	#				Type 1 (Open Sea Disposal)
	13.9-14.9	#				Type 1 (Open Sea Disposal)
VB4	Grab Sample		#			**Type 1# Open Sea Disposal (Dedicated Sites)**
	0.0-0.9	#				Type 1 (Open Sea Disposal)
	0.9-1.9	#				Type 1 (Open Sea Disposal)
	1.9-2.9	#				Type 1 (Open Sea Disposal)
	4.9-5.9	#				Type 1 (Open Sea Disposal)
VB4	7.9-8.9	#				Type 1 (Open Sea Disposal)
	10.9-11.9	#				Type 1 (Open Sea Disposal)
	13.9-14.9	#				Type 1 (Open Sea Disposal)
	15.9-16.7	#				Type 1 (Open Sea Disposal)
VB5	Grab Sample		#			**Type 1# Open Sea Disposal (Dedicated Sites)**
	01-0.9	#				Type 1 (Open Sea Disposal)
	0.9-1.9	#				Type 1 (Open Sea Disposal)
	1.9-2.9	#				Type 1 (Open Sea Disposal)
	4.9-5.9	#				Type 1 (Open Sea Disposal)
	7.9-8.9	#				Type 1 (Open Sea Disposal)
	10.9-11.9	#				Type 1 (Open Sea Disposal)
	12.8-13.8	#				Type 1 (Open Sea Disposal)
VB6	Grab Sample			#		**Type 2 (Confined Marine Disposal)**
	0.1-0.9	#				Type 1 (Open Sea Disposal)

Sampling Location	Sampling Depth (meter below seabed level)	Sediment Category				Proposed Disposal Option (according to ETWB TC(W) No. 34/2002)
		L	Mp	Mf	H	
	0.9-1.9	#				Type 1 (Open Sea Disposal)
	1.9-2.9	#				Type 1 (Open Sea Disposal)
	4.9-5.9	#				Type 1 (Open Sea Disposal)
	7.9-8.9	#				Type 1 (Open Sea Disposal)
	10.9-11.9	#				Type 1 (Open Sea Disposal)
	13.9-14.9	#				Type 1 (Open Sea Disposal)
	14.9-15.7			#		**Type 2 (Confined Marine Disposal)**
VB7	Grab Sample		#			**Type 1# Open Sea Disposal (Dedicated Sites)**
	0.1-0.9	#				Type 1 (Open Sea Disposal)
	0.9-1.9	#				Type 1 (Open Sea Disposal)
	1.9-2.9	#				Type 1 (Open Sea Disposal)
	4.9-5.9	#				Type 1 (Open Sea Disposal)
	7.9-8.9	#				Type 1 (Open Sea Disposal)
	10.9-11.9	#				Type 1 (Open Sea Disposal)
	13.9-14.9	#				Type 1 (Open Sea Disposal)
VB8	Grab Sample	#				Type 1 (Open Sea Disposal)
	0.2-0.9	#				Type 1 (Open Sea Disposal)
	0.9-1.9	#				Type 1 (Open Sea Disposal)
	1.9-2.9	#				Type 1 (Open Sea Disposal)
	4.9-5.9	#				Type 1 (Open Sea Disposal)
	7.9-8.9	#				Type 1 (Open Sea Disposal)
	10.9-11.9	#				Type 1 (Open Sea Disposal)
	12.3-13.3	#				Type 1 (Open Sea Disposal)
VB9	Grab Sample		#			**Type 1# Open Sea Disposal (Dedicated Sites)**
	0.5-0.9	#				Type 1 (Open Sea Disposal)
VB9	0.9-1.9	#				Type 1 (Open Sea Disposal)

Sampling Location	Sampling Depth (meter below seabed level)	Sediment Category				Proposed Disposal Option (according to ETWB TC(W) No. 34/2002)
		L	Mp	Mf	H	
	1.9-2.9	#				Type 1 (Open Sea Disposal)
	4.9-5.9	#				Type 1 (Open Sea Disposal)
	7.9-8.9	#				Type 1 (Open Sea Disposal)
	10.9-11.9	#				Type 1 (Open Sea Disposal)
	13.9-14.9	#				Type 1 (Open Sea Disposal)
VB11	Grab Sample		#			**Type 1# Open Sea Disposal (Dedicated Sites)**
	0.5-0.9	#				Type 1 (Open Sea Disposal)
	0.9-1.9				#	**Type 2 (Confined Marine Disposal)**
	1.9-2.9	#				Type 1 (Open Sea Disposal)
	4.9-5.9	#				Type 1 (Open Sea Disposal)
	7.9-8.9	#				Type 1 (Open Sea Disposal)
	10.9-11.9	#				Type 1 (Open Sea Disposal)
VB12	Grab Sample		#			**Type 1# Open Sea Disposal (Dedicated Sites)**
	0.1-0.9	#				Type 1 (Open Sea Disposal)
	0.9-1.9	#				Type 1 (Open Sea Disposal)
	1.9-2.9	#				Type 1 (Open Sea Disposal)
	4.9-5.9	#				Type 1 (Open Sea Disposal)
	7.9-8.9	#				Type 1 (Open Sea Disposal)
	10.9-11.9	#				Type 1 (Open Sea Disposal)
	12.6-13.6	#				Type 1 (Open Sea Disposal)

7.6.2 The classification of sediment samples given in **Table 7.17** above was used to estimate the quantities of different category of marine deposit to be excavated and disposed from CBL. This information is vital to determine the disposal options of excavated marine deposit in accordance with ETWB TC(W) No. 34/2002.

Estimation of quantities of excavated marine deposit

7.6.3 In accordance with the proposed CBL alignment and preliminary bridge design, there are total 12 piers along the alignment. The four Western Approach Piers are numbered 1 to 4 and the six Eastern Approach Piers are numbered 5 to 10. The two piers of the main bridge are named as Pylon A and Pylon B. Among the 11 sediment sampling locations, VB3 to VB7 are located along the recommended alignment. Therefore, the testing results of these sampling locations are applied to each pier as illustrated in **Drawing no. 209506/EIA/SQ/003** based on the proximity.

7.6.4 Classification of sediment samples given in **Table 7.17** and the design details of the foundations at each pier and pylon, together with the data from geotechnical investigations are used to estimate the quantities of different category of marine deposit to be excavated and disposed. A summary of the estimation is provided in **Table 7.18**. Detailed calculations are given in **Appendix 7.3**. It is estimated that a total of approximately 4,300m^3 marine deposit is required to be excavated. Amongst the excavated volume, approximately 96.7% is Category L sediment. Category Mp, Mf, and H sediments contribute to about 3.3% of the total volume.

Table 7.18 Estimated quantities of different categories of excavated marine deposit

Sampling Location	Pier	Estimated quantities of excavated marine sediment (m^3)				Total estimated quantities of excavated marine sediment (m^3)
		Category L	Category Mp	Category Mf	Category H	
Western Approach Piers						
VB3	**1**	254.5	0.0	0.0	9.4	263.9
VB3	**2**	254.5	0.0	0.0	9.4	263.9
VB3	**3**	273.3	0.0	0.0	9.4	282.7
VB4	**4**	256.4	7.5	0.0	0.0	263.9
Main Bridge Piers						
VB4	**Pylon A**	688.0	18.8	0.0	0.0	706.9
VB5	**Pylon B**	735.1	18.8	0.0	0.0	754.0
Eastern Approach Piers						
VB6	**5**	256.4	0.0	7.5	0.0	263.9
VB6	**6**	256.4	0.0	7.5	0.0	263.9
VB6	**7**	273.3	0.0	28.3	0.0	301.6
VB7	**8**	312.9	7.5	0.0	0.0	320.4
VB7	**9**	284.6	7.5	0.0	0.0	292.2
VB7	**10**	275.2	7.5	0.0	0.0	282.7
Total estimated quantities of each category (m^3)		**4120.5**	**67.9**	**43.4**	**28.3**	**4260.0**
Total estimated quantities of each disposal options to the nearest digit (percentage,%)		**Type 1**	**Type 1#**	**Type 2**		
		4120.5 (96.7)	**67.9 (1.6)**	**71.7 (1.7)**		**4260.0 (100.0)**

Note:

1. Type 1 - Open sea disposal (applicable to Category L).
2. Type 1# - Open sea disposal (Dedicated sites) (applicable to Category Mp).
3. Type 2 - Confined marine disposal (applicable to Category Mf & H).

7.7 Conclusion

7.7.1 This section reviewed the sediment quality data and summarised the findings of the site investigation for sediment quality in relation to the proposed alignment of CBL. The sediment was classified in accordance with ETWB TC(W) No. 34/2002. The corresponding disposal methods were also proposed.

7.7.2 Classification of the sediment samples based on the chemical and biological test results, estimation of the quantities of different Categories of marine deposit to be excavated from the marine works of CBL and the corresponding disposal options are provided in this section.

7.7.3 Sediment quality been assessed according to the requirements of Annex 15, Guidelines for Assessment of Waste Management Implications, of the TM-EIAO. It is concluded that in respect of the marine sediment to be excavated and disposed at sea during the construction of the CBL, Annex 7, Criteria for Evaluating Waste Management Implications, of the TM-EIAO would be complied with.

8 Water Quality

8.1 Legislation and Standards

8.1.1 Environmental Impact Assessment Ordinance (EIAO), Cap.499, S16

8.1.1.1 This Study follows the TM-EIAO to assess the potential water quality impact that may arise during the construction and operational phases of the Project. Sections in the TM-EIAO relevant to the water quality impact assessment are:

- Annex 6 - Criteria for Evaluating Water Pollution; and
- Annex 14 - Guidelines for Assessment of Water Pollution

8.1.2 Water Quality Objectives (WQOs)

8.1.2.1 The Water Pollution Control Ordinance (WPCO) (Cap.358) provides the major statutory framework for the protection and control of water quality in Hong Kong. According to WPCO and its subsidiary legislation, the whole Hong Kong waters are divided into ten Water Control Zones (WCZs). Water Quality Objectives (WQOs) were established to protect the beneficial uses of water quality in each WCZ.

8.1.2.2 The proposed CBL is located within the Junk Bay WCZ and the study area covers Junk Bay, Victoria Harbour, Eastern Buffer, Port Shelter, Southern and Mirs Bay WCZs. According to the approved EIA Report for the Further Development of Tseung Kwan O Feasibility Study (EIA-111/2005) (EIA-TKOFS), the affected waterbodies are limited to Junk Bay, Victoria Harbour and Eastern Buffer WCZs. Specific WQOs are applied to each of these affected WCZs and are summarized in **Tables 8.1, 8.2** and **8.3** below.

Table 8.1 Summary of Water Quality Objectives for Junk Bay WCZ

Parameters	Objectives	Sub-Zone
Offensive Odour, Tints	Not to be present	Whole zone
Visible foam, oil scum, litter	Not to be present	Whole zone
Dissolved Oxygen	Not less than 2.0 mg/L for 90% of samples	Marine waters

Parameters	Objectives	Sub-Zone
(DO) within 2 m of the seabed		
Depth-averaged DO	Not less than 4.0 mg/L for 90% of samples	Marine waters excepting fish culture subzones
	Not less than 5.0 mg/L for 90% of samples	Fish culture subzones
	Not less than 4.0 mg/L	Inland waters
5-Bay Biochemical Oxygen Demand (BOD_5)	Change due to waste discharges not to exceed 5 mg/L	Inland waters
Chemical Oxygen Demand (COD)	Change due to waste discharges not to exceed 30 mg/L	Inland waters
pH	To be in the range of 6.5 - 8.5, change due to waste discharges not to exceed 0.2	Marine waters
	To be in the range of 6.0 –9.0	Inland waters
Salinity	Change due to waste discharges not to exceed 10% of ambient	Whole zone
Temperature	Change due to waste discharges not to exceed 2 ^{o}C	Whole zone
Suspended solids (SS)	Not to raise the ambient level by 30% caused by waste discharges and shall not affect aquatic communities	Marine waters
	Change due to waste discharges not to exceed 25 mg/L of annual median	Inland waters
Unionised Ammonia (UIA)	Annual mean not to exceed 0.021 mg/L as unionised form	Whole zone
Nutrients	Shall not cause excessive algal growth	Marine waters
Total Inorganic Nitrogen (TIN)	Annual mean depth-averaged inorganic nitrogen not to exceed 0.3 mg/L	Marine waters
Dangerous substances	Should not attain such levels as to produce significant toxic effects in humans, fish or any other aquatic organisms	Whole zone
	Waste discharges should not cause a risk to any beneficial use of the aquatic environment	Whole zone
Bacteria	Not exceed 610 per 100ml, calculated as the geometric mean of all samples collected in one calendar year	Secondary contact recreation subzones and fish culture subzones
	Not exceed 1000 per 100ml, calculated as the geometric mean of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days	Inland waters
Colour	Change due to waste discharges not to exceed 50 Hazen units	Inland waters

Source: Statement of Water Quality Objectives (Junk Bay Water Control Zone).

Table 8.2 Summary of Water Quality Objectives for Victoria Harbour WCZ

Parameters	Objectives	Sub-Zone
Offensive Odour, Tints	Not to be present	Whole zone
Visible foam, oil scum, litter	Not to be present	Whole zone
Dissolved Oxygen (DO) within 2 m of the seabed	Not less than 2.0 mg/L for 90% of samples	Marine waters
Depth-averaged DO	Not less than 4.0 mg/L for 90% of samples	Marine waters
pH	To be in the range of 6.5 - 8.5, change due to human activity not to exceed 0.2	Marine waters
Salinity	Change due to human activity not to exceed 10% of ambient	Whole zone
Temperature	Change due to human activity not to exceed 2 ^{o}C	Whole zone
Suspended solids (SS)	Not to raise the ambient level by 30% caused by human activity	Marine waters
Unionised Ammonia (UIA)	Annual mean not to exceed 0.021 mg/L as unionised form	Whole zone
Nutrients	Shall not cause excessive algal growth	Marine waters
Total Inorganic Nitrogen (TIN)	Annual mean depth-averaged inorganic nitrogen not to exceed 0.4 mg/L	Marine waters
Toxic substances	Should not attain such levels as to produce significant toxic, carcinogenic, mutagenic or teratogenic effects in humans, fish or any other aquatic organisms.	Whole zone
	Human activity should not cause a risk to any beneficial use of the aquatic environment.	Whole zone

Source: Statement of Water Quality Objectives (Victoria Harbour Water Control Zone).

Table 8.3 Summary of Water Quality Objectives for Eastern Buffer WCZ

Parameters	Objectives	Sub-Zone
Offensive Odour, Tints	Not to be present	Whole zone
Visible foam, oil scum, litter	Not to be present	Whole zone
Dissolved Oxygen (DO) within 2 m of the seabed	Not less than 2.0 mg/L for 90% of samples	Marine waters
Depth-averaged DO	Not less than 4.0 mg/L for 90% of samples	Marine waters excepting fish culture subzones

Parameters	Objectives	Sub-Zone
	Not less than 5.0 mg/L for 90% of samples	Fish Culture Subzones
	Not less than 4.0 mg/L	Water Gathering Ground Subzone and other Inland waters
5-Bay Biochemical Oxygen Demand (BOD_5)	Change due to waste discharges not to exceed 3 mg/L	Water Gathering Ground Subzones
	Change due to waste discharges not to exceed 5 mg/L	Inland waters
Chemical Oxygen Demand (COD)	Change due to waste discharges not to exceed 15 mg/L	Water Gathering Ground Subzones
	Change due to waste discharges not to exceed 30 mg/L	Inland waters
pH	To be in the range of 6.5 – 8.5, change due to waste discharges not to exceed 0.2	Marine waters
	To be in the range of 6.5 – 8.5	Water Gathering Ground Subzones
	To be in the range of 6.0 – 9.0	Inland waters
Salinity	Change due to waste discharges not to exceed 10% of ambient	Whole zone
Temperature	Change due to waste discharges not to exceed 2 ^{o}C	Whole zone
Suspended solids (SS)	Not to raise the ambient level by 30% caused by waste discharges and shall not affect aquatic communities	Marine waters
	Change due to waste discharges not to exceed 20 mg/L of annual median	Water Gathering Ground Subzones
	Change due to waste discharges not to exceed 25 mg/L of annual median	Inland waters
Unionised Ammonia (UIA)	Annual mean not to exceed 0.021 mg/L as unionised form	Whole zone
Nutrients	Shall not cause excessive algal growth	Marine waters
Total Inorganic Nitrogen (TIN)	Annual mean depth-averaged inorganic nitrogen not to exceed 0.4 mg/L	Marine waters
Dangerous substances	Should not attain such levels as to produce significant toxic effects in humans, fish or any other aquatic organisms	Whole zone
	Waste discharges should not cause a risk to any beneficial use of the aquatic environment	Whole zone
Bacteria	Not exceed 610 per 100ml, calculated as the geometric mean of all samples collected in one calendar year	Fish Culture Subzones

Parameters	Objectives	Sub-Zone
	Less than 1 per 100ml, calculated as the geometric mean of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days	Water Gathering Ground Subzones
	Not exceed 1000 per 100ml, calculated as the geometric mean of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days	Inland waters
Colour	Change due to waste discharges not to exceed 30 Hazen units	Water Gathering Ground
	Change due to waste discharges not to exceed 50 Hazen units	Inland waters

Source: Statement of Water Quality Objectives (Eastern Buffer Water Control Zone).

8.1.3 Technical Memorandum on Effluent Discharge Standards

8.1.3.1 Discharges of effluents are subject to control under the WPCO. The Technical Memorandum on Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters (TM-DSS) specifies limits for effluent discharges in different water control zones.

8.1.4 WSD Seawater Intakes

8.1.4.1 The criteria for assessing the water quality impact on the Water Supplies Department (WSD) seawater intakes are based on the Water Quality Criteria of Seawater for Flushing Supply (at intake point) issued by the Water Supplies Department (WSD) and are summarized in the **Table 8.3a**.

Table 8.3a: WSD Water Quality Criteria for Salt Water Intakes

Parameter	Concentration
Colour	< 20 H.U.
Turbidity	< 10 N.T.U.
Threshold Odour No.	< 100
Ammonia Nitrogen	< 1 mg/l
Suspended Solids	< 10 mg/l
Dissolved Oxygen	> 2 mg/l
Biochemical Oxygen Demand	< 10 mg/l
Synthetic Detergents	< 5 mg/l
E. coli.	< 20,000 cfu/100 ml

8.1.5 Practice Note for Professional Persons on Construction Site Drainage

8.1.5.1 The Practice Note for Professional Persons (ProPECC Note PN1/94) on Construction Site Drainage provides guidelines for the handling and disposal of construction discharges. This note is applicable to this study in controlling the site runoff and wastewater generated during the construction phase. The types of discharges from construction sites outlined in the ProPECC Note PN1/94 include:

- Surface run-off,
- Groundwater,
- Boring and drilling water,
- Wastewater from concrete batching,
- Wheel washing water,
- Bentonite slurries,
- Water for testing and sterilization of water retaining structures and water pipes,
- Wastewater from building construction and site facilities, and
- Acid cleaning, etching and pickling wastewater.

8.2 Description of Existing Environment

8.2.1 Marine Water Quality

8.2.1.1 The marine water quality monitoring data routinely collected by EPD were used to establish the baseline condition. The EPD monitoring stations in the Junk Bay WCZ (JM3 and JM4), Eastern Buffer WCZ (EM1 and EM2) and Victoria Harbour WCZ (VM1 and VM2) are shown in **Drawing No. 209506/EIA/WQ/001**. Other WCZs such as Southern WCZ are considered far away from site and will not take into account. Summaries of the EPD's Routine Water Quality Monitoring Data in year 2009 and 2010 are given in **Tables 8.4, 8.5** and **8.6** as below.

Table 8.4 Summary of 2009-2010 Marine Water Quality in Junk Bay WCZ Monitoring Stations

Parameter	JM3		JM4	
	2009	2010	2009	2010
Temperature (OC)	23.5 (16.8-28.4)	22.5 (16.3-28.7)	23.3 (17.0-28.4)	22.4 (16.3-27.6)
Salinity (ppt)	32.1 (27.7-33.6)	32.4 (30.8-33.8)	32.5 (29.5-33.8)	32.6 (30.9-33.9)

Parameter		JM3		JM4	
		2009	2010	2009	2010
Dissolved Oxygen (DO) (% saturation)		86 (71-112)	86 (71-96)	83 (69-102)	87 (68-100)
	Bottom	79 (50-100)	82 (56-98)	74 (39-101)	81 (42-100)
DO (mg/L)		6.0 (4.9-7.3)	6.2 (4.9-7.6)	5.8 (4.8-7.0)	6.3 (4.5-7.9)
	Bottom	5.6 (3.5-7.0)	6.0 (3.9-7.7)	5.3 (2.7-7.1)	5.9 (2.9-8.0)
pH		8.0 (7.7-8.3)	7.9 (7.6-8.2)	8.0 (7.7-8.3)	7.9 (7.6-8.2)
Secchi Disc Depth (m)		2.7 (1.8-3.5)	2.9 (1.8-4.2)	2.8 (1.8-3.5)	3.0 (1.8-5.6)
Turbidity (NTU)		4.0 (1.2-9.1)	2.8 (0.7-6.4)	4.6 (2.0-9.9)	3.2 (1.3-7.2)
Suspended Solids (mg/L)		4.3 (2.2-7.9)	2.5 (0.8-4.6)	5.0 (2.5-8.6)	2.8 (1.7-5.3)
5-day Biochemical Oxygen Demand (mg/L)		0.8 (0.2-1.7)	0.7 (0.3-1.5)	0.8 (<0.1-1.8)	0.6 (0.1-1.5)
Ammonia Nitrogen (mg/L)		0.05 (0.017-0.089)	0.058 (0.027-0.097)	0.04 (0.021-0.068)	0.047 (0.020-0.082)
Unionised Ammonia (mg/L)		0.002 (<0.001-0.003)	0.002 (<0.001-0.006)	0.001 (<0.001-0.003)	0.002 (<0.001-0.005)
Nitrite Nitrogen (mg/L)		0.019 (0.003-0.091)	0.021 (0.006-0.051)	0.015 (0.002-0.057)	0.019 (0.005-0.048)
Nitrate Nitrogen (mg/L)		0.064 (0.029-0.174)	0.068 (0.017-0.111)	0.056 (0.020-0.147)	0.056 (0.007-0.099)
Total Inorganic Nitrogen (mg/L)		0.13 (0.05-0.29)	0.15 (0.07-0.20)	0.11 (0.05-0.24)	0.12 (0.04-0.19)
Total Kjeldahl Nitrogen (mg/L)		0.18 (0.08-0.29)	0.18 (0.10-0.26)	0.15 (0.06-0.22)	0.16 (0.10-0.22)
Total Nitrogen (mg/L)		0.26 (0.14-0.41)	0.27 (0.14-0.35)	0.23 (0.11-0.33)	0.23 (0.12-0.32)
Orthophosphate Phosphorus (mg/L)		0.013 (0.004-0.022)	0.014 (0.006-0.019)	0.012 (0.007-0.018)	0.012 (0.004-0.023)
Total Phosphorus (mg/L)		0.03 (<0.02-0.04)	0.03 (<0.02-0.05)	0.03 (0.02-0.03)	0.03 (<0.02-0.05)

Parameter	JM3		JM4	
	2009	2010	2009	2010
Silica (as SiO2) (mg/L)	0.6 (0.09-1.77)	0.063 (0.15-0.97)	0.59 (0.15-1.40)	0.61 (0.13-0.89)
Chlorophy ll-α (µg/L)	4.4 (0.8-11.5)	3.9 (0.5-21.4)	4.0 (0.6-13.0)	3.3 (0.5-14.3)
E. Coli (cfu/100ml)	49 (11-430)	46 (5-140)	55 (11-150)	30 (4-240)
Faecal Coliforms (cfu/100ml)	140 (59-770)	110 (10-400)	140 (18-380)	66 (12-720)

Notes:

(1) Data presented are depth averaged (except as specified) and are the annual arithmetic mean except for E. coli (geometric mean)

(2) Data in bracket indicate ranges

Table 8.5 Summary of 2009-2010 Marine Water Quality in Eastern Buffer WCZ Monitoring Stations

Parameter		EM1		EM2	
		2009	2010	2009	2010
Temperature (OC)		23.2 (17.4-28.5)	22.4 (16.5-27.5)	23.4 (17.5-28.5)	22.4 (16.4-27.7)
Salinity (ppt)		32.7 (30.8-33.9)	32.6 (30.8-33.9)	32.2 (25.7-33.9)	32.7 (30.9-33.9)
Dissolved Oxygen (DO) (% saturation)		79 (53-103)	88 (64-98)	82 (66-106)	87 (69-101)
	Bottom	75 (38-102)	81 (44-100)	76 (44-102)	83 (45-101)
DO (mg/L)		5.6 (3.7-7.1)	6.3 (4.2-7.7)	5.8 (4.5-7.3)	6.3 (4.5-8.0)
	Bottom	5.3 (2.7-7.1)	5.9 (3.0-8.0)	5.4 (3.1-7.2)	6.0 (3.1-8.0)
pH		8.0 (7.6-8.2)	7.9 (7.6-8.2)	8.0 (7.6-8.3)	8.0 (7.7-8.1)
Secchi Disc Depth (m)		2.6 (2.0-3.2)	2.9 (1.8-4.5)	2.7 (1.8-4.0)	3.0 (1.9-4.5)
Turbidity (NTU)		4.4 (2.0-9.9)	3.5 (1.4-7.2)	4.4 (2.3-9.3)	3.6 (1.0-6.8)
Suspended Solids (mg/L)		4.5 (2.8-6.9)	3.2 (1.0-7.5)	4.0 (2.8-6.6)	3.2 (1.3-7.7)
5-day Biochemical Oxygen Demand (mg/L)		0.6 (<0.1-1.6)	0.7 (0.2-1.7)	0.6 (<0.1-1.6)	0.5 (0.1-1.0)
Ammonia Nitrogen (mg/L)		0.039 (0.014-0.063)	0.051 (0.012-0.101)	0.029 (0.008-0.055)	0.041 (0.009-0.099)

Parameter	EM1		EM2	
	2009	2010	2009	2010
Unionised Ammonia (mg/L)	0.001 (<0.001-0.003)	0.002 (<0.001-0.006)	0.001 (<0.001-0.003)	0.002 (<0.001-0.005)
Nitrite Nitrogen (mg/L)	0.016 (0.003-0.073)	0.018 (0.005-0.047)	0.015 (<0.002-0.087)	0.018 (0.005-0.047)
Nitrate Nitrogen (mg/L)	0.062 (0.019-0.197)	0.058 (0.007-0.113)	0.055 (0.009-0.217)	0.054 (0.006-0.108)
Total Inorganic Nitrogen (mg/L)	0.12 (0.04-0.30)	0.13 (0.03-0.23)	0.10 (0.02-0.34)	0.11 (0.03-0.22)
Total Kjeldahl Nitrogen (mg/L)	0.15 (0.11-0.23)	0.16 (0.09-0.31)	0.15 (0.09-0.20)	0.13 (0.08-0.25)
Total Nitrogen (mg/L)	0.23 (0.14-0.40)	0.24 (0.12-0.41)	0.22 (0.11-0.47)	0.21 (0.12-0.37)
Orthophosphate Phosphorus (mg/L)	0.012 (0.008-0.018)	0.013 (0.003-0.029)	0.010 (0.005-0.019)	0.013 (0.004-0.027)
Total Phosphorus (mg/L)	0.03 (0.02-0.03)	0.03 (<0.02-0.04)	0.02 (<0.02-0.03)	0.03 (<0.02-0.05)
Silica (as SiO2) (mg/L)	0.62 (0.23-1.76)	0.61 (0.15-0.85)	0.58 (0.20-1.87)	0.61 (0.25-0.94)
Chlorophy ll-α (μg/L)	3.5 (0.8-8.6)	4.8 (0.5-24.3)	3.4 (0.6-10.7)	1.9 (0.5-9.5)
E. Coli (cfu/100ml)	65 (6-470)	25 (1-330)	19 (3-240)	15 (1-180)
Faecal Coliforms (cfu/100ml)	140 (7-1400)	61 (7-1400)	46 (5-970)	33 (2-1100)

Notes:

(1) Data presented are depth averaged (except as specified) and are the annual arithmetic mean except for E. coli (geometric mean)

(2) Data in bracket indicate ranges

Table 8.6 Summary of 2009-2010 Marine Water Quality in Victoria Harbour WCZ Monitoring Stations

Parameter		VM1		VM2	
		2009	2010	2009	2010
Temperature (OC)		23.6 (18.6-28.4)	22.8 (16.5-27.3)	23.8 (18.7-28.5)	23.0 (16.5 - 27.3)
Salinity (ppt)		32.3 (27.0-33.6)	32.0 (29.2-33.6)	31.7 (22.5-33.5)	31.7 (29.1 - 33.7)
Dissolved		78	77	79	74

Parameter		VM1		VM2	
		2009	2010	2009	2010
Oxygen (DO) (% saturation)		(53-102)	(49-95)	(61-102)	(53 - 90)
	Bottom	76 (48-102)	67 (16-84)	78 (61-102)	67 (17 - 93)
DO (mg/L)		5.5 (3.5-7.0)	5.6 (3.3-7.6)	5.6 (4.1-7.0)	5.4 (3.5 - 6.7)
	Bottom	5.4 (3.3-7.1)	4.8 (1.1-6.3)	5.5 (4.2-7.0)	4.8 (1.2 - 6.4)
pH		8.0 (7.8-8.3)	7.9 (7.6-8.2)	8.0 (7.6-8.3)	7.9 (7.6 - 8.2)
Secchi Disc Depth (m)		2.5 (1.5-3.4)	3.0 (1.9-4.1)	2.3 (1.5-3.2)	2.9 (2.0 - 4.6)
Turbidity (NTU)		5.6 (2.6-11.3)	4.0 (1.5-12.1)	4.9 (2.2-9.9)	3.2 (1.1 - 5.9)
Suspended Solids (mg/L)		7.2 (3.5-17.9)	4.0 (1.4-8.1)	5.2 (2.7-8.3)	3.6 (0.9 - 7.6)
5-day Biochemical Oxygen Demand (mg/L)		0.6 (0.2-1.0)	0.7 (<0.1-1.2)	0.7 (<0.1-1.2)	0.9 (<0.1 - 1.6)
Ammonia Nitrogen (mg/L)		0.06 (0.029-0.190)	0.083 (0.042-0.187)	0.08 (0.041-0.200)	0.120 (0.063 - 0.197)
Unionised Ammonia (mg/L)		0.002 (0.001-0.005)	0.003 (<0.001-0.010)	0.003 (0.002-0.006)	0.004 (<0.001 - 0.011)
Nitrite Nitrogen (mg/L)		0.021 (0.004-0.102)	0.024 (0.008-0.055)	0.027 (0.004-0.154)	0.027 (0.007 - 0.053)
Nitrate Nitrogen (mg/L)		0.076 (0.022-0.201)	0.097 (0.027-0.203)	0.097 (0.020-0.313)	0.123 (0.029 - 0.257)
Total Inorganic Nitrogen (mg/L)		0.16 (0.07-0.34)	0.20 (0.09-0.32)	0.21 (0.07-0.60)	0.27 (0.10 - 0.40)
Total Kjeldahl Nitrogen (mg/L)		0.19 (0.09-0.33)	0.21 (0.12-0.32)	0.21 (0.10-0.35)	0.25 (0.15 - 0.32)
Total Nitrogen (mg/L)		0.29 (0.19-0.48)	0.33 (0.16-0.45)	0.33 (0.18-0.75)	0.4 (0.19 - 0.59)
Orthophosphate Phosphorus (mg/L)		0.016 (0.008-0.030)	0.020 (0.010-0.036)	0.019 (0.008-0.041)	0.024 (0.011 - 0.039)
Total Phosphorus (mg/L)		0.03 (0.02-0.05)	0.03 (0.02-0.06)	0.03 (0.02-0.06)	0.04 (0.02 - 0.05)
Silica (as SiO2) (mg/L)		0.65 (0.18-1.80)	0.74 (0.25-1.30)	0.72 (0.21-2.60)	0.79 (0.22 - 1.50)

Parameter	VM1		VM2	
	2009	2010	2009	2010
Chlorophy ll-α (μg/L)	2.8 (0.4-7.3)	2.8 (0.5-12.2)	3.1 (0.7-9.1)	3.3 (0.5 - 15.4)
E. Coli (cfu/100ml)	210 (53-950)	710 (180-4400)	710 (100-9400)	2000 (420 - 17000)
Faecal Coliforms (cfu/100ml)	490 (69-3400)	1600 (410-9400)	1400 (150-21000)	4500 (680 - 27000)

Notes:

(1) Data presented are depth averaged (except as specified) and are the annual arithmetic mean except for E. coli (geometric mean)

(2) Data in bracket indicate ranges

8.2.1.2 According to EPD's Marine Water Quality Report 2010, with the implementation of the HATS Stage 1 in 2002 by which all sewage generated from Junk Bay and Eastern Buffer WCZ was diverted and treated at the Stonecutter Island Sewerage Treatment Works, the water quality of these two WCZs has improved significantly with full compliance (100%) with the WQOs.

8.2.1.3 In the Victoria Harbour WCZ, the 2010 compliance rate was 77% compared with 93% in 2009. The lower compliance rate was mainly due to the non-compliance with DO objective at 6 stations in west of Victoria Harbour (VM1, 4, 5, 6, 12 and 15) in the summer months of 2010. Similar to the Tolo Harbour WCZ, the low DO situation was likely related to the unusually hot and wet weather during July to September. The E. coli level in the general western Victoria Harbour area decreased by 47%-68% compared with that in 2009 which could be attributed to the commissioning of the Advance Disinfection Facilities (ADF) at the Stonecutters Island Sewage Treatment Works (SCISTW) in March 2010. However, no decrease in E. coli level was observed in central Victoria Harbour (from North Point to Sai Wan) because the discharges from the four remaining sewage screening plants on the north side of Hong Kong Island have not yet been intercepted for treatment at the SCISTW.

8.3 Water Quality Sensitive Receivers & Pollution Sources

8.3.1 Water Quality Sensitive Receivers

8.3.1.1 The water quality sensitive receivers (WSR) in the vicinity will include the followings:

- Cooling Water Intakes,
- Salt Water Intakes,
- Gazetted Beaches,
- Fish Culture Zones,
- Coral Communities,
- Site of Special Scientific Interest (SSSI), and
- Benthic Communities, in particular Amphioxus (Spotted Occurrence of Amphioxus).

8.3.1.2 The key WSRs that are potentially affected during the construction and operational phases of the CBL project are listed in **Table 8.7**. **Drawing No. 209506/EIA/WQ/001** shows the locations of these water quality sensitive receivers. The information of benthic and coral sites have been updated in accordance with the latest dive survey results.

Table 8.7 Water Sensitive Receivers

WSR ID	Description	Reference
SWI1	WSD's Salt Water Intakes at Tseung Kwan O	1, 3
SWI2	WSD's Salt Water Intakes at Yau Tong	1, 3
SWI3	WSD's Salt Water Intakes at Tai Wan	1
SWI4	WSD's Salt Water Intakes at Cha Kwo Lang	1, 3
SWI5	WSD's Salt Water Intakes at North Point	1, 3
SWI6	WSD's Salt Water Intakes at Quarry Bay	1, 3
SWI7	WSD's Salt Water Intakes at Sai Wan Ho	1, 3
SWI8	WSD's Salt Water Intakes at Heng Fa Chuen	1, 3
SWI9	WSD's Salt Water Intakes at Siu Sai Wan	1, 3
SWI10	Salt Water Intakes at Cape D'Aguilar for Swire Institute of Marine Science, The University of Hong Kong	3
CWI1	Cooling Water Intakes for Dairy Farm Ice Plant	1, 3
CWI2	Cooling Water Intakes for Pamela Youde Nethersole Eastern Hospital	1, 3
CWI3	Future Kai Tak Cooling Water Intakes	9
CC1	Coral Sites at Chiu Keng Wan	1, 3, 4, 8
CC2	Coral Sites at Junk Bay	3, 4, 8
CC3	Coral Sites at Junk Island	3, 4, 8
CC4	Coral Sites at Fat Tong Chau West	3, 4
CC5	Coral Sites at Tso Tui Wan North	3, 4
CC6	Coral Sites at Joss House Bay	1, 4
CC7	Coral Sites at Tung Lung Chau West	1, 3, 4
CC8	Coral Sites at Tung Lung Chau East	1, 4

WSR ID	Description	Reference
CC9	Coral Sites at Shek Mei Tau	3, 4
CC10	Coral Sites at So Shi Tau	1
CC11	Coral Sites at Tai Wang Tau	1
CC12	Coral Sites at Po Keng Teng	1
CC13	Coral Sites at Junk Bay near Chiu Keng Wan	8
SS1	SSSI at Shek O Headland	1, 6
SS2	SSSI at Cape D'Aguilar	1, 6
FCZ1	Fish Culture Zone at Po Toi O	1, 3, 7
FCZ2	Fish Culture Zone at Tung Lung Chau	1, 3, 7
AM1	Spotted Occurrence of Amphioxus (historical record of summer survey)	3
AM2	Spotted Occurrence of Amphioxus (Yr 2006 record of summer survey)	3
AM3	Spotted Occurrence of Amphioxus (Yr 2006 record of summer survey)	3
GB1	Shek O Rocky Bay	1, 3, 5
GB2	Shek O Beach	1, 3, 5
GB3	Big Wave Bay Beach	1, 3, 5
GB4	Clear Water Bay First Beach	1, 3, 5
GB5	Clear Water Bay Second Beach	1, 3, 5

References:

(1) EIA-TKOFS

(2) Not used

(3) EIA Report for Hong Kong Offshore Wind Farm in Southeastern Waters (EIA-167/2009)

(4) Binnie Consultants Ltd (1995) Marine Ecology of Hong Kong - Report on Underwater Dive Surveys

(5) LCSD websites: http://www.lcsd.gov.hk

(6) Tai Tam & Shek O Outline Zoning Plan S/H18/10

(7) AFCD websites: http://www.afcd.gov.hk/tc_chi/fisheries/fish_aqu/fish_aqu_mpo/fish_aqu_mpo.html

(8) AECOM Marine Ecological Survey Report, 2003

(9) Revised Preliminary Outline Development Plan for Kai Tak Development

8.3.2 Pollution Sources

Construction Phase

8.3.2.1 The principal water quality concern associated with the CBL is related to the seabed disturbance during the construction period. There will be a need for excavation and filling activities for the bridge piers of the project. These operations will inevitably result in the loss and resuspension of sediment into the water column where they will add to the suspended sediment loads.

8.3.2.2 During excavation works, fine material will be displaced and may be carried downstream of the works area. The extent of the suspended sediment plume will depend on the rate of release, the working methods adopted, the particle size of the excavated material, settling velocity, the prevailing currents and hydrodynamic conditions. Similar disturbance may be experienced during backfilling, the backfill material will be very much coarser grained and heavier.

8.3.2.3 Sediment laden plumes may directly affect marine organisms through abrasion and clogging of fish gills and other organs or possibly result in reducing light penetration.

8.3.2.4 Depending on the sediment quality, excavation operations can give rise to concerns about possible release of nutrients or organically rich material which could result in oxygen depletion.

8.3.2.5 In addition to the marine works, the CBL project would entail significant land based works for construction works. The main water quality related issues will be to prevent erosion on site and minimise suspended sediment loads washed out in stormwater and to control wastewater streams from temporary sewage facilities, cementitious waters and general construction refuse. Control of construction phase sewage will also be an issue. Toilets are required to be connected to the local sewerage system if possible during construction. Otherwise, chemical toilets will be used.

8.3.2.6 In summary, the key construction phase water pollution sources will be as follows:

- Excavation activities during the construction period, which may cause release of suspended solids, contaminants and nutrients into the water body;
- Changes in sediment deposition rate, which may affect the adjacent WSRs and ecological sensitive receivers;
- Construction site runoff, which may cause the increase in suspended solids levels and possibly oils due to erosion of exposed surfaces, stockpiles and material storage areas, fuel and oil storage and maintenance areas and dust suppression sprays;
- Wastewater and sewage generated from construction activities, which may cause pollution to the surrounding water bodies;
- Litter from packaging materials and waste construction materials; and
- Construction workforce sewage.

Operational Phase

8.3.2.7 There will be no routine discharge of wastewater or contaminated surface drainage to sea or surface watercourse in the operational phase but there will be some run-off from the road surfaces that could be marginally contaminated with pollution from vehicles fuel.

8.3.2.8 In summary, the key operational phase water pollution sources will be as follows:

- Changes in hydraulic friction that may lead to long-term impacts on the hydrodynamic and water quality conditions, and WSRs within the Junk Bay WCZ, Eastern Buffer WCZ and Victoria Harbour WCZ; and
- Surface run-off from the road surfaces.

8.4 Potential Concurrent Projects

8.4.1.1 The tentative construction period of marine works (excavation) for CBL will be from May 2017 to August 2018. The major existing/planned projects and bridge projects that might potentially affect the hydrodynamic regime and water quality are listed in **Table 8.8**.

Table 8.8 Planned Projects that will Affect the Hydrodynamic Regime and Water Quality

Project	Construction Programme	Effect on Cumulative Water Quality Impact (Construction Phase)	Effect on Hydrodynamic Regime (Operational Phase)
Shatin Central Link (1)			
Dredging at Kai Tak Runway	Jul 2012 to Dec 2012	×	×
Dredging at Open Harbour	2016	×	×
Dredging at Causeway Bay Typhoon Shelter	2016	×	×
Cruise Terminal (2)			
Dredging Stage 1 - Seawall	2011 to 2012	×	×
Dredging Stage 1 – Manoeuvre	2011 to 2012	×	✓
Dredging Stage 1 - Fireboat Berth	2011 to 2012	×	✓
Dredging Stage 2 - Phase II Berth	2013 to 2014	×	✓

Project	**Construction Programme**	**Effect on Cumulative Water Quality Impact (Construction Phase)**	**Effect on Hydrodynamic Regime (Operational Phase)**
Trunk Road T2 (3)			
Dredging	Mar 2012 to Jan 2014	✗	✗
Dredging	Feb 2015 to May 2017	✓	✗
Filling - Public Fill	May 2012 to Dec 2012	✗	✗
Filling - Public Fill	Apr 2013 to Dec 2016	✓	✗
TKO LT-Tunnel Reclamation (4)			
Reclamation (Public fill)	Jul 2018 to Sept 2018	✓	✓
CLP Windfarm (5)			
Grab Dredging - Cable	Jan 2017 to Apr 2017	✓	✗
Jetting – Cable	Jan 2017 to Apr 2017	✓	✗
Suction Caisson - Windfarm foundation	Apr 2017 to Sep 2017	✗	✗
Gas Pipeline (2)			
Grab Dredging - TKW to NP	Apr 2012 to Dec 2012	✗	✗

Note:

(1) Information from MTR (SCL-COR-HSD-ENV-040363 dated 9 Dec 2010) and SCL project teams. According to the findings of the EIA study, there will be no impact to Junk Bay from the SCL dredging works.

(2) EIA reports of Submerged Gas Pipeline and Cruise Terminus.

(3) Information from T2 project team (A0516-EB000560-HCL-HKL-00 dated 1 Nov 2010).

(4) Information from TKO-LT Tunnel project team.

(5) Information from CLP project team, the Suction Caisson of windfarm are considered far away from site and not included in the model.

8.5 Assessment Methodology

8.5.1 Introduction

8.5.1.1 Indicator points have been selected in the water quality model to provide hydrodynamic and water quality outputs to evaluate the water quality impact. The selected indicator points include the WSR and EPD marine water sampling stations. The locations of EPD marine water sampling stations JM3 & JM4 in the Junk Bay WCZ; EM1, EM2 & EM3 in the Eastern Buffer WCZ; and VM1 & VM2 in the Victoria Harbour WCZ are also shown in **Drawing No. 209506/EIA/WQ/001**.

8.5.1.2 The 3-dimensional modelling tool, Delft3D, has been adopted to simulate the hydrodynamic and water quality impact due to the construction and operation of CBL. The Delft3D-FLOW module and Delft3D-WAQ module have been used for hydrodynamic and water quality simulations respectively.

8.5.1.3 The hydrodynamic outputs from the model will provide inputs for the water quality simulation. The hydrodynamic forcing including averaged fresh water flows, wind and boundary conditions of the dry season and wet seasons will be applied separately in the corresponding hydrodynamic simulations.

8.5.1.4 The Junk Bay Model was nested and validated with the Update Model, which is already well calibrated against the criteria in **Table 8.9**.

Table 8.9 Calibration Parameters for Update Model

Criteria	Level of fitness with field data
Tidal elevation (rms)	< 8%
Maximum phase error at high water and low water	< 20 minutes
Maximum current speed deviation	< 30%
Maximum phase error at peak speed	< 20 minutes
Maximum direction error at peak speed	< 15 degrees
Maxium salinity deviation	< 2.5 ppt

8.5.1.5 The hydrodynamic parameters of Junk Bay model has been validated and linked to the Update Model under EIA-TKOFS (EIA-111/2005). The model has therefore been adopted for hydrodynamic and water quality modelling in the present study.

8.5.2 Assessment Criteria

Water Quality Objectives

8.5.2.1 For the WCZs of interest, the WQO for suspended solids is defined as "waste discharge not to raise the natural ambient level by 30% nor cause the accumulation of suspended solids which may adversely affect aquatic communities.” In order to determine the ambient suspended solids concentrations in the waters likely to be impacted by the construction works, the suspended solids level for Stations JM3, JM4, VM1, VM2, EM1, EM2, EM3 and MM19 (see **Drawing No. 209506/EIA/WQ/001**) has been adopted as the ambient suspended solids concentrations (**Table 8.10**).

8.5.2.2 The WQO of suspended solid is usually interpreted as the depth averaged suspended solids concentrations. However, the suspended solids concentrations near the seabed, especially when impacted by dredging and filling works, can be significantly larger than the depth averaged suspended solids concentrations. As a result, when assessing the impacts of the dredging and filling works on the suspended solids concentrations, it is proposed that ambient SS level shall be the depth averaged 90th percentile concentrations. **Table 8.11** summarises the depth averaged 90th percentile concentrations. Thus, the WQO for each EPD monitoring station shall be 30% increment of the 90th percentile concentration and are presented in **Table 8.12**.

Table 8.10 Average Suspended Solids Concentrations from EPD Routine Monitoring Programme (2001-2010)

Station	Suspended Solids Concentrations (mg/L) 2001 - 2010							
	Dry Season				Wet Season			
	Surface	Middle	Bottom	Depth Averaged	Surface	Middle	Bottom	Depth Averaged
JM3	3.1 (13-0.8)	3.8 (31-0.6)	4.9 (14-0.9)	4.0 (15.2-1.2)	2.3 (7.2-0.6)	2.8 (9.9-0.7)	3.9 (9.0-1.0)	3.0 (8.4-0.8)
JM4	2.9 (7.5-0.5)	5.2 (110-1)	5.6 (16-1.1)	4.5 (38.7-1.1)	2.9 (13-0.7)	3.5 (17-1.2)	6.5 (31-1.4)	4.3 (19-1.6)
EM1	2.8 (7.7-0.8)	3.2 (9.2-1.1)	5.3 (23-1.3)	3.8 (12.8-1.2)	2.9 (11-1)	3.7 (12-0.8)	5.8 (21-1.7)	4.1 (13.2-1.3)
EM2	2.8 (9-0.6)	3.2 (13-0.8)	6.3 (64-0.6)	4.1 (22.9-0.7)	2.7 (11-0.6)	3.1 (17-0.8)	5.3 (19-1.2)	3.7 (15.7-1.3)
EM3	3.0 (10-0.7)	3.7 (15-0.8)	5.6 (21-1.3)	4.1 (14.2-1.2)	2.3 (11-0.6)	2.7 (13-0.8)	5.9 (52-1.2)	3.6 (25.3-1.1)
VM1	3.4 (9.5-1)	4.2 (18-1)	6.0 (47-0.8)	4.6 (17.9-0.9)	3.2 (12-1.2)	5.8 (19-1.1)	10.1 (36-2.4)	6.4 (18-1.9)
VM2	3.4 (6.9-1)	4.1 (9.2-1.1)	5.0 (15-1.2)	4.2 (9.9-1.3)	3.8 (8.3-0.6)	4.3 (26-0.8)	5.3 (20-0.9)	4.5 (12.8-0.9)
MM19	1.9 (6.1-0.5)	2.5 (12-0.6)	5.5 (23-0.9)	3.3 (13.7-0.8)	1.6 (3.8-0.5)	1.9 (4.2-0.6)	5.5 (13-0.8)	3.0 (6.4-0.7)

Notes: The data are presented as the arithmetic mean and range (max – min) of the suspended solids concentrations at each station at the three monitoring levels and as the depth averaged concentrations.

Table 8.11 90th Percentile Suspended Solids Concentrations from EPD Routine Monitoring Programme (2001-2010)

Station	90th Percentile Suspended Solids Concentrations (mg/L) 2001 - 2010							
	Dry Season				Wet Season			
	S	M	B	DA	S	M	B	DA
JM3	4.5	5.9	9.8	6.4	4.0	4.1	6.7	5.4
JM4	4.7	6.3	11.0	7.4	4.7	5.1	12.0	8.8
EM1	4.2	4.8	8.9	7.0	4.6	5.9	9.5	7.8
EM2	4.5	4.7	9.4	6.4	4.5	5.0	7.6	6.6
EM3	6.5	7.7	11.1	7.7	3.9	4.4	7.8	6.2
VM1	5.7	6.9	8.9	7.4	5.3	8.9	18.0	12.0
VM2	5.5	7.0	8.8	6.9	6.2	6.7	8.8	7.2
MM19	2.8	4.7	12.0	6.8	2.8	3.1	9.4	6.2

Note:

1. *S – Surface; M – Middle; B – Bottom; DA – Depth-averaged*

Table 8.12 Water Quality Objectives for the Assessment of Elevations in Suspended Solids Concentrations (mg/L) due to Construction Impacts

Station	30% of 90th Percentile Suspended Solids Concentrations (mg/L) 2001 - 2010							
	Dry Season				Wet Season			
	S	M	B	DA	S	M	B	DA
JM3	1.4	1.8	2.9	1.9	1.2	1.2	2.0	1.6
JM4	1.4	1.9	3.3	2.2	1.4	1.5	3.6	2.6
EM1	1.3	1.4	2.7	2.1	1.4	1.8	2.8	2.3
EM2	1.4	1.4	2.8	1.9	1.3	1.5	2.3	2.0
EM3	2.0	2.3	3.3	2.3	1.2	1.3	2.4	1.9
VM1	1.7	2.1	2.7	2.2	1.6	2.7	5.4	3.6
VM2	1.7	2.1	2.6	2.1	1.9	2.0	2.7	2.2
MM19	0.8	1.4	3.6	2.0	0.8	0.9	2.8	1.9

Note:

1. *S – Surface; M – Middle; B – Bottom; DA – Depth-averaged*

8.5.2.3 In the current study, rather than averaging the 90th percentile concentrations over the whole area which could be impacted by the construction works, it is proposed to assign each sensitive receiver to the nearest EPD water quality monitoring station and to set the WQO at each station as 30% of the 90th percentile at that station.

8.5.2.4 Based upon the values detailed in **Table 8.12** above, each specific point/sensitive receiver has been assigned a specific WQO for suspended solids, as detailed in **Table 8.13**.

Table 8.13 Allowable SS Elevation for Water Quality Sensitive Receivers

Observation Points	Associated EPD Station	WQO/WQC (mg/L)							
		Dry Season				Wet Season			
		S	M	B	DA	S	M	B	DA
SWI1	JM3	1.4	1.8	2.9	1.9	1.2	1.2	2.0	1.6
SWI2	VM1	1.7	2.1	2.7	2.2	1.6	2.7	5.4	3.6
SWI3	VM2	1.7	2.1	2.6	2.1	1.9	2.0	2.7	2.2
SWI4	VM1	1.7	2.1	2.7	2.2	1.6	2.7	5.4	3.6
SWI5	VM2	1.7	2.1	2.6	2.1	1.9	2.0	2.7	2.2
SWI6	VM2	1.7	2.1	2.6	2.1	1.9	2.0	2.7	2.2
SWI7	VM1	1.7	2.1	2.7	2.2	1.6	2.7	5.4	3.6
SWI8	EM1	1.3	1.4	2.7	2.1	1.4	1.8	2.8	2.3
SWI9	EM1	1.3	1.4	2.7	2.1	1.4	1.8	2.8	2.3
SWI10	EM3	2.0	2.3	3.3	2.3	1.2	1.3	2.4	1.9
CWI1	VM1	1.7	2.1	2.7	2.2	1.6	2.7	5.4	3.6
CWI2	EM1	1.3	1.4	2.7	2.1	1.4	1.8	2.8	2.3
CC1	JM4	1.4	1.9	3.3	2.2	1.4	1.5	3.6	2.6
CC2	JM3	1.4	1.8	2.9	1.9	1.2	1.2	2.0	1.6
CC3	JM3	1.4	1.8	2.9	1.9	1.2	1.2	2.0	1.6
CC4	JM4	1.4	1.9	3.3	2.2	1.4	1.5	3.6	2.6
CC5	EM2	1.4	1.4	2.8	1.9	1.3	1.5	2.3	2.0
CC6	EM2	1.4	1.4	2.8	1.9	1.3	1.5	2.3	2.0
CC7	EM2	1.4	1.4	2.8	1.9	1.3	1.5	2.3	2.0
CC8	EM3	2.0	2.3	3.3	2.3	1.2	1.3	2.4	1.9
CC9	MM19	0.8	1.4	3.6	2.0	0.8	0.9	2.8	1.9
CC10	MM19	0.8	1.4	3.6	2.0	0.8	0.9	2.8	1.9
CC11	MM19	0.8	1.4	3.6	2.0	0.8	0.9	2.8	1.9
CC12	MM19	0.8	1.4	3.6	2.0	0.8	0.9	2.8	1.9
CC13	JM3	1.4	1.8	2.9	1.9	1.2	1.2	2.0	1.6
SS1	EM3	2.0	2.3	3.3	2.3	1.2	1.3	2.4	1.9
SS2	EM3	2.0	2.3	3.3	2.3	1.2	1.3	2.4	1.9
FCZ1	MM19	0.8	1.4	3.6	2.0	0.8	0.9	2.8	1.9
FCZ2	EM2	1.4	1.4	2.8	1.9	1.3	1.5	2.3	2.0
AM1	EM3	2.0	2.3	3.3	2.3	1.2	1.3	2.4	1.9
AM2	EM3	2.0	2.3	3.3	2.3	1.2	1.3	2.4	1.9

Observation Points	Associated EPD Station	WQO/WQC (mg/L)							
		Dry Season				Wet Season			
		S	M	B	DA	S	M	B	DA
AM3	EM2	1.4	1.4	2.8	1.9	1.3	1.5	2.3	2.0
GB1	EM3	2.0	2.3	3.3	2.3	1.2	1.3	2.4	1.9
GB2	EM3	2.0	2.3	3.3	2.3	1.2	1.3	2.4	1.9
GB3	EM3	2.0	2.3	3.3	2.3	1.2	1.3	2.4	1.9
GB4	MM19	0.8	1.4	3.6	2.0	0.8	0.9	2.8	1.9
GB5	MM19	0.8	1.4	3.6	2.0	0.8	0.9	2.8	1.9

Note:

S – Surface Layer, M – Middle Layer, B – Bottom Layer, DA – Depth Averaged

Criteria for Seawater Intakes

8.5.2.5 In addition to the general WQO described above, other beneficial uses of the coastal waters, for example, fish culture zones and seawater abstraction pumping stations, have specific limit levels on the absolute maximum suspended solids concentrations at the intake points.

8.5.2.6 The Water Quality Objectives of Sea Water for Flushing Supply (at intake point) issued by the Water Supplies Department (WSD) specify the criteria for assessing the water quality impacts on WSD's seawater intakes. **Table 8.14** tabulates a list of the criteria.

Table 8.14 WSD's Water Quality Criteria for Flushing Water at Sea Water Intakes

Parameter	Concentration (mg/L)
Colour (H.U.)	< 20
Turbidity (N.T.U.)	< 10
Threshold Odour No.	< 100
Ammonia Nitrogen	< 1
Suspended Solids	< 10
Dissolved Oxygen	> 2
Biological Oxygen Demand	< 10
Synthetic Detergents	< 5
E. coli 100 ml	< 20,000

8.5.2.7 According to the EIA-TKOFS, no specific requirement on seawater quality was imposed at the cooling water intakes for both Dairy Farm Ice Plant and Pamela Youde Nethersole Eastern Hospital. Thus, the WQO was adopted to these cooling water intakes.

Criteria for Coral Sites

8.5.2.8 Deposition of fine sediment in ecologically sensitive areas including coral sites could also have an adverse impact on the marine ecosystem. In previous studies (Binnie 1996, Meinhardt 2007, Mouchel 2002), an indicator level above which sustained deposition could harm sediment sensitive hermatypic corals of 200g/m^2/day has been used. Typical soft corals in the north western coastal waters where the sediment regime is more dynamic than in other parts of Hong Kong's coastal waters are expected to be even more tolerant of deposition. In a recent study in Tolo Harbour and north eastern waters (ERM 2003), an impact criterion of 100g/m^2/day has been used for eastern waters and this criterion has been adopted in the current study.

SS Criterion for Fish Cultural Zone (FCZ)

8.5.2.9 The AFCD consultancy Study on Fisheries and Marine Ecological Criteria for Impact Assessment (2001) suggests a maximum suspended solid (SS) concentration of 50mg/L for protecting the local marine fisheries resources in terms of their short-term acute effects.

Assessment Criteria for Heavy Metals and Trace Organics

8.5.2.10 Elutriate tests were conducted to estimate the amount of pollutants that would be released into the water during seawall excavation and filling. However, there are no relevant standards in Hong Kong for assessment of acceptable concentrations of heavy metals and micro-pollutants in marine water.

8.5.2.11 There is no existing legislation or guideline for individual heavy metals and trace organics (PCBs, PAHs and TBT) in Hong Kong waters. According to the common practices in the past EIA studies, a conservative selection was made by comparing the standards of EU and USA. The lowest values from various international standards have been adopted as the assessment criteria. The adopted criteria for heavy metals and trace organics are presented in **Table 8.15**.

Table 8.15 Proposed Assessment Criteria for Heavy Metal and Trace Organics

Heavy Metal/Trace Organics	Proposed Criteria (μg/l)	Reference
Arsenic	25	2
Cadmium	2.5	2
Chromium	15	2

Heavy Metal/Trace Organics	Proposed Criteria (μg/l)	Reference
Copper	5	2
Lead	25	2
Mercury	0.3	2
Nickel	30	2
Silver	1.9	3
Zinc	40	2
Total PAHs	3.0	4, 6
PCBs	0.3	1, 5
TBT	0.01	3

References:

(1) Proposed Marine Water Quality Standards of EU Shellfish Waters Directive (79/923/EEC).

(2) The European Union Water Quality Standards.

(3) USEPA National Recommended Water Quality Criteria, Criterion Continuous Concentration.

(4) Australian Water Quality Guidelines for Fresh and Marine Waters.

(5) EIA of Hong Kong Zhuhai Macro Bridge Hong Kong Boundary Crossing Facilities (EIA-173/2009).

(6) EIA of Hong Kong Offshore Windfarm in Southern Waters (EIA-167/2009).

8.5.3 Modeling Parameters

Grid Layout and Bathymetry Schematisation

8.5.3.1 The grid layout of Junk Bay Model is shown in **Drawing No. 209506/EIA/WQ/002**. In the Junk Bay Model, finer grids have been made in the vicinity of Junk Bay. Coarser grids have been made in the region far away from the CBL in order to maintain a reasonable total grid number in the refined grid model.

8.5.3.2 The Junk Bay Model consists of 2,971 active grid cells. The smallest grid is inside Junk Bay and is less than 50m. The grid sizes are comparatively larger at the open boundaries of the model and the largest grid is about 650m x 500m.

8.5.3.3 The reference level of the model is the Principal Datum Hong Kong and the depth data is relative to this datum. The bathymetry schematisation of the Junk Bay Model, which was based on the depth data from the Update Model, is shown in **Drawing No. 209506/EIA/WQ/003**.

Simulation Period

8.5.3.4 The simulation period for this modeling exercise is the same as that adopted in the EIA-TKOFS, which covers a duration of 15 days spring-neap tidal cycle. The simulation period were as follows:

- Dry Season: 9 Feb 1996 15:00 to 24 Feb 1996 15:00
- Wet Season: 31 May 2003 12:00 to 15 Jun 2003 12:00

Modeling Scenarios

Construction Phase

8.5.3.5 Potential water quality impact will be due to excavation of marine sediment. Marine excavators with cage type silt curtain will be used to remove the marine deposits to reach a suitable depth and ground layer for the construction of pile caps. Excavated materials will be placed into barges for transport to disposal or reuse sites in accordance with the regulations.

8.5.3.6 **Appendix 8.1** shows the comparison of sediment loss rate of CBL and all relevant concurrent projects. In considering the highway connectivity, CBL and TKO-LT will be considered together in the model run as the worst scenario. Cumulative impacts with TKO-LT Tunnel, offshore windfarm and T2 were taken into account and the modeling scenarios for construction phase is described below:

- Scenario 1a – CBL and TKO-LT Tunnel Marine Works (Item 1, 2, 3, 5 and 23 in App 8.1)
- Scenario 1c – CBL and TKO-LT Tunnel Marine Works (Item 1, 2, 3, 5 and 23 in App 8.1) with cumulative projects (Item 17 to 20 & 24 to 26 in App 8.1) (N.B. Although there might be no concurrent works with those projects, Scenario 1c is done to allow hypothesis and potential programme change.)

Operational Phase

8.5.3.7 Changes in hydraulic friction may lead to long-term impacts on the hydrodynamic and water quality conditions. In order to compare the impact on flow regime with and without the project, two modeling scenarios were conducted:

- Scenario 2a – Ultimate Scenario (with CBL piers and TKO-LT Tunnel Reclamation)
- Scenario 2b – Ultimate Scenario (Do-nothing)

Meteorological Conditions

8.5.3.8 The wind conditions adopted in the hydrodynamic simulation are 5m/s NE for the dry season and 5 m/s SW for the wet season. The horizontal eddy viscosity and diffusivity to be used are $1m^2/s$. The values for vertical eddy viscosity and diffusivity were computed using the k-ε model. For the vertical eddy viscosity, a minimum value is set at 5×10^{-5} m^2/s.

8.5.3.9 The ambient environmental conditions including solar surface radiation and water temperature are closely linked to the process of water quality changes. Meteorological forcing including solar surface radiation and water temperature are required to define in the model for water quality simulation.

8.5.3.10 Solar radiation is recorded only at King's Park station by Hong Kong Observatory. The monthly averaged solar radiation was calculated based on the hourly data recorded at this station. Average values of solar radiation for the simulation period were adopted in the model.

8.5.3.11 The ambient water temperature were determined based on the EPD routine monitoring data collected within the Hong Kong Waters. Average water temperature values for both dry and wet seasons were adopted in the water quality model.

Initial Conditions

8.5.3.12 Hydrodynamic computations were first carried out using the Update Model. A restart file from previous hydrodynamic computations was then used to provide initial conditions to the Update Model. The initial conditions for the Junk Bay Model were selected to be the same as those for the Update Model. This was done by using a utility program to map the information contained in the restart file of the Update Model to the restart file of the Junk Bay model.

Open Boundary Conditions

8.5.3.13 The open boundary conditions of Junk Bay Model were regenerated through the nesting process from the Update Model. The coastline and additional pier friction in Update Model were revised based on the projects listed in **Table 8.8**.

8.5.3.14 During the nesting process, both the water level and velocity boundaries were defined in the Junk Bay Model for both dry and wet seasons. As the Update Model covers the discharges from the major Pearl River estuaries, which include Humen, Jiaomen, Hongqili, Hengmen, Muodaomen and Aimen, the influences on hydrodynamics due to the discharges from Pearl River estuaries were therefore incorporated into the Junk Bay Model.

Sediment Plume

8.5.3.15 Delf3D-WAQ module was used to model dispersion of sediment during excavation activities. The settling velocity adopted in the Junk Bay Model is 0.5mm/s. The hydrodynamic conditions generated from the Delf3D-FLOW module provided basic hydrodynamic information for modeling of sediment plume dispersion. The processes of settling of sediment particles and exchange of sediment particles between the water column and the seabed govern the sediment transport.

8.5.3.16 Erosion and deposition in the water quality model are defined in terms of a critical stress for deposition above which no deposition can take place and a critical stress for erosion above which erosion can take place. The critical stress for deposition was set at $0.2N/m^2$ while the water depth of 0.2m was selected as the minimum depth in which deposition can take place. The critical stress for erosion was set at $0.3N/m^2$ which is applicable to relatively soft new deposits with a density of around $200kg/m^3$ (HWR, 1993) and typically applied in Hong Kong (e.g., HZMB (EIA 173/2009), To Kwa Wan Gas Pipeline (EIA 182/2010), etc).

8.5.3.17 The deposition rate and erosion rate were calculated using the following equations:

(1) Bed Shear Stress (τ) < Critical Shear Stress for Deposition (τ_d = 0.2 Pascal)
Deposition rate = $W_s C_b (1 - \tau / \tau_d)$
where: W_s = settling velocity (= 0.5 mm/s); and C_b = bottom layer SS concentration
(2) Bed Shear Stress (τ) > Critical Shear Stress for Erosion (τ_e = 0.3 Pascal)
Erosion rate = $Re (\tau / \tau_e – 1)$
where: Re = erosion coefficient (= 0.0002 $kg/m^2/s$).
(3) Water depth of 0.2m has been selected as the minimum depth in which deposition can take place.

8.5.3.18 No open sea dredging will be required. Excavation activities will be carried out during the construction of pier foundations and within a cofferdam. Under normal condition there will be no contact with seawater when the construction activities were within the cofferdam and water quality impact is negligible. A sediment loss of 25kg per unit excavated material for excavation activities was adopted. Silt curtain will normally be adopted to mitigate the potential water quality impact. The effectiveness of silt curtain is summarized in **Table 8.16**. Sediment loss reduction efficiency for excavation works within the cofferdam is much higher than all types of silt curtains since there will be no contact with seawater under normal condition. In conservative approach, 80% is adopted.

Table 8-16 Summary Table of Loss Reductions from Silt Curtain Configurations

Mitigation Measures	Loss Reduction Factor	Remark
Excavation with cage type silt curtain (1)	80%	Approved HKBCF EIA (EIA-173/2009)
Floating Single Silt Curtain (2)	75%	Approved HKBCF EIA (EIA-173/2009)
Filling Behind Seawall (3)	80%	Approved HKBCF EIA (EIA-173/2009)
Combined Reduction (1+2)	95%	Approved HKBCF EIA (EIA-173/2009)
Combined Reduction (2+3)	95%	

Note [1]: Before construction, the contactor shall conduct field measurement before construction to re-confirm the efficiency of the silt curtain. This requirement will be incorporated into the particular specification.

Sediment Disposal

8.5.3.19 Disposal of sediment during construction in Hong Kong Water would be made according to ETWB TC 34/2002. It is anticipated that the daily excavated quantity is small and the disposal site in Hong Kong may have enough capacity for the sediment/mud. Given that the disposal sites (such as East of Ninepins, South Cheung Chau) are far away from the study area, well controlled and monitored, the cumulative impact is hence negligible.

Frictional Loss for Bridge Piers

8.5.3.20 The sizes of bridge piers (including both from CBL and TKO-LT Tunnel) are expected to be small in comparison to the modeling grid sizes. It is not practicable to refine the model grid accordingly as the computation capacity would be overloaded. Additional frictional losses due to bridge piers have been included in the Junk Bay Model by using an add-on function for porous plate in Delft3D-FLOW module.

8.5.3.21 The approach to simulate the frictional loss for bridge piers on current flows has been employed in several EIA studies. The loss terms take the following form:

Loss term in u-direction = $\{ C_{loss,u}\ U\ |\langle U\rangle| \} / \{ \Delta x \}$ [m/s^2]

Loss term in v-direction = $\{ C_{loss,v}\ V\ |\langle U\rangle| \} / \{ \Delta y \}$ [m/s^2] (Eq 8.1)

where:

$\langle U\rangle$ = Velocity vector (u,v) [m/s]

$|\langle U\rangle|$ = Magnitude of the velocity vector $(u^2+v^2)^{1/2}$ [m/s]

Δx Δy = Grid distances in the u and v coordinate directions [m]

$C_{loss,u}$ = Loss coefficients in the u-direction

$C_{loss,v}$ = Loss coefficients in the v-direction

8.5.3.22 This additional friction terms influence the horizontal flow distribution in each model layer according to the current velocity in each model cell. Consequently, these would affect the vertical turbulent exchange indirectly.

8.5.3.23 The bridge piers would also reduce the flow area resulting in local increase in current velocities. This effect is taken into account by calculating the effective flow area (A_{eff}) (i.e. the original total flow area (A_{tot}) minus the area blocked by the bridge piers). Using the ratio of the original total flow area to the effective area (a), the increased approach velocity $\langle U_{eff}\rangle$ can be calculated by:

A_{eff} = A_{tot} – area blocked by piles as seen by the flow

A = A_{tot}/A_{eff}

$\langle U_{eff}\rangle$ = $a \times \langle U\rangle$

8.5.3.24 The forces due to the flow on a vertical section Δz of a single pier can be described as follows:

F_u = $\frac{1}{2} C_d\ \rho\ D\ u_{eff}\ |\langle U_{eff}\rangle|\ \Delta z$

F_v = $\frac{1}{2} C_d\ \rho\ D\ v_{eff}\ |\langle U_{eff}\rangle|\ \Delta z$

where:

F_u = the drag force in u-direction on a pile [N];

F_v = the drag force in v- direction on a pile [N];

C_d = the drag coefficient (≈1 in the case of a cylinder in a tidal regime);

ρ = the density of water [kg/m^3];

<Ueff> = the effective approach velocity vector (u_{eff},v_{eff}) [m/s];

$|<U_{eff}>|$ = magnitude of the effective approach velocity $(u_{eff}^2 + v_{eff}^2)^{1/2}$ [m/s];

D = the diameter of a pier [m]; and

Δz = the length of the vertical section [m].

8.5.3.25 For multiple piers in the same model grid cell, on assuming that the piles under consideration are not in the shadow of each other, the total force on the flow equals to:

$F_{tot,u} = ½\ n \times C_d\ \rho\ D\ u_{eff}\ |<U_{eff}>|\ \Delta z$

$F_{tot,v} = ½\ n \times C_d\ \rho\ D\ v_{eff}\ |<U_{eff}>|\ \Delta z$.

where:

n = The number of piers in the control grid cell;

$F_{tot,u}$, $F_{tot,v}$ = The total force in the (u,v) coordinate directions [N]

8.5.3.26 Dividing the forces by the mass in the control volume (=ρ Δx Δy Δz) yields the following terms in the u-momentum equation and the v-momentum equation respectively:

Loss term in u-direction $= \{½\ n \times C_d\ D\ u_{eff}\ |<U_{eff}>|\ \} / \{\ \Delta x \times \Delta y\ \}$

Loss term in v-direction $= \{½\ n \times C_d\ D\ v_{eff}\ |<U_{eff}>|\ \} / \{\ \Delta x \times \Delta y\ \}$ (Eq 8.2)

8.5.3.27 Combining Equation (8.1) and Equation (8.2), the loss coefficients for n numbers of piles in the x and y directions are:

$C_{loss,u} = \{½\ n \times C_d\ D \times a^2\ \} / \{\ \Delta y\ \}$

$C_{loss,v} = \{½\ n \times C_d\ D \times a^2\ \} / \{\ \Delta x\ \}$

8.5.3.28 Based on the above calculation, the loss coefficients of piers are 0.29 to 0.69.

<u>Oxygen Depletion</u>

8.5.3.29 The degree of oxygen depletion exerted by a sediment plume is a function of the sediment oxygen demand of the sediment, its concentration in the water column and the rate of oxygen replenishment. For the purposes of this assessment, the impact of the sediment oxygen demand on dissolved oxygen concentrations has been calculated based on the following equation:

DO_{Dep} = C * SOD * K * 0.001

where:

DO_{Dep} = Dissolved Oxygen depletion (mg/L)

C = Suspended Solids concentration (kg/m^3)

SOD = Sediment Oxygen Demand

K = Daily oxygen uptake factor (set at 1.0/day for worse case estimate)

8.5.3.30 An SOD of 16,000mg/kg has been taken with reference to EPD Marine Monitoring data in Year 2010 as a suitably representative value for sediments in Junk Bay (JS2).

8.5.3.31 The analysis using the above equation does not allow for re-aeration which would tend to reduce any impact of the suspended sediment on the water column DO concentrations. The analysis, therefore, tends to be on the conservative side so as not to underestimate the extent of DO depletion. Further, it should be noted that, for sediment in suspension to exert any oxygen demand on the water column will take time and, in that time, the sediment will be transported and mixed/dispersed with oxygenated water. As a result, the oxygen demand and the impact on dissolved oxygen concentrations will diminish as the suspended sediment concentrations decrease.

8.5.3.32 Oxygen depletion is not instantaneous and thus previous studies have assumed that the impact of suspended sediment on dissolved oxygen will depend on tidally averaged suspended sediment concentrations. The previous studies (ERM, 1997) assumed that the oxygen demand would be satisfied at the same rate as the biological demand which equates to a K value of 0.23/day.

8.5.3.33 However for the purposes of this demonstration, the maximum increase in suspended sediment has been used as the basis for the calculation in order to identify the hypothetical worst case. As such, the daily uptake factor, K, in the equation above was set to be equal to 1.0 which indicates instantaneous oxidation of the sediment oxygen demand and represents a worst case to ensure oxidation rates are not underestimated. The resulting calculated dissolved oxygen deficit, therefore, is anticipated to be much larger than that would be experienced in reality.

Model Outputs

8.5.3.34 Statistical analysis of hydrodynamic and water quality changes were conducted at representative indicator points in the study area. The locations of the water quality sensitive receivers and EPD marine water sampling stations are shown in **Drawing No. 209506/EIA/WQ/001**. Cross sections were put across Junk Bay, Victoria Harbour (North Point to Hung Hom), Lei Yu Mun and Tathong Channel to assess the changes of accumulated flows. The proposed cross sections are shown in **Drawing No. 209506/EIA/WQ/004**.

8.5.3.35 Suspended solids (SS) and sedimentation rate are the key water quality parameters to be assessed using the Junk Bay Model. The dissolved oxygen depletions were further evaluated based on the SS modeling results.

8.5.3.36 Dry and Wet Seasons results in the form of table, contour plots and time series plots for depth-averaged SS and sedimentation rate at bottom layer were included in the water quality impact assessment. The predicted SS levels at the water quality sensitive receivers summarised in tables to compare with the relevant criteria for compliance check.

8.6 Construction Phase Assessment

8.6.1 Pile Excavation and Filling

8.6.1.1 The main potential impact on water quality arising from this project during the construction phase will be related to disturbances to the seabed and re-suspension of marine sediment, which lead to the potential for physio-chemical changes in the water column. Conventional grab dredgers may release sediment into suspension by the following activities:

- Impact of the grab on the seabed as it is lowered;
- Washing of sediment off the outside of the grab as it is raised through the water column and when it is lowered again after being emptied;
- Leakage of water from the grab as it is hauled above the water surface;
- Spillage of sediment from over-full grabs;

- Loss from grabs which cannot be fully closed due to the presence of debris; and
- Disturbance of the seabed as the closed grab is removed.

8.6.1.2 Sediment excavation for CBL will only be carried out within the pile casing. Closed grab with a maximum size of 5m^3 will be used. All the excavation area (i.e. pier locations) will be covered by a cofferdam and separated from the sea. Thus, sediment loss is considered negligible. Nevertheless, water quality modelling was conducted in a conservative side. The sediment loss rate for CBL excavation and filling activities are 25kg/m^3 and 5% respectively. These values have been widely used in previous EIA such as Cruise Terminal and Kai Tak Development. The maximum excavation and filling rates and the associated sediment loss rate under the worst scenarios are summarized in **Tables 8.17** to **8.18**. The detailed calculations of excavation/filling are attached in **Appendix 8.1** and the sediment loss locations are presented in **Drawing No. 209506/EIA/WQ/005**. Although there may not be concurrent CBL+TKO-LT Tunnel excavation/filling with other projects (see **Table 8.8**), a hypothetical worst scenario is assumed to cater for potential overlapping of CBL+TKO-LT Tunnel excavation/filling with T2 and Windfarm due to programme change. The assessment has thus been based on worst case scenario in terms of source location and work program.

Table 8.17 Summary of Excavation/Filling Rate and Sediment Loss Rate under the Worst Scenario (Scenario 1a, CBL and TKO-LT Tunnel Only)

Project	Excavation / Filling Activities	Description	Production Rate	Sediment Loss Rate
CBL	Excavating Main Bridge Piles / Pile Caps	1 excavator (with cage type silt curtain), plus floating single silt curtain	400 m^3/day	0.06 kg/s
CBL	Excavating Eastern Approach Piles / Pile Caps	1 excavator (with cage type silt curtain), plus floating single silt curtain	400 m^3/day	0.06 kg/s
CBL	Excavating Western Approach Piles / Pile Caps	1 excavator (with cage type silt curtain), plus floating single silt curtain	400 m^3/day	0.06 kg/s
CBL	Filling	1 trip per day with floating single silt curtain	769 m^3/event	0.32 kg/event

Project	Excavation / Filling Activities	Description	Production Rate	Sediment Loss Rate
TKO-LT Tunnel	Reclamation Filling	3 trips per day with floating single silt curtain and behind seawall	1000 m^3/event x 3 trips	0.11 kg/s

Table 8.18 Summary of Excavation/Filling Rate and Sediment Loss Rate under the Worst Scenario (Scenario 1c, Hypothetical worst case scenario)

Project	Excavation / Filling Activities	Description	Production Rate	Sediment Loss Rate
CBL	Excavation Main Bridge Piles / Pile Caps	1 excavator (with cage type silt curtain), plus floating single silt curtain	400 m^3/day	0.06 kg/s
CBL	Excavating Eastern Approach Piles / Pile Caps	1 excavator (with cage type silt curtain), plus floating single silt curtain	400 m^3/day	0.06 kg/s
CBL	Excavating Western Approach Piles / Pile Caps	1 excavator (with cage type silt curtain), plus floating single silt curtain	400 m^3/day	0.06 kg/s
CBL	Filling Eastern Approach	1 trip per day with floating single silt curtain	769 m^3/event	0.32 kg/event
TKO-LT Tunnel	Reclamation Filling	3 trips per day with floating single silt curtain and behind seawall	1000 m^3/event x 3 trips	0.11 kg/s
Windfarm	Dredging at P1 – cable	2 grab dredgers with floating single silt curtain	6,300 m^3/day	0.455 kg/s x 2 dredgers
Windfarm	Jetting – cable	Moving at 150 m/hr	-	18.43 kg/s
T2[1]	Dredging	1 grab dredger with floating single silt curtain	8,000 m^3/day	0.93 kg/s
T2[1]	Filling	-	9,000 m^3/day	0.83 kg/s

Note:

[1] According to the approved EIA reports for Cruise Terminal (EIA-138-2007) and Submarine Gas Pipeline (EIA-182/2010), plume from T2 project will be localised in Kai Tak Approach channel and will not encroach to Junk Bay. Furthermore, according to the latest information from the T2 project team, the T2 tunnel is now envisaged as TBM method. Cumulative impact is taken as a conservative approach.

8.6.1.3 The sediment loss locations (**Drawing No. 209506/EIA/WQ/005**) have been selected as the worst case scenario[1] for the following reasons:

- **CBL Emission**: Emission point 1 and 2 has been selected at the largest pier location (Main Bridge Pier Pylon A and B) where the longer dredging period is anticipated. Emission point 3 has been based on construction separation constraint and closest to SWI1.
- **TKO-LT Tunnel Emission**: Emission point 23 has been selected at the location of seawall opening as worst scenario.
- **Wind Farm Emission**: Emission point 24 and 25 have been selected according to the representative locations in the EIA-Wind farm.

Suspended Solids

8.6.1.4 The predicted SS extents, sedimentation rates and time series plots are shown in **Appendix 8.2**. According to the modeling results of Scenario 1a, it is observed that the plume due to CBL and TKO-LT Tunnel project is highly localised. The envelope of 1 mg/L SS elevation due to CBL and TKO-LT Tunnel project did not reach the coastal areas (Drawings S1a-SS-Dry-Map and S1a-SS-Wet-Map of **Appendix 8.2**) and the affected WSR due to CBL project involves CC1 to CC3, CC13 and SWI1 only. Impact to other WSRs such as fish culture zones outside Junk Bay is not anticipated.

8.6.1.5 The predicted maximum elevations in SS at selected observation points are summarised in **Tables 8.19** to **8.20**. A full compliance of SS levels at identified WSRs was predicted due to CBL and TKO-LT Tunnel project (Scenario 1a) and with cumulative projects (Scenario 1c).

[1] According to the approved EIA reports for Cruise Terminal (EIA-138-2007) and Submarine Gas Pipeline (EIA-182/2010), plume from T2 project will be localised in Kai Tak Approach channel and will not encroach to Junk Bay. Therefore it is not presented in (Drawing No. 20 9506/EIA/WQ/005).

Table 8.19 Predicted Maximum SS (mg/L) Elevations (Dry Season)

WSR	Scenario 1a				Scenario 1c				WQO/WQC				Compliance to WQO/WQC
	S	M	B	DA	S	M	B	DA	S	M	B	DA	
SWI1	0.1	0.1	0.2	0.1	0.2	0.4	0.6	0.4	1.4	1.8	2.9	1.9	Yes
CC1	0.0	0.0	0.0	0.0	0.2	0.3	0.4	0.3	1.4	1.9	3.3	2.2	Yes
CC2	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.2	1.4	1.8	2.9	1.9	Yes
CC3	0.1	0.1	0.2	0.1	0.1	0.2	0.3	0.2	1.4	1.8	2.9	1.9	Yes
CC4	0.1	0.1	0.1	0.1	0.3	0.4	0.6	0.4	1.4	1.8	2.9	1.9	Yes
CC13	0.1	0.2	0.2	0.2	0.3	0.5	0.5	0.5	1.4	1.8	2.9	1.9	Yes

Notes:
(1) WQO = Water Quality Objective; WQC = Water Quality Criteria.
(2) Grey cell = Values with WQO/WQC exceedances.
(3) S – Surface Layer, M – Middle Layer; B – Bottom Layer; DA – Depth Averaged.
(4) Brackets shows the percentage of exceedance period

Table 8.20 Predicted Maximum SS (mg/L) Elevations (Wet Season)

WSR	Scenario 1a				Scenario 1c				WQO/WQC				Compliance to WQO/WQC
	S	M	B	DA	S	M	B	DA	S	M	B	DA	
SWI1	0.0	0.2	0.4	0.2	0.1	0.2	0.6	0.2	1.2	1.2	2.0	1.6	Yes
CC1	0.0	0.2	0.3	0.2	0.3	0.5	0.5	0.5	1.4	1.5	3.6	2.6	Yes
CC2	0.3	0.5	0.5	0.3	0.5	1.0	1.5	1.0	1.2	1.2	2.0	1.6	Yes
CC3	0.2	0.2	0.4	0.2	0.1	0.5	1.5	0.5	1.2	1.2	2.0	1.6	Yes
CC4	0.0	0.0	0.0	0.0	0.4	0.7	1.5	0.7	1.4	1.8	2.9	1.9	Yes
CC13	0.2	0.3	0.4	0.3	0.3	0.5	1.0	0.5	1.2	1.2	2.0	1.6	Yes

Notes:
(1) WQO = Water Quality Objective; WQC = Water Quality Criteria.
(2) Grey cell = Values with WQO/WQC exceedances.
(3) S – Surface Layer, M – Middle Layer; B – Bottom Layer; DA – Depth Averaged.
(4) Brackets shows the percentage of exceedance period.

8.6.1.6 For WSR SWI1, the maximum SS elevation is 0.6 mg/L. According to Table 8.4, the baseline total SS levels are within 1.7 to 8.6mg/L. Non-compliance with the assessment criteria for WSD's salt water intakes for flushing water (10 mg/L) in the vicinity is not anticipated.

8.6.1.7 Similar to the SS elevations, the plume of daily sedimentation rates due to CBL and TKO-LT Tunnel project is highly localised (Scenario S1a). The envelope of 20g/m^2/day due to CBL and TKO-LT Tunnel project is constrained within Junk Bay (Drawings S1a-Sed-Dry-Map and S1a-Sed-Wet-Map of **Appendix 8.2**) and the affected ecological sensitive receivers will be limited to CC1 to CC3 and CC13 only.

8.6.1.8 The predicted maximum daily sedimentation rates at affected ecological sensitive receivers are summarised in **Table 8.21**. According to the modeling results, it is clear that the predicted daily sedimentation rates due to CBL and TKO-LT Tunnel project (Scenario 1a) and with cumulative impact (Scenario 1c) at all WSRs are well within the criterion of 100 g/m^2/day.

Table 8.21 Predicted Maximum Sedimentation Rates

Ecological Sensitive Receivers	Predicted Maximum Sedimentation Rates (g/m^2/day)			
	Dry Season		Wet Season	
	Scenario 1a	Scenario 1c	Scenario 1a	Scenrio 1c
CC1	0	16	5	20
CC2	4	12	20	50
CC3	6	13	20	55
CC4	3	26	0	62
CC13	10	20	10	48

Notes:

(1) Grey cell = Values exceed the criterion of 100 g/m^2/day.

(2) Brackets shows the percentage of exceedance period.

<u>Oxygen Depletion</u>

8.6.1.9 The oxygen depletion exerted by the SS elevation is calculated in **Table 8.22** below. It is anticipated that the oxygen depletion at most WSR will be less than 0.02mg/L, which is less a detection limit of 0.1mg/L. Thus the DO depletion of all sensitive receivers will be same as prevailing conditions.

Table 8.22 Predicted Oxygen Depletion (mg/L)

WSR	Scenario 1a				Scenario 1c			
	S	M	B	DA	S	M	B	DA
Dry Season								
SWI1	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01
CC1	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
CC2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CC3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CC4	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01
CC13	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01
Wet Season								
SWI1	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00
CC1	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
CC2	0.00	0.01	0.01	0.00	0.01	0.02	0.02	0.02
CC3	0.00	0.00	0.01	0.00	0.00	0.01	0.02	0.01
CC4	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.01
CC13	0.00	0.00	0.01	0.00	0.00	0.01	0.02	0.01

Notes:

(1) S – Surface Layer, M – Middle Layer; B – Bottom Layer; DA – Depth Averaged.

Release of Contaminants and Nutrients

8.6.1.10 There is no open sea dredging to be conducted under the CBL project since all marine works will be undertaken within cofferdam. In general, release in contaminants and nutrients should be negligible and much less than open sea dredging with silt curtain.

8.6.1.11 Nevertheless, release of contaminants and nutrients were quantified in a conservative approach. Therefore, elutriate tests were conducted. The details of elutriate test results are summarised in **Appendix 8.3** and the highest concentrations with exceedance levels are listed in **Table 8.23**. The elutriate results for other concurrent projects are presented in **Table 8.24**.

8.6.1.12 The concentration and dilution factor from dredging points to WSR is determined by tracer simulation. The initial discharge is estimated by first order equation[2]: $C(x) = q/DX\omega\pi^{0.5}$. Same approach has been

[2] Where C(x) = concentration at distance x from the source, q = sediment loss rate, D = water depth, x = distance from source, ω = diffusion velocity (=0.01 m/s).

adopted in several previous approved EIA studies[3]. On assuming that the radius of initial release is 10m and an average water depth of about 6 to 9m, the initial dilution within a modelling grid was then calculated.

8.6.1.13 A tracer simulation was then conducted by using Delft3D-WAQ as far field plume dispersion. The total concentrations of contaminants and nutrients due to CBL projects at the affected WSRs are presented in Tables 8.25 and 8.26. The maximum extent of mixing zone and time series plot are presented in Appendix 8.4.

8.6.1.14 According to Tables 8-25 and 8-26, all the calculated concentrations of heavy metals, metalloid, TIN and UIA comply with the proposed criteria. Thus, adverse impacts due to release of contaminants on WSRs is not anticipated for all scenario.

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[3] Hong Kong Boundary Crossing Facilities (EIA-173/2009), Hong Kong Link Road (EIA-172/2009), Hong Kong Electric's 132kV cable in Deep Water Bay EIA-065/2001 and Penny's Bay Theme Park EIA-041/2000.

Table 8.23 Elutriate Test Results (for those sampling points with exceedance only)

Sampling Location	Metals (µg/L)				Metalloid (µg/L)	TKN (mg/L)	NH4-N (mg/L)	UIA (mg/L)	NO3-N (mg/L)	TIN (mg/L)	NO2-N (mg/L)	Total P (mg/L)	Ortho-P (mg/L)
	Cr	Cu	Pb	Zn	As								
Criteria / Baseline	**15**	**5**	**25**	**40**	**25**	**0.1675**	**0.04875**	**0.021**	**0.061**	**0.3**	**0.0185**	**0.03**	**0.01275**
VB1 (CBL)	22	57	41	80	33	4.10	3.80	0.21	1.30	4.07	0.02	0.39	0.11
VB2 (CBL)	-	44	61	-	41	-	0.15	-	-	-	0.03	0.23	0.03
VB3 (CBL)	-	71	48	85	26	2.20	2.10	0.12	0.19	2.15	0.02	0.34	0.07
VB4 (CBL)	-	41	38	61	37	3.60	2.70	0.15	0.21	2.81	0.02	0.38	0.11
VB5 (CBL)	-	43	58	-	38	-	0.12	-	-	-	0.03	0.26	0.03
VB6 (CBL)	-	43	58	-	43	-	0.13	-	-	-	0.03	0.33	0.03
VB7 (CBL)	-	40	39	-	34	4.10	4.10	0.23	0.77	4.29	0.04	0.65	0.13
VB8 (CBL)	-	42	61	-	48	-	0.10	-	-	-	0.03	0.26	0.03
VB9 (CBL)	-	42	57	-	44	-	0.16	-	0.13	-	0.03	0.54	0.03
VB11 (CBL)	-	45	55	-	42	-	0.22	-	-	-	0.03	0.53	0.03
VB12 (CBL)	-	44	62	-	43	-	0.25	-	-	-	0.03	0.57	0.03
Maximum	22	71	62	85	48	4.1	4.1	0.23	1.3	4.29	0.04	0.65	0.13

Table 8.24 Elutriate Test Results for Concurrent Projects

	Metals (µg/L)				Metalloid (µg/L)	UIA (mg/L)	TIN (mg/L)	Reference
	Cr	Cu	Pb	Zn	As			
Windfarm (P1)	[1]	[1]	[1]	[1]	72.7	[1]	[1]	Windfarm EIA
Windfarm (P2)	[1]	[1]	[1]	[1]	104	[1]	[1]	Windfarm EIA
Windfarm (trench)	[1]	[1]	[1]	[1]	98.9	[1]	[1]	Windfarm EIA

Note:

(1) Data is far away less than the proposed criteria and thus not taken into account.

(2) According to the approved EIA reports for Cruise Terminal (EIA-138-2007) and Submarine Gas Pipeline (EIA-182/2010), plume from T2 project will be localised in Kai Tak Approach channel and will not encroach to Junk Bay. Thus, elutriate results in T2 is not taken into account.

Table 8.25 Modeling Results for Contaminants (Depth Averaged) (Scenario 1a)

	Dry Season							Wet Season						
	Metals (µg/L)				Metalloid (µg/L)	UIA[1][2] (mg/L)	TIN[1][2] (mg/L)	Metals (µg/L)				Metalloid (µg/L)	UIA[1][2] (mg/L)	TIN[1][2] (mg/L)
	Cr	Cu	Pb	Zn	As			Cr	Cu	Pb	Zn	As		
Criteria	**15**	**5**	**25**	**40**	**25**	**0.021**	**0.3**	**15**	**5**	**25**	**40**	**25**	**0.021**	**0.3**
SWI1	1	2.0	2	3	3	0.010	0.26	0	1.3	2	2	1	0.006	0.20
CC1	0	0.3	0	0	0	0.003	0.15	0	0.7	1	1	1	0.005	0.17
CC2	0	0.5	0	1	0	0.005	0.16	0	1.0	2	2	1	0.006	0.18
CC3	0	0.9	2	2	1	0.009	0.18	0	0.7	1	1	0	0.005	0.18
CC4	0	1.3	1	2	1	0.006	0.21	0	0.1	0	0	0	0.002	0.14
CC13	0	0.7	1	2	1	0.010	0.18	0	1.3	1	1	1	0.006	0.18

Note:

(1) For nutrient, WQO criteria is only applicable to TIN and UIA, thus this table only presents these parameters.

(2) Include baseline levels.

Table 8.26 Modeling Results for Contaminants (Depth Averaged, incl background levels) (Scenario 1c)

	Dry Season							Wet Season						
	Metals (µg/L)				Metalloid (µg/L)	UIA[1][2] (mg/L)	TIN[1][2] (mg/L)	Metals (µg/L)				Metalloid (µg/L)	UIA[1][2] (mg/L)	TIN[1][2] (mg/L)
	Cr	Cu	Pb	Zn	As			Cr	Cu	Pb	Zn	As		
Criteria	**15**	**5**	**25**	**40**	**25**	**0.021**	**0.3**	**15**	**5**	**25**	**40**	**25**	**0.021**	**0.3**
SWI1	[3]	[3]	[3]	[3]	3	[3]	[3]	[3]	[3]	[3]	[3]	2	[3]	[3]
CC1	[3]	[3]	[3]	[3]	1	[3]	[3]	[3]	[3]	[3]	[3]	2	[3]	[3]
CC2	[3]	[3]	[3]	[3]	1	[3]	[3]	[3]	[3]	[3]	[3]	2	[3]	[3]
CC3	[3]	[3]	[3]	[3]	2	[3]	[3]	[3]	[3]	[3]	[3]	2	[3]	[3]
CC4	[3]	[3]	[3]	[3]	2	[3]	[3]	[3]	[3]	[3]	[3]	1	[3]	[3]
CC13	[3]	[3]	[3]	[3]	2	[3]	[3]	[3]	[3]	[3]	[3]	2	[3]	[3]

Note:

(1) For nutrient, WQO criteria is only applicable to TIN and UIA, thus this table only presents these parameters.

(2) Include baseline levels.

(3) Refer to Table 8.24, no cumulative impact is anticipated for this parameters. Results for Scenario 1c is anticipated to be identical to Scenario 1a.

8.6.2 Construction Site Runoff

8.6.2.1 The construction site runoff comprises the following:

- Runoff and erosion from site surfaces, earth working areas and stockpiles;
- Wash water from dust suppression sprays and wheel washing facilities; and
- Fuel, oil, solvents and lubricants from maintenance of construction machinery and equipment.

8.6.2.2 Construction runoff may cause physical, biological and chemical effects. The physical effects include potential blockage of drainage channels and increase of SS levels in Junk Bay. Runoff containing significant amounts of concrete and cement-derived material may cause primary chemical effects such as increasing turbidity and discoloration, elevation in pH, and accretion of solids. A number of secondary effects may also result in toxic effects to water biota due to elevated pH values, and reduced decay rates of faecal micro-organisms and photosynthetic rate due to the decreased light penetration. Mitigation measures will be in place to control runoff.

8.6.3 Sewage from Workforce

8.6.3.1 Sewage effluents will arise from the sanitary facilities provided for the on-site construction workforce. The characteristics of sewage would include high levels of BOD_5, Ammonia and *E. coli* counts. Since portable chemical toilets and sewage holding tank will be provided, no adverse water quality impact is anticipated.

8.6.4 Mitigation Measures

Dredging and Filling

8.6.4.1 No exceedance of SS, sedimentations, DO depletion and release of contaminants were anticipated under both Scenario 1a (CBL+TKO-LT Tunnel dredging/filling) and Scenario 1c (CBL+TKO-LT Tunnel dredging/filling and cumulative projects). Non-compliance with the assessment criteria for WSD's salt water intakes for flushing water (10 mg/L) and any Fish Culture Zone in the vicinity is not anticipated either. Although the interface of the marine works for CBL project with T2 is anticipated, the plume from CBL was well confined in Junk

Bay area and superpositions of plume with T2 is not anticipated (refer to Drawings S1a-SS-Dry-Map, S1a-SS-Wet-Map, S1a-Sed-Dry-Map and S1a-Sed-Wet-Map of **Appendix 8.2**).

8.6.4.2 To further protect WSRs and ensure the effectiveness of mitigation measures, it is recommended to monitor the SS and TIN during construction phase under the EM&A programme.

8.6.4.3 Pile excavation works operations should be undertaken in such a manner as to minimise resuspension of sediments. Standard good site practice measures should, therefore, be implemented including the following requirements which should be written into the contract.

- all excavation works shall be conducted within the cofferdam (**Drawing No. 209506/EIA/WQ/006**);
- floating single silt curtain shall be employed for all marine works;
- mechanical grabs (with a maximum size of $5m^3$) shall be designed and maintained to avoid spillage and should seal tightly while being lifted;
- barges and hopper excavators shall have tight fitting seals to their bottom openings to prevent leakage of material;
- any pipe leakages shall be repaired quickly. Plant should not be operated with leaking pipes;
- loading of barges and hoppers shall be controlled to prevent splashing of excavated material to the surrounding water. Barges or hoppers shall not be filled to a level which will cause overflow of materials or pollution of water during loading or transportation;
- excess material shall be cleaned from the decks and exposed fittings of barges and hopper excavators before the vessel is moved;
- adequate freeboard shall be maintained on barges to reduce the likelihood of decks being washed by wave action;
- all vessels shall be sized such that adequate clearance is maintained between vessels and the sea bed at all states of the tide to ensure that undue turbidity is not generated by turbulence from vessel movement or propeller wash; and
- the works shall not cause foam, oil, grease, litter or other objectionable matter to be present in the water within and adjacent to the works site.

<u>Construction Site Runoff</u>

8.6.4.4 In accordance with the Practice Note for Professional Persons on Construction Site Drainage, Environmental Protection Department, 1994 (ProPECC PN 1/94), construction phase mitigation measures, where appropriate, should include the following:

- The design of efficient silt removal facilities should be based on the guidelines in Appendix A1 of ProPECC PN 1/94. The detailed design of the sand/silt traps should be undertaken by the contractor prior to the commencement of construction.
- Open stockpiles of construction materials (for example, aggregates, sand and fill material) of more than 50m3 should be covered with tarpaulin or similar fabric during rainstorms. Measures should be taken to prevent the washing away of construction materials, soil, silt or debris into any marine water bodies.
- All vehicles and plant should be cleaned before leaving a construction site to ensure no earth, mud, debris and the like is deposited by them on roads. An adequately designed and sited wheel washing facilities should be provided at every construction site exit where practicable. Wash-water should have sand and silt settled out and removed at least on a weekly basis to ensure the continued efficiency of the process. The section of access road leading to, and exiting from, the wheel-wash bay to the public road should be paved with sufficient backfall toward the wheel-wash bay to prevent vehicle tracking of soil and silty water to public roads and drains.
- Construction solid waste, debris and rubbish on site should be collected, handled and disposed of properly to avoid water quality impacts.
- All fuel tanks and storage areas should be provided with locks and sited on sealed areas, within bunds of a capacity equal to 110% of the storage capacity of the largest tank to prevent spilled fuel oils from reaching water sensitive receivers nearby.
- Regular environmental audit on the construction site should be carried out in order to prevent any malpractices. Notices should be posted at conspicuous locations to remind the workers not to discharge any sewage or wastewater into the meander, wetlands and fish ponds.

8.6.4.5 By adopting the above mitigation measures with best management practices, it is anticipated that the impacts of construction site runoff from the construction site will be reduced to satisfactory levels before discharges.

Sewage from Workforce

8.6.4.6 Portable chemical toilets and sewage holding tanks should be provided for handling the construction sewage generated by the workforce. A licensed contractor should be employed to provide appropriate and adequate portable toilets and be responsible for appropriate disposal and maintenance.

8.6.4.7 Notices should be posted at conspicuous locations to remind the workers not to discharge any sewage or wastewater into the nearby environment during the construction phase of the Project. Regular environmental audit on the construction site should be conducted in order to provide an effective control of any malpractices and achieve continual improvement of environmental performance on site. It is anticipated that sewage generation during the construction phase of the Project would not cause water quality impact after undertaking all required measures.

8.7 Operational Phase Assessment

8.7.1 Change of Hydrodynamic Regime

8.7.1.1 The key operational phase issues are related to the change in hydraulic friction and coastline due to CBL and TKO-LT Tunnel would have impact on the hydrodynamic regime within the Junk Bay WCZ, Eastern Buffer WCZ and Victoria Harbour WCZ. The key issues are as follows:

- reduction or acceleration of tidal flows resulting in siltation or erosion of seabed and scour hole formation;
- poorly flushed embayments;
- accumulation of floating debris; and
- increase in siltation and loss of water depth if significant change in hydrodynamic regime predicted.

8.7.1.2 The coastline with and without CBL and TKO-LT Tunnel reclamation is presented in **Appendix 8.5**. Tidal flows simulations have been undertaken in order to obtain results for:-

- Scenario 2a – Ultimate Scenario (with CBL piers and TKO-LT Tunnel Reclamation)
- Scenario 2b – Ultimate Scenario (Do-nothing)

8.7.1.3 By comparing the results from these simulations, the possible hydrodynamic impacts for the CBL and TKO-LT Tunnel were assessed.

8.7.1.4 The modeling results are presented in **Appendix 8.5**. The graphical presentations for flow velocity vectors and accumulated flows show an insignificant hydrodynamic impact with and without the CBL and TKO-LT Tunnel.

8.7.1.5 A summary of depth averaged velocities within a whole spring-neap cycle are presented in **Table 8.28** for both dry and wet seasons.

Table 8.28 Depth Averaged Velocities in Dry and Wet Season (in m/s)

Locations	Ultimate Scenario (Scenario 2a)	Do-nothing Scenario (Scenario 2b)	Ultimate Scenario (Scenario 2a)	Do-nothing Scenario (Scenario 2b)
	Dry Season		Wet Season	
JM3	0.04 (0.01 to 0.08)	0.04 (0.01 to 0.08)	0.08 (0.02 to 0.26)	0.08 (0.02 to 0.26)
JM4	0.15 (0.02 to 0.32)	0.14 (0.02 to 0.32)	0.20 (0.05 to 0.43)	0.20 (0.05 to 0.43)
Seashore outside Ocean Shores (Refer to Appendix 8.5)[1]	0.01 (0.01 to 0.04)	0.02 (0.01 to 0.04)	0.03 (0.01 to 0.10)	0.04 (0.01 to 0.12)

Notes:

(1) It should be noted that the reduction of current velocities in the seashore outside Ocean Shores were due to TKO-LT Tunnel reclamation but not the CBL project. Nevertheless, the zoom-in figures of current velocities in flood/ebb at this embayed area are presented in Appendix 8.5.

8.7.1.6 As the Junk Bay is already a semi-enclosed water body, the existing flow condition is already limited. Based on the model results there is no significant surface/bottom flow retardation even stagnation of water at the seashore outside Ocean Shores (embayed area formed by TKO-LT Tunnel reclamation) in both dry and wet season.

8.7.1.7 According to the drainage design of Road P2 of TKO-LT Tunnel reclamation, all the stormwater from west TKO will be discharged to the east of Road P2, i.e. open sea of Junk Bay, except a stormwater discharge point was diverted to embayed area formed by TKO-LT Tunnel reclamation. However, the catchment of this stormwater pipe is only 69200m^2 and the land use is only residential area or park. In ideal case there will be no discharge unless during rainy periods. Nevertheless, there might be minor baseflow in reality and pollutant might be trapped within the embayed area if inadequate flushing capacity.

8.7.1.8 According to the hydrodynamic modelling results in Table 8.28, it is observed that the average velocity within the embayed area will be reduced by 0.01 m/s, compared with the prevailing velocity of 0.01-0.04 m/s and 0.01-0.12 m/s for dry and wet season respectively. Given the small change of average velocity, significant change in flushing capacity is not anticipated. In order to further supplement the interpretation, a drogue track analysis has been conducted to investigate the residence time of pollutants within the embayed area and the Junk Bay. As a worst scenario consideration, the model assumes the drogue track starting in neap tide under dry season and hourly drogue track is predicted.

8.7.1.9 The modelled hourly drogue track is presented in **Appendix 8.6**. It is observed that it takes about 3-4 hours for the pollutants to flush out of the embayment and more than 12 hours to flush out of the Junk Bay. As the residence time is relatively short, accumulation of pollutant (e.g. BOD_5 or DO depletion) within the embayed area and the Junky Bay is not anticipated.

8.7.2 Runoff from Road Surfaces

8.7.2.1 During operational phase, vehicle dust, tyre scraps and oils might be washed away from the road surfaces to the nearby marine water environment by surface runoff or road surface cleaning. Therefore, potential water quality impacts may arise from the road runoff discharge during operational phase. Substances such as dust and lubricant oil deposited and accumulated on the road surfaces will be washed into the marine water bodies during rainfall or road cleaning. Measures to mitigate the water quality from road runoff would be required.

8.7.3 Mitigation Measures

Change of Hydrodynamic Regime

8.7.3.1 No significant change in hydrodynamic and water quality regime is anticipated and therefore no mitigation measure such as maintenance dredging is required.

Runoff from Road Surfaces

8.7.3.2 As a precautionary measure, proper drainage systems with silt traps and oil interceptors should be installed, and maintained and cleaned at regular intervals.

8.8 Residual Impacts

8.8.1.1 No adverse residual water quality impact is anticipated. To further protect the WSRs and to ensure the effectiveness of mitigation measures, it is recommended to monitor the SS during construction phase under the EM&A programme.

8.9 Conclusion

8.9.1.1 During construction phase, it is anticipated that the SS elevation, sedimentations and DO depletion due to CBL+TKO-LT Tunnel dredging/filling works and all concurrent projects will be well within the proposed criteria.

8.9.1.2 During operational phase, an insignificant change in hydrodynamic regime is predicted for CBL+TKO-LT Tunnel project. Therefore, the change of water quality regime, which associated with the hydrodynamic impact, is not anticipated.

8.9.1.3 The water quality assessment has been conducted according to Annex 15, Guidelines for Assessment of Water Pollution, of the TM-EIAO. Overall, it is concluded that water quality impacts will comply with Annex 6, Criteria for Evaluating Water Pollution, during both the construction and operational phases of CBL.

9 Waste Management Implication

9.1 Legislation and Standards

9.1.1 This section identifies the potential waste arising from the construction and operation of CBL, and evaluates the potential waste management implications that may result from waste generated during these phases.

9.1.2 Mitigation measures and good site practices, including waste handling, storage and disposal, have been recommended with reference to waste legislation and management guidelines.

9.2 Legislation and Standards

9.2.1 The relevant legislation and associated guidance notes related to the study for the assessment of waste management implications include:

- Waste Disposal (Amendment) Ordinance (Cap 354) and subsidiary regulations;
- Environmental Impact Assessment Ordinance (EIAO) (Cap. 499), Technical Memorandum on Environmental Impact Assessment Process (TM-EIAO) Annex 7 and Annex 15;
- Dumping at Sea Ordinance (Cap 466);
- Land (Miscellaneous Provisions) Ordinance (Cap 28), and
- Public Health and Municipal Service Ordinance (Cap 132) – Public Cleansing and Prevention of Nuisances By-laws.

9.2.2 Under the Waste Disposal (Amendment) Ordinance, regulations relevant to this EIA include:

- Waste Disposal (Charges for Disposal of Construction Waste) Regulation (Cap 354); and
- Waste Disposal (Chemical Waste) (General) Regulation (Cap 354).

Waste Disposal (Amendment) Ordinance and the Waste Disposal (Charges for Disposal of Construction Waste) Regulation

9.2.3 The Waste Disposal (Amendment) Ordinance (WDO) prohibits unauthorised disposal of wastes. Schedule 5 of the Waste Disposal (Charges for Disposal of Construction Waste) Regulation (Charging Regulation) defines that inert construction waste includes rock, rubble, boulder, earth, soil, sand, concrete, brick, tile, masonry or used bentonite.

9.2.4 Under the WDO and the Charging Regulation, wastes can only be disposed of at designated waste disposal facilities licensed by EPD. Breach of this Ordinance can lead to a fine and/or imprisonment. The WDO also stipulates the requirements for issuing licenses for the collection and transportation of wastes.

9.2.5 The Construction Waste Disposal Charging Scheme entered into operation on 1 December 2005. Starting from 1 December 2005, the main contractor undertaking construction work under a contract with value of HK$1 million or above is required to establish a billing account with EPD before transporting the construction waste to the designated waste disposal facilities (e.g. landfill, public fill, etc.). Vehicles delivering construction waste to public fill reception facility require prior approval from EPD. Breach of these regulations can lead to a fine and/or imprisonment.

Waste Disposal (Chemical Waste) (General) Regulation

9.2.6 Chemical waste includes any scrap materials, or unwanted substances specified under Schedule 1 of this Regulation if such a substance or chemical occurs in such a form, quantity or concentration that causes pollution or constitutes a danger to health or risk of pollution to the environment.

9.2.7 A person shall not produce, or cause to be produced, chemical wastes unless he is registered with EPD. Any person who contravenes this requirement commits an offence and is liable to a fine and/or imprisonment. Chemical wastes must be treated utilising on-site plant licensed by EPD, or be collected a licensed collector to transport the wastes to a licensed treatment facility. For each consignment of wastes, the waste producer, collector and disposer of the wastes must sign all relevant parts of a computerised trip ticket. The system is designed to trace wastes from production through to disposal.

9.2.8 This regulation also prescribes the storage facilities to be provided on site and labelling and warning signs. To minimise the risk of pollution and danger to human health or life, the waste producer is required to prepare and make available written emergency procedures for spillage, leakage or accidents arising from the storage of chemical wastes. The waste producer must also provide employees with training for such procedures.

Dumping at Sea Ordinance

9.2.9 According to the Dumping at Sea Ordinance, a permit from EPD is required if any waste producer intends to dump materials from vessels to designated marine dumping areas. The Authority will consider a number of factors including the source and nature of materials to be dumped, dumping rates, need for inspection/testing, water pollution avoidance measures, etc. before determining whether such a permit would be granted, and where deemed necessary, any conditions to be complied with. Breach of the requirements of the permit would result in a fine and/or imprisonment.

Land (miscellaneous Provisions) Ordinance

9.2.10 The inert portion of construction and demolition (C&D) materials may be taken to public filling facilities including public filling area, public filling barging points and stockpiling areas. Delivery of inert C&D materials to such public filing facilities requires a Dumping License (to be issued by CEDD).

Public Cleansing and Prevention of Nuisances Regulation

9.2.11 This regulation provides further control on illegal dumping of litter or waste in street and public places (including water course, stream, channel, etc). An offence of this regulation would result in a fine and/or imprisonment.

Other Relevant Guidelines

9.2.12 **Table 9.1** summaries other documents and guidelines that are related to waste management and disposal:

Table 9.1 Other relevant documents and guidelines

Bureau / Department	Documents / Guidelines / Technical Circulars
EPD	• Waste Reduction Framework Plan, 1998 • Code of Practice on the Packaging, labeling and Storage of Chemical Wastes (1992)
CEDD	• Project Administration Handbook for Civil Engineering Works, 2008 Edition

Bureau / Department	Documents / Guidelines / Technical Circulars
EPD / CEDD	• New Disposal Arrangements for Construction Waste (1992)
Development Bureau	• WBTC No. 2/93, Public Dumps • WBTC No 2/93B, Public Filling Facilities • WBTC No. 16/96, Wet Soil in Public Dumps • WBTC Nos. 4/98 and 4/98A, Use of Public Fill in Reclamation and Earth Filling Project • WBTC Nos. 25/99, 25/99A and 25/99C, Incorporation of Information on Construction and Demolition Material Management in Public Works Sub-committee Papers • WBTC No. 12/2000, Fill Management • WBTC No. 19/2001, Metallic Site Hoardings and Signboards • WBTC No. 06/2002 & 06/2002A, Enhanced Specification for Site Cleanliness and Tidiness • WBTC No. 12/2002, Specification Facilitating the Use of Recycled Aggregates • Environment, Transport and Works Bureau Technical Circular (ETWBTC) (Works) No. 33/2002, Management of Construction and Demolition Material Including Rock • ETWBTC (Works) No. 34/2002, Management of Dredged / Excavated Sediment • ETWBTC (Works) No. 06/2010, Trip-ticket System for Disposal of Construction and Demolition Material • ETWBTC (Works) No. 19/2005, Environmental Management on Construction Sites
PlanD	• Environmental Guidelines for Planning In Hong Kong (1990), Hong Kong Planning Standards and Guidelines

Construction & Demolition (C&D) Material Management

9.2.13 According to ETWBTC (Works) No. 33/2002, for Designated Projects, where C&D materials are expected to exceed 50,000m^3, a Construction & Demolition Material Management Plan (C&DMMP) has to be submitted together with the Environmental Impact Assessment (EIA) Report to the Public Fill Committee (PFC) for approval.

9.2.14 ETWBTC (Works) No. 19/2005 sets out the policy and procedures requiring contractors to prepare and implement an environmental management plan to encourage on-site sorting of C&D materials and to reduce C&D waste generation during construction.

Disposal Criteria for Dredged Sediment

9.2.15 ETWBTC (Works) No. 34/2002 sets out the procedure to be followed in assessing and classifying sediment and explains the marine disposal arrangement for classified material. Applications for approval of dredging proposal and allocation of marine disposal shall be made to the Secretary of Marine Fill Committee (MFC). Marine Dumping Permits as stipulated under the Dumping at Sea Ordinance are required from EPD for the disposal of dredged sediment.

9.3 Assessment Methodology

9.3.1 The assessment of waste management implications from handling, storage, collection, transportation and disposal of solid waste materials generated by the construction of CBL has been undertaken in accordance with the Annexes 7 and 15 of the TM-EIAO and the EIA Study Brief and included:

- Estimation of the type, timing and quantity of the wastes to be generated; and
- Assessment of the potential environmental implications on the capacity of waste collection, transfer and disposal facilities.

9.3.2 Secondary environmental impacts due to the management of waste, including potential air emission and noise impacts have been assessed and evaluated in other relevant sections.

9.4 Construction Phase – Evaluation of Waste Generation

9.4.1 During the construction phase, the main activities which will result in generation of waste include the construction of the CBL bridge substructure and superstructure, the bridge foundation and the seawall upgrading works at Road D9. The typical waste types associated with these activities include:

- Dredged marine sediment,
- C&D materials,
- Chemical waste, and
- General refuse and sewage from workers.

C&D Materials

9.4.2 C&D material consists of the following two portions:

- inert portion – soil, rock and concrete, etc. which can be reused as fill material; and
- non-inert portion – timber, glass, steel, plastics, etc. which are not suitable for reuse as fill material and should be recycled before deposal at landfills.

9.4.3 As discussed in **Section 4**, precast segmental construction for the approaches and off-site fabrication of the main bridge decks and arch will be adopted. As a result, the majority of the works will occur off-site. Since the need for formwork and temporary falseworks is greatly reduced by adopting such construction methods, most of the C&D material that will be generated by the project will be from marine excavation for the construction of the bridge foundations and the seawall upgrading works.

9.4.4 Based on the preliminary estimation, a total of approximately 98.71 thousand m^3 excavated materials, including 80.06 thousand m^3 of inert C&D soft materials, 15.48 thousand m^3 of Grade III rock and 3.17 thousand m^3 of other C&D materials (bitumen, concrete, etc.) would be generated from the construction of CBL. It is anticipated that a portion of the inert C&D materials (about 64.69 thousand m^3) generated from the construction works can be reused on-site as filling material. There will be approximately 34.02 thousand m^3 inert C&D soft materials to be delivered to public fill reception facilities.

9.4.5 For the excavation at Road D9, the excavation behind the existing seawall has been greatly reduced by the introduction of temporary retaining structure. Thus the C&D materials generated has been minimized.

9.4.6 The estimated quantity of C&D materials to be generated, reused and delivered to public fill reception facilities is summarised in **Table 9.2**.

Table 9.2 Estimated quantities of C&D materials to be generated, reused and delivered to public fill reception facilities in thousand m^3

Materials	Sources	Generated	To be reused on site	Public fill reception facilities (PFRF)
Inert C&D soft materials	Excavation for seawall upgrading works, construction of prebored H-piles, bored piles and pile caps	80.06	46.04	34.02
Grade III rock (low quality rock)	Excavation for construction of prebored H-piles, bored piles	15.48	15.48	-
Other C&D materials (bitumen & concrete)	Excavation for the existing road	3.17	3.17	-
Total		**98.71**	**64.69**	**34.02**

Notes:

(1) The unit of above figures is thousand m^3.

(2) The above quantities are estimated from the ground investigation information currently available. These quantities will be reviewed when the foundation design of the works and the further ground investigation information are available in the detailed design stage.

On-site sorting of C&D material & Temporary Stockpiles

9.4.7 All C&D materials arising from the construction will be sorted on-site to recover the inert C&D materials as well as the reusable and recyclable materials. Temporary stockpiles will be located at the GI/C site at Road D9.

9.4.8 Any surplus C&D materials will become the property of the Contractor once they are removed from the site. The Contractor will be responsible for devising a system to work for on-site sorting of C&D materials and to promptly remove all sorted and processed material arising from the construction activities to optimise temporary stockpiling on-site. It is recommended that the system should include the identification of the source of generation, estimated quantity, arrangement for on-site sorting and/or collection, temporary storage areas, and frequency of collection by recycling contractors or frequency of removal off-site.

Excavated Marine Sediment

9.4.9 According to the proposed methodology for the construction of CBL, which is discussed in detail in **Section 4**, excavation of sediment from pile casings will be required for the construction of bridge foundations.

9.4.10 Sediment quality assessment including a preliminary marine ground investigation with sediment sampling and laboratory testing has been undertaken in accordance with the requirements in ETWBTC (Works) No. 34/2002.

9.4.11 In accordance with the ETWBTC (Works) No. 34/3002, the marine sediment to be dredged has been classified as Category L (i.e. require Type 1 - Open Sea Disposal), Category Mp (i.e. require Type 1 - Open Sea Disposal (Dedicated Sites)), Category Mf (i.e. require Type 2 - Confined Marine Disposal), and Category H (i.e. require Type 2 – Confined Marine Disposal). **Table 9.3** summarises the estimated quantity of each category of sediment to be dredged and corresponding deposal options. The assessment methodology and results are presented in **Section 7**.

Table 9.3 Summary of the estimated quantity of excavated marine sediment in thousand m^3

Category (1)	Disposal option (1)	Estimated quantity(2)
L (3)	Type 1 – Open Sea Disposal	4.121
Mp (4)	Type 1 – Open Sea Disposal (Dedicated Site)	0.068
Mf (4) and H (5)	Type 2 – Confined Marine Disposal	0.071
Total		**4.26**

Notes:

(1) As per ETWBTC (Works) No. 34/2002

(2) Bulk volume, thousand m^3.

(3) Chemical analytical test results of the sediment are below or equal to the Lower Chemical Exceedance Level (LCEL)

(4) Chemical analytical test results of the sediment are greater than the LCEL, but less than or equal to the Upper Chemical Exceedance Level (UCEL); Mp - Biological test passed; Mf - Biological test failed.

(5) Analytical results greater than the UCEL

9.4.12 The testing results presented in this report are for EIA purposes only. Detailed analysis will be required to apply for a Dumping Permit for the sediments. A proposal for sampling and testing of the sediment will be prepared and submitted to the EPD for approval. The approved detailed sediment sampling and testing will be carried out prior to the commencement of the excavation activities to confirm the sediment disposal option. A Sediment Quality Report (SQR) shall be prepared for EPD approval as required under the Dumping at Sea Ordinance which will include the sampling details, the laboratory testing results, proposed classification and disposal option of the sediment according to the requirements of the Appendix A of ETWBTC (Works) No. 34/2002.

9.4.13 The final disposal site will be determined by the MFC and a dumping licence will be obtained from the DEP prior to the commencement of the excavation works.

9.4.14 Assessment of potential impacts relating to sediment and water quality is presented in **Section 8.** With proper preventive and mitigation measures in place for handling, transport and disposal as per the requirements given in the ETWBTC (Works) No. 34/2002, no insurmountable environmental impacts would be anticipated.

Chemical Wastes

9.4.15 Chemical wastes likely to be generated from the construction activities and associated facilities may include:

- scrap batteries or spent acid/alkali from their maintenance;
- used paint, engine oils, hydraulic fluids and waste fuel;
- spent mineral oils/cleansing fluids from mechanical machinery; and
- spent solvents/solutions, some of which may be halogenated, from equipment cleansing activities.

9.4.16 Chemical wastes may pose environmental, health and safety hazards if not stored and disposed of in an appropriate manner as outlined in the Waste Disposal (Chemical Waste) (General) Regulation and the Code of Practice on the Packaging, Labelling and Storage of Chemical Waste. These hazards may include:

- toxic effects to workers;
- adverse effects on air, water and land from spills; and
- fire hazards.

9.4.17 The amount of chemical waste that will arise will be highly dependent on the contractor's on-site maintenance practice and the number of plant and vehicles utilized. Nevertheless, it is anticipated that the quantity of chemical waste would be small and in the order of few hundred litres per month.

9.4.18 Suitable arrangements for the storage, handling, transport and disposal of chemical waste shall be made in accordance with the Code of Practice on the Packaging, Labelling and Storage of Chemical Waste. Wherever possible opportunities should be taken to reuse and recycle materials.

Sewage

9.4.19 Sewage will arise from amenity facilities used by the construction workforce and site office's sanitary facilities. The sewage generated should be properly managed to minimise the adverse impact of odour and potential health risks to the workers by attracting pests and other disease vectors.

9.4.20 As the workers will be scattered within the construction site, the most cost-effective solution will be to provide an adequate number of portable toilets within the site to ensure that sewage from site staff is properly collected. No adverse waste impact is anticipated if the chemical toilets are properly maintained and licensed collectors are employed for the collection and disposal of sewage on a regular basis.

General Refuse

9.4.21 The presence of a construction site with workers and site office will result in the generation of a general refuse (consisting mainly of good waste, aluminium cans and waste paper) which will require off-site disposal. It is conservatively assumed that between 100 and 200 construction workers would be working on site at any one time. With a general refuse generation rate of 0.65kg per worker per day[1], the quantity of refuse generated would be about 65kg to 130kg per day.

9.4.22 Effective collection of site waste will be required to prevent waste materials being blown around by wind, flushed or leached into the marine environment, or creating an odour nuisance or pest and vermin problem. Waste storage areas shall be well maintained and cleaned regularly. In addition, disposal of waste at sites other than approved waste transfer or disposal facilities shall be prohibited.

9.4.23 With the implementation of good waste management practices at the site, adverse environmental impacts are not expected to arise from the storage handling and transportation of general refuse generated from the site.

9.5 Construction Phase – Recommended Mitigation Measures

9.5.1 This section recommends the mitigation measures and good site practice to avoid or reduce potential adverse environmental impacts associated with handling, collection and deposal of waste arising from the construction and operation of the proposed CBL. The recommendations are made based on the waste management hierarchy principles. The waste management options considered to be most preferable have the least environmental impacts and are more sustainable in the long term. The hierarchy is as follows:

- avoidance and minimization,
- reuse of materials,

[1] This is considered as a conservative estimate based on the number reported in a number of EIA reports approved under the EIAO.

- recovery and recycling, and
- treatment and disposal.

9.5.2 Prior to the commencement of the construction works, the contractors should incorporate these recommendations into a Waste Management Plan to provide an overall framework for waste management and reduction. Recommended of good site practice, waste reduction measures as well as the waste transportation, storage and collection are as follows:

Good Site Practice

9.5.3 Adverse waste management implications are not expected, provided that good site practices are strictly implemented. The following good site practices are recommended throughout the construction phase of the project:

- nomination of an approved personnel to be responsible for the implementation of good site practices, arrangements for collection and effective deposal to an appropriate facility of all wastes generated at the site;
- training of site personnel in proper waste management and chemical handling procedures;
- provision of sufficient waste disposal points and regular collection for disposal;
- separation of chemical wastes for special handling and appropriate treatment at the Chemical Waste Treatment Centre;
- regular cleaning and maintenance programme for drainage systems, sumps and oil interceptors; and
- implementation of a recording system for the amount of wastes generated/recycled and disposal sites.

Waste Reduction Measures

9.5.4 The amount of waste generated can be significantly reduced through good management and control. Waste reduction is best achieved at the site planning and design phase, as well as by ensuring the implementation of good site practices when the works are in progress. Recommendations for achieving waste reduction include:

- on-site reuse of any material excavated as far as practicable;
- segregation and storage of different types of waste in different containers, skips or stockpiles to enhance reuse or recycling of material and their proper disposal;
- collection of aluminium cans and waste paper by individual collectors during construction should be encouraged. Separately

labelled recycling bins should also be provided to segregate these wastes from other general refuse by the workforce;

- recycling of any unused chemicals and those with remaining functional capacity as far as possible;
- prevention of potential damage or contamination to the construction materials though proper storage and good site practices;
- planning and stocking of construction materials should be made carefully to minimise amount of waste generated avoid unnecessary generation of waste; and
- training on the importance of appropriate waste management procedures, including waste reduction, reuse and recycling should be provided to workers.

Storage, Collection and Transportation of Waste

9.5.5 Storage of waste on site may induce adverse environmental implications if not properly managed. The following recommendations should be implemented to minimise the impacts:

- waste such as soil should be handled and stored well to ensure secure containment;
- stockpiling area should be provided with covers and water spraying system to prevent materials from being washed away and to reduce wind-blown litter
- different locations should be designated to stockpile each material to enhance reuse.

9.5.6 With respect to the collection and transportation of waste from the construction works area to respective disposal sites, the following recommendations should be implemented to minimise the potential adverse environmental impacts:

- remove waste in timely manner;
- employ trucks with cover or enclosed containers for waste transportations;
- obtain relevant waste disposal permits from the appropriate authorities; and disposal of waste should be done at licensed waste disposal facilities.

9.5.7 In addition to the above measures, other specific mitigation measures on handling other specific waste generated from construction phase are recommended in the following subsections.

C&D Materials

9.5.8 Wherever practicable, C&D materials should be segregated from other wastes to avoid contamination and ensure acceptability at public filling areas or reclamation sites. The following mitigation measures should be implemented in handling the waste:

- maintain temporary stockpiles and reuse excavated fill material for backfilling and reinstatement;
- carry out on-site sorting;
- make provisions in the contract documents to allow and promote the use of recycled aggregates where appropriate; and
- implement a trip-ticket system for each works contract to ensure that the disposal of C&D materials are properly documented and verified.

9.5.9 In addition, disposal of the C&D materials onto any sensitive location such as agricultural land, etc. should be avoided. The contractor shall propose the final disposal sites to the Project Proponent and obtain its approval before implementation.

9.5.10 Standard formwork or pre-fabrication should be used as far as practicable in order to minimise the arising of C&D materials. The use of more durable formwork or plastic facing for the construction works should be considered. Metal hoarding should be used to enhance the possibility of recycling. The purchasing of construction materials should be carefully planned in order to avoid over ordering and wastage.

9.5.11 The contractor should recycle as much of the C&D materials as possible on-site. Public fill and C&D waste should be segregated and stored in different containers or skips to enhance reuse or recycling of materials and their proper disposal. Where practicable, concrete and masonry can be crushed and used as fill. Steel reinforcement bar can be used by scrap steel mills. Different areas of the construction site should be considered for such segregation and storage.

Excavated Sediments

9.5.12 The basic requirements and procedures for excavated/dredged sediment disposal are specified under ETWBTC (Works) No. 34/2002. The final disposal site will be determined by the MFC and a dumping licence will be obtained from EPD prior to the commencement of the excavation works.

9.5.13 During transportation and disposal of the excavated marine sediments, the following measures should be taken to minimise potential environmental impacts:

- bottom opening of barges should be fitted with tight fitting seals to prevent leakage of material. Excess material should be cleaned from the decks and exposed fittings of barges and hopper excavators before the vessel is moved;
- monitoring of the barge loading should be conducted to ensure that loss of material does not take place during transportation;
- transport barges or vessels should be equipped with automatic self-monitoring devices as specified by the DEP; and
- barges or hopper barges should not be filled to a level that would cause the overflow of materials or sediment-laden water during loading or transportation.

Chemical Waste

9.5.14 For those processes which generate chemical waste, the contractor shall identify any alternatives that generate reduced quantities or even no chemical waste, or less dangerous types of chemical waste.

9.5.15 If chemical waste is produced at the construction site, the contractors should register with EPD as chemical waste producers. Chemical waste should be handled in accordance with the Code of Practice on the Packaging, Handling and Storage of Chemical Wastes. Containers used for storage of chemical wastes should:

- be suitable for the substance they are holding, resistant to corrosion, maintained in a good condition, and securely closed;
- have a capacity of less than 450 L unless the specification have been approved by EPD; and
- display a label in English and Chinese in accordance with instructions prescribed in Schedule 2 of the Regulations.

9.5.16 The storage area for chemical wastes should:

- be clearly labelled and used solely for the storage of chemical wastes;
- be enclosed on at least 3 sides;
- have an impermeable floor and bunding, of capacity to accommodate 110% of the volume of the largest container or 20% by volume of the chemical waste stored in the area, whichever is greatest;
- have adequate ventilation;

- be covered to prevent rainfall entering (water collected within the bund must be tested and disposed as chemical waste, if necessary); and
- be arranged so that incompatible materials are adequately separated.

9.5.17 Disposal of chemical waste should:

- be via a licensed waste collector; and
- be to a facility licensed to receive chemical waste, such as the CWTC which also offers a chemical waste collection service and can supply the necessary storage containers; or
- be to a re-user of the waste, under approval from EPD.

Sewage

9.5.18 An adequate number of portable toilets should be provided for the on-site construction workers. Any waste should be transferred to a sewage treatment works by a licensed collector.

General Refuse

9.5.19 General refuse generated on-site should be stored in enclosed bins or compaction units separately from construction and chemical wastes. Recycling bins should also be provided to encourage recycling. A reputable waste collector should be employed by the contractor to remove general refuse from the site on a daily basis separately from the construction and chemical wastes. Burning of refuse on construction sites is prohibited by law.

9.6 Operational Phase

9.6.1 It is not anticipated that large quantities of waste would be generated during the operational phase. Only a small amount of general refuse would be generated from the footpath and cycle track along CBL and Road D9. Waste collection bins and recycling bins would be provided and therefore adverse waste management implications are not anticipated.

9.7 Residual Environmental Impacts

9.7.1 With the implementation of recommended mitigation measures for the handling, transportation and disposal of the identified wastes, adverse residual waste management implications are not anticipated for both the construction and operational phases.

9.8 Conclusion

9.8.1 Potential waste management implications from the generation of waste during the construction and operational phase of the Project have been evaluated. A range of best practice mitigation measures have been proposed for implementation by the contractor during the construction period to minimise waste generation and off-site disposal and has compiled with Annex 7 and Annex 15 of the TM-EIAO. In addition, monitoring and audit measures are proposed to ensure that robust measures are promoted to minimise impacts and that waste is controlled effectively.

10 Marine Ecology Impact

10.1 Legislation and Standards

10.1.1 Local

10.1.1.1 The HKSAR ordinances and regulations relevant to ecological assessment of this Project include the following:

(1) Forests and Countryside Ordinance (Cap. 96A) and its subsidiary legislation, the Forestry Regulation;

(2) Wild Animals Protection Ordinance (Cap. 170);

(3) Country Parks Ordinance (Cap. 208) and its subsidiary legislation;

(4) Marine Parks Ordinance (Cap. 476);

(5) Environmental Impact Assessment Ordinance ("the EIAO", Cap. 499) and the associated EIAO-TM; and

(6) Protection of Endangered Species of Animals and Plants Ordinance (Cap. 586) and its subsidiary legislation.

10.1.1.2 This assessment also makes reference to the following guidelines and standards as well as international conventions:

(1) Hong Kong Planning Standards and Guidelines (HKPSG) Chapter 10, "Conservation";

(2) PELB Technical Circular 1/97 / Works Branch Technical Circular 4/97, "Guidelines for Implementing the Policy on Off-site Ecological Mitigation Measures";

(3) EIAO Guidance Note No. 6/2002 - Some Observations on Ecological Assessment from the Environmental Impact Assessment Ordinance Perspective;

(4) EIAO Guidance Note No. 7/2002 – Ecological Baseline Survey for Ecological Assessment;

(5) EIAO Guidance Note No. 10/2004 – Methodologies for Terrestrial and Freshwater Ecological Baseline Surveys; and

(6) EIAO Guidance Note 11/2004 “Methodologies for Marine Ecological Baseline Surveys”.

10.1.2 Local

Regional and International

10.1.2.1 This assessment also makes reference to the following Mainland legislation:

(1) List of State Protected Wild Animals, promulgated by the State Council 國家重點保護野生動物名錄.

10.1.2.2 Other international conventions and guidelines that are relevant to this study include the following:

(2) Convention on International Trade in Endangered Species of Wild Fauna and Flora ("CITES"). This Convention regulates international trade in animal and plant species considered to be at risk from such trade. Depending on the degree of threat posed by international trade, CITES classifies endangered species of animals and plants into three Appendices. Appendix I includes highly endangered species threatened with extinction. Commercial trade in specimens of these species is prohibited. Appendix II includes species which are not presently threatened with extinction but may become so unless trade is controlled. Their trade is allowed but subject to licensing controls. Appendix III species are species identified by any Party to CITES as requiring cooperation in controlling their trade. Their trade is subject to permits or certificates of origin. Hong Kong's obligations under this Convention are enforced via the Protection of Endangered Species of Animals and Plants Ordinance (Cap. 586).

(3) IUCN - The World Conservation Union maintains, through its Species Survival Commission, a “Redlist” of globally threatened species of wild plants and animals (see http://www.iucnredlist.org/static/introduction). The Redlist is considered the authoritative publication to classify species into nine groups as Extinct (EX) - No individuals remaining; Extinct in the Wild (EW) - Known only to survive in captivity, or as a naturalized population outside its historic range; Critically Endangered (CR) - Extremely high risk of extinction in the wild; Endangered (EN) - Very high risk of extinction in the wild; Vulnerable (VU) - High risk of extinction in the wild; Near

Threatened (NT) - Likely to become endangered in the near future; Least Concern (LC) - Lowest risk. Does not qualify for a more at risk category. Widespread and abundant taxa are included in this category; Data Deficient (DD) - Not enough data to make an assessment of its risk of extinction; Not Evaluated (NE) - Has not yet been evaluated against the criteria.

(4) United Nations Convention on Biological Diversity, which requires parties to regulate or manage biological resources important for the conservation of biological diversity, to promote the protection of ecosystems, natural habitats and the maintenance of viable populations of species in natural surroundings; and

(5) Convention on Wetlands of International Importance Especially as Waterfowl Habitat (the "Ramsar Convention"), which requires parties to conserve and make wise use of wetlands, particularly those supporting waterfowl populations. The PRC ratified the Ramsar Convention on 31st July 1992, and various wetlands have since been listed as wetlands of international importance (i.e. Ramsar sites). One of these, Mai Po Marshes and Inner Deep Bay Ramsar site in Hong Kong SAR, was listed on 4 September 1995.

10.1.2.3 Relevant existing ecological studies will be thoroughly reviewed, including EIA- Further Development of Tseung Kwan O Feasibility Study (EIA-111/2005). Species groups of concern were identified based on background information on the study areas, field survey results, and consultation with relevant government authorities. Desk-top study and field survey results produced a complete picture of the ecology of the study area.

10.2 Methodology for Baseline Establishment

10.2.1 Assessment Area

10.2.1.1 The marine ecological assessment area includes the following three Water Control Zones (WCZ) within HKSAR (see **Drawing no. 209506/EIA/MEC/001**) as well as any areas likely to be impacted by the Project:

- the Junk Bay Water Control Zone;
- the Eastern Buffer Water Control Zone; and
- the Victoria Harbour Water Control Zone.

10.2.2 Ecological Sensitive Receivers

Recognized Sites of Conservation Importance

10.2.2.1 There were no recognised sites of conservation importance, including existing, gazetted or proposed marine park or marine reserve, inside the Marine Ecological Assessment Area.

Important Habitats

10.2.2.2 Special attention was given to sites/habitats of conservation importance, such as:

- Coral communities (including all hard corals, octocorals and black corals)
- Marine benthic communities
- Intertidal habitats

Species of Conservation Importance

10.2.2.3 Species of conservation importance were also covered by the assessment, including:

- Philippine Neon Goby *Stiphodon atropurpureum*
- Amphioxus *Branchiostoma belcheri*

10.2.3 Collection and Review of Relevant Information

10.2.3.1 Relevant literatures/publications on the ecological information of the marine and fisheries study area (i.e. the Junk Bay, the eastern buffer and the Victoria Harbour Water Control Zones) and nearby areas were reviewed. Findings of relevant studies/surveys were reviewed, including:

- Baseline survey information conducted in EIA study- Further Development of Tseung Kwan O Feasibility Study
- Feasibility Study on the Alternative Alignment for the Western Coast Road, Tseung Kwan O
- Harbour Area Treatment Scheme
- Southeast New Territories Landfill Extension
- Kai Tak Development
- Consultancy Study on Marine Benthic Communities in Hong Kong (CCPC 2002)

- Field Guide to Hard Corals of Hong Kong (Chan et al. 2005)

10.2.3.2 After reviewing the collected information, information gap for the assessment was identified and collect necessary data by field surveys to facilitate impact assessment of the EIA. For all ecological field works to be undertaken for the EIA, Agriculture, Fisheries and Conservation Department (AFCD) was consulted to agree the details of the surveys.

10.2.4 Marine Ecological Field Survey

Survey programme

10.2.4.1 Ecological surveys were designed and conducted to fill in data gap identified from reviewed literature. The field survey programme included intertidal survey, dive survey, marine benthic survey and fish survey, and covered a period of approximately 7 months, from June to December 2009. Standard survey techniques were used as described below:

Dive Survey

10.2.4.2 Dive surveys for corals and other hard substrate marine organisms were conducted in August to October 2009. The methodology used in the present survey followed those adopted in the AFCD 2001-2002 territory-wide dive survey (AFCD 2004). The dive surveys focused on shallow coastal waters within the extent of Survey Area, i.e. mainly artificial coastlines in and near the Project Site (there were no natural coastlines in the vicinity).

10.2.4.3 Spot reconnaissance dives were conducted in August and September 2009 along the bridge alignment and along the coastline near the bridge landing point (See the blue line in **Drawing no. 209506/EIA/MEC/002a**). The purpose of the field surveys is to verify and update the information gaps in the literature and thus the focus of the survey should be on the direct impact areas, and fulfil the requirements in the Study Brief to cover corals colonies along the eastern cost of Junk Bay. Therefore the reconnaissance dives were to check the presence and locations of major coral communities (including all hard corals, octocorals and black corals) and other marine organisms with conservation importance within the areas potentially subject to direct impacts. The subtidal hard substrata (i.e. hard substratum seabed, intertidal rocky area) within the spot-check dive survey areas were surveyed, and any presence of coral communities including hard corals (order Scleractinia), octocorals (sub-class Octocorallia) and black corals (order Antipatharia) were recorded. For each spot-check dive, information recorded included the depth; the substrata of seabed; and the visibility. Areas with corals were located and suitable locations to carry out the REA surveys were determined. Besides the biota, the habitat types present within the areas and their approximate proportions/distributions were also recorded. Representative photographs of any important ecological habitat and coral species were taken.

10.2.4.4 Corals were recorded during the Spot-check Dives, and a semi-quantitative Rapid Ecological Assessment (REA) was recommended. The REA survey was conducted in October 2009 at two locations on the coastlines of eastern Junk Bay where corals had been identified during the spot reconnaissance dives (including the alignment landing point). The planned REA transect locations are shown in **Drawing no. 209506/EIA/MEC/002a**. The starting points of the REA transects were determined on site in accordance with the site conditions and underwater visibility. The REA survey was performed along 100m underwater transects parallel to the coastlines. Perpendicular transects would not be required as the focal area is a section of vertical seawall. The benthic cover, taxon abundance and ecological attributes of the transects were recorded in a swathe of 2m wide, 1m either side of the transects (subject to the underwater visibility), following the REA technique. The exact locations and routes of the REA transects were recorded on site by GPS and map. Photos of REA locations and underwater photos along the transects and of the surveyed areas were taken during the REA dive surveys.

10.2.4.5 The purposes of the REA survey are to semi-quantitatively record the habitat types and ecological values of the area by SCUBA diving and the application of Rapid Ecological Assessment (REA) approach. The REA approach (see **Annex 1** in **Appendix 10.1** for details) aims at collecting data on the type of substrate and the abundance of marine organisms in particular the occurrence of corals and the extent of the coral distribution from the coastline, for ranking the ecological values. Other parameters recorded during the surveys included site condition (e.g. observations regarding the degree of exposure of the sites to wave action), species list of corals and other marine organisms, coral colony number, coral sizes, coral health status, and translocation feasibility of corals. The conservation status (including local, regional and international, such as China Redlist and IUCN Redlist) of the recorded biota was also provided.

10.2.4.6 Further to the above dive survey performed in 2009 for the present EIA study, a verification dive survey was also conducted in early 2013, to check and verify if there have been any changes in the baseline conditions of the coral communities previously surveyed.

Intertidal Survey

10.2.4.7 Intertidal surveys for epifauna communities were conducted coastlines within Junk Bay in particular the eastern shore where direct impacts from the Project are anticipated as well as nearby coastlines (see **Drawing no. 209506/EIA/MEC/002b**), covering both artificial coastlines and/or natural (if any) as well as hard and/or soft (if any) shore habitats, during both wet and dry seasons (August and November 2009). All intertidal surveys were conducted during suitable ebbing tides. In each location, horizontal transects (at least 50m in length) at three tidal levels (High, Middle and Low) were established. There were ten 0.5m x 0.5m quadrats on each transect. For hard shores, the epifauna in each quadrat were identified and their numbers/coverage percentages were recorded. For the soft shores, in addition to the epifauna, the infauna within the top 5cm sediment inside the quadrat as well as from one core (10cm diameter x 20cm depth) collected inside the quadrat would also be identified and recorded. Species and abundance of biota in quadrats were reported. Diversity index, evenness index and other statistical analyses should be provided for evaluating and ranking the ecological values.

10.2.4.8 In addition to the above quantitative surveys, suitable qualitative or walk-through surveys were also conducted in the Survey Area to facilitate the smooth implementation of the ecological survey and to help audit the survey findings (June 2009). Undertaking an initial observation along the shore, for example, could find out the species present and their occurrence and hence facilitate the determination of representative sites for conducting more detailed quantitative surveys. A walk-through survey along the transect during or after a quantitative sampling event could also help assess whether the sampling exercise has collected representative data (e.g. the number and type of species encountered) and whether the sampling effort is deemed adequate. Effort spent in such qualitative surveys, such as number of surveyors involved and time spent should be recorded and provided in the report as appropriate. Photos of the recorded species were taken where possible. The conservation status including local, regional and international, such as China Redlist and IUCN Redlist of the recorded biota were recorded.

10.2.4.9 Further to the above intertidal survey performed in 2009 for the present EIA study, a verification intertidal walk-through survey was also conducted in early 2013, to check and verify if there have been any changes in the general environments and intertidal communities in intertidal habitats.

Fish Survey

10.2.4.10 Philippine Neon Goby *Stiphodon atropurpureum* is a key issue in ecology of the present EIA as stipulated in the EIA study brief. This species inhabits lower to middle section of small to medium-sized streams close to the sea. It is also known that most species of this genus are diadromous. Adults live and breed (in the wet season) in pure freshwater sections of coastal streams, but the larvae would drift downstream into the sea, and remain close to the breeding streams and feed around the estuaries, before they reach juvenile stage and travel upstream to return the pure freshwater sections. While the intertidal survey and the benthic grab survey would provide information on the potential habitats and habitat use of this species, in addition to the survey required in the EIA Study Brief, a fish survey was conducted during wet season to strength the baseline data.

10.2.4.11 To address the special concern on the previously recorded fish of conservation interest, namely the Grassy Puffer Fish (*Takifugu niphobles*) and Philippine Neon Goby (*Stiphodon atropurpureus*), surveys on the fish communities were conducted along the coastline of the eastern Junk Bay (see **Drawing no. 209506/EIA/MEC/002b**). Fish survey techniques including direct field observation, active searching, fish cage-trapping and gill netting were employed to examine the diversity and abundance of fish species in the site. Special attention was paid to the possible occurrence of Grassy Puffer Fish and Philippine Neon Goby, or other species of conservation interest (if any).

10.2.4.12 The fish survey focused on searching for any potential habitats for the juvenile and adult stages of fish species of conservation interest, such as Philippine Neon Goby *Stiphodon atropurpureum* and Grassy Puffer Fish or any other notable fish species, mainly freshwater courses inside and near the Project Site (mainly the eastern shore of inner Junk Bay where the Cross Bay Link alignment goes through). If freshwater courses are identified during the survey, further surveys on adults and juveniles of fish species of conservation interest in the watercourses, as well as larvae of fish species of conservation interest in estuaries, would be conducted during both wet and dry seasons, to verify the habitat use of fish species inside and in the vicinity of the Project Site. The further survey, if required, would be conducted by active searching and direct observations at watercourses and water course outlets, and cage-trapping or net casting (subject to the site conditions) with particular attention on the presence of any fish species of conservation interest, such as Philippine Neon Goby *Stiphodon atropurpureum* and Grassy Puffer Fish or any other notable fish fauna. Boulders in the stream will be overturned to locate fish species beneath. Hand net will be used to collect organisms. All encountered fish species will be identified and recorded.

10.2.4.13 Samples from subtidal and estuary habitats were collected by fish cage-trapping and fish gill-netting to obtain quantitative data on fish abundance at 5 sampling points (G1 to G5, as shown in Figure 5). The mesh size of fish cage and gill-net were both smaller than 30 mm. At each sampling location, five fish cages were deployed to subtidal habitat for 2 hours, whilst 3 replicates of fish gill-netting were undertaken. All fish sampled were quantified and identified to the lowest taxonomic level whenever possible, and then returned to their natural habitat after identification works. Representative photograph of fish identified were taken.

Marine grab sample

10.2.4.14 Marine grab samplings on soft substrate seabed for benthic communities were conducted at 5 locations along the bridge alignment and one additional location on each side of the bridge alignment (see **Drawing no. 209506/EIA/MEC/002b**) during both wet season and dry season (July 2009 and December 2009), with particular attention on the presence of any amphioxus or any other notable marine benthos. Three grab sample replicas of 0.1m2 were collected in each of the sampling stations by van Veen Grab (or other sampling devices with equivalent surface area coverage). Collected samples were sieved by 0.5mm mesh-size sieve and then preserved in 5% buffered seawater formalin. Organisms inside the samples were sorted from the sediments by staining with Rose Bengal and then identified to the lowest practicable taxonomic level. Species composition, abundance and biomass were reported. Diversity index, evenness index and Abundance/Biomass Comparison (ABC) plots were provided for evaluating and ranking the ecological values. The conservation status including local, regional and international, such as China Redlist and IUCN Redlist of the recorded biota were recorded.

10.3 Ecological Baseline Conditions

10.3.1 Habitats

10.3.1.1 While the marine ecological assessment area covers 3 WCZs, the areas in the vicinity of the CBL alignment are considered more relevant with the impact assessment, and thus the habitat map would cover 500m distance from the CBL alignment (see **Drawing no. 209506/EIA/MEC/003**). As the Project includes construction of the marine section of CBL (in viaduct bridge form) across Junk Bay and its landing section at the artificial seawall at the eastern shore of Junk Bay, both marine waters and land areas are present in the vicinity of its alignment. But it should be noted that the construction works for the CBL would only be conducted in marine waters and the seawalls, and thus the impact assessment in later sections would concentrate on marine ecology only.

10.3.1.2 For the areas within a 500m distance from the CBL alignment, the majority of habitats are marine waters in Junk Bay and the developed areas/restored landfills on the eastern shore of Junk Bay. In their interfaces, there are intertidal habitats.

Table 10.1 Habitat types in the vicinity (500m distance) of the CBL alignment

Habitat types	Area (ha)/Length (m)
Marine waters	166 ha
Vertical Seawalls	929m
Sloping Seawalls	875m
Natural Coastlines	633m
Developed Areas/Restored Landfills	127 ha

10.3.2 Corals

10.3.2.1 Several dive surveys were previously conducted for EIA studies inside Junk Bay (covering the study area of Area 131, Tai Miu Wan and Fat Tong Chau), and hard and soft coral colonies were recorded during at least two dive surveys.

10.3.2.2 Most corals were found at the western coast of Junk Bay. None of the corals (both hard and soft corals) is considered rare. Examples of the recorded corals include Faviid corals, *Goniopora* spp., *Tubastrea* spp., Gorgonians and *Dendronephthys* spp.

10.3.2.3 Dive surveys within the footprint of the proposed WCR reclamation area in Chiu Keng Wan coastline as well as a 100m section of coastline to the south of the proposed reclamation was performed under the EIA Study for Further Development of TKO. Dive survey results revealed that most of the Chiu Keng Wan coast supported a low cover (in general about 1% cover) of octocorals (soft coral, seawhips and seafans) and a sparse cover (<1% cover) of hard corals. At the south of the dive survey area at the margin of the southernmost edge of the proposed reclamation area it was estimated that patches of octocoral reached up to about 10% cover. Results indicated that the Chiu Keng Wan coast supports a sparse cover of hard corals of species that are common and widespread across Hong Kong as well as patches of low to moderate cover of common and widespread soft and gorgonian corals.

10.3.2.4 Dive surveys were also conducted at Chiu Keng Wan for the TKO-LT Tunnel EIA study. Hard corals, gorgonians, soft corals, black corals and sea pen were recorded but all are commonly found in Hong Kong waters except three locally uncommon hard coral species, i.e. *Favia helianthoides*, *Montipora mollis*, and *Coscinaraea* sp.

10.3.2.5 In recent years soft and hard corals were also recorded in Victoria Harbour during survey for the Harbour Area Treatment scheme. They are potentially subject to indirect impacts from the proposed project.

10.3.2.6 In light of this, it was decided further ecological surveys were needed. In the present EIA study, a total of 5 species of corals (two species of hermatypic hard corals, one species of ahermatypic cup coral, one species of soft coral, and one species of gorgonian) and 13 species of other marine organisms were recorded during the dive survey. The recorded corals included hard corals and octocorals, but no black coral was found. All recorded hard coral species were either common (*Oulastrea crispata* and *Tubastrea* sp.), or dominant (*Porites lutea*) in Hong Kong waters, and the Soft coral *Dendronephthya* sp. and the Gorgonian *Echinomuricea* sp. was also common in Hong Kong. There was no species of conservation importance found during the dive survey.

10.3.2.7 Spot check dive survey was performed in various locations. Based upon the findings from spot dive survey, 2 REA transects of 100m length were laid within the study area, one covered the Project Site (the vertical seawall at the CBL landing point) and the other one covered a section of sloping seawall nearby. On these REA transects, the abundance of coral colonies was low. No rare or uncommon coral species was recorded on these REA transects. All these coral colonies were difficult to translocate with the substrate, as the boulders on the sloping seawalls and the blocks of the vertical seawalls were all of large sizes. Details on the methodology, location, results and discussion are provided in **Appendix 10.1**.

10.3.2.8 The results of the verification survey in early 2013 revealed that there was no obvious change in the baseline conditions of those coral communities. The detailed results of the verification dive survey are presented in **Appendix 10.5**.

10.3.3 Intertidal habitats

10.3.3.1 There are some natural coastlines between Lei Yue Mun and TKO town centre. Only a limited extent of natural intertidal habitats could still be found in the vicinity of TKO due to the rapid development in the recent years.

10.3.3.2 The rocky shore habitat at Chiu Keng Wan was surveyed under the EIA study of Further Development of TKO in the wet season of 2004. Rocky shore fauna along the Chiu Keng Wan coast comprised species typical of other semi-exposed rocky shores of eastern Hong Kong waters and followed typical vertical zonation patterns mediated by tidal exposure. On the high shore, fauna was dominated by Littorinid snails, while seaslaters, *Ligia exotica* were also present but very infrequent along the coast. At the mid-shore, assemblages were dominated by the limpet *Cellana toreuma*, and barnacles *Tetraclita* spp. and Common Top Shell *Monodonata labio*. On the low shore, rock oysters *Saccostrea cucullata* and mussels *Sepifera virigatus* dominated. Also occasionally seen close to the water's edge was the Common Rock Crab, *Grapsus albolineatus*.

10.3.3.3 The coastlines including rocky shore, sandy shores and artificial seawalls at Chiu Ken Wan were surveyed in wet and dry seasons in 2009 for the TKO-LT Tunnel EIA study. A total 67 taxa were recorded. The most frequently recorded species included Rock Oyster *Saccostrea cucullata*, Littorinid snails, Limpets, Barnacles, Sea Anemone, crabs and algae. All the recorded organisms were common and widespread in intertidal environment in Hong Kong.

10.3.3.4 In the present EIA study, a total of 17 taxa were recorded during the wet and dry season intertidal survey (including walk-through surveys and transect surveys). During the quantitative transect survey, a total of 10 taxa were recorded. The most frequently recorded species included littorinid snails *Echinolittorina malaccana* and *Echinolittorina radiata*, Rock Oyster *Saccostrea cucullata*, and Barnacle. All recorded taxa were common intertidal organisms in Hong Kong. No species of conservation importance was found and none of the species are listed in the IUCN Red List (IUCN 2009). Details on the methodology, location, results and discussion are provided in **Appendix 10.2**.

10.3.3.5 The results of the verification survey revealed that there was no obvious change in the coastline environment and the intertidal species occurred. The detailed results of the verification intertidal walk-through survey are presented in **Appendix 10.5**.

10.3.4 Benthic communities

10.3.4.1 During a territorial-wide benthic fauna survey conducted for AFCD, amphioxus *Branchiostoma belcheri*, which is a living fossil and the only benthic species considered of conservation concern in Hong Kong. This species is only recorded in limited locations in Hong Kong, mostly in Sai Kung and Port Shelter, but was also recorded in sampling stations in Tathong Channel near Junk Bay.

10.3.4.2 A benthic grab survey was conducted along the north west coast of Junk Bay (Chiu Keng Wan) under the EIA study of Further Development of TKO in 2004. In total, more than 600 infaunal individuals were enumerated from 15 grab samples, each of $0.1m^2$. Overall, the benthos was numerically dominated by the polychaetes (83.1%). The remaining portion comprised crustaceans (10.4%), sipunculids (2.5%), molluscs (1.7%), nermerteans (1.3%), phoronids (0.5%), echinoderms (0.2%), actinians (0.2%) and chordates (0.2%). 51 species of benthic fauna were found in the samples. In terms of diversity, the sampled benthic community off Chiu Keng Wan was considered to be of moderate diversity (average H’ = 2.49) in comparison to other benthic communities in Hong Kong. The survey results indicated that the soft substrata seabed off Chiu Keng Wan supported a disturbed benthic community of moderate diversity and of low abundance. No species of conservation interest were identified.

10.3.4.3 Benthic surveys were conducted for the on-going LT Tunnel EIA study at Chiu Keng Wan in wet and dry seasons of 2009. Three replicates from each of the four sampling stations were collected in each survey. A total of 94 and 149 specimens were collected in wet season and dry season respectively. 54 taxa were recorded, with the polychaetes dominated (35 species) followed by Crustaceans (over 11 species). The biodiversity of the benthic community in the survey area was between Eastern and Southern Waters and Deep Bay group, while the species evenness was higher than other areas in Hong Kong. These results indicated that the benthic community in the survey area was generally healthy and comparable to clean water bodies in Hong Kong.

10.3.4.4 In the present EIA study, benthic grab surveys were conducted at sampling stations along the proposed CBL alignment and in the nearby coastal waters. A total of 177 and 243 benthic organisms were recorded in the wet and dry season survey respectively. No species of conservation importance was found during the survey and none of the species are listed in the IUCN Red List (IUCN 2008). Details on the methodology, location, results and discussion are provided in **Appendix 10.3**.

10.3.5 Fish communities

10.3.5.1 The catadromous Philippine Neon Goby *Stiphodon atropurpureum* is an uncommon fish species in Hong Kong. It is only recorded in a few streams in North-East of New Territories and on Lantau Island. Catadromous fish would need to migrate between freshwater stream and the sea to complete their life cycle. To protect this species, it is important to maintain the access from their habitat to the sea.

10.3.5.2 Fish species of conservation interest, i.e. Grassy Puffer Fish *Takifugu niphobles*, and Neon Goby *Stiphodon atropurpureus* were previously recorded in TKO area by other previous studies. The construction of the proposed CBL might involve coastal construction works and might affect these fish species.

10.3.5.3 During the EIA study for Further Development of TKO, fish communities along the Chiu Keng Wan coast were reported. Fish recorded included the goby *Bathygobius fusca*, Doublebar cardinalfish *Apogon pseudotaeniatus*, juvenile grey mullet *Mugil cephalus*, Rockfish *Sebasticus marmoratus*, Russell's snapper *Lutjanus russellii*, White-spotted Rabbit fish *Siganus canaliculatus*, Chinese damselfish *Neopomacentrus bankieri*, Japanese seaperch *Lateolabrix japonicus*, Red Drum *Sciaenops ocellatus*, and the Grassy Puffer fish (also known as the Starry or Snowy Puffer) *Takifugu niphobles*. *Takifugu niphobles* is listed as 'data deficient' in the IUCN red list of threatened species. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate. As an intertidal spawner, *Takifugu niphobles* gathers at the water edge at dusk at the full or new moon when tidal heights are at their highest and strands in rock pools to spawn.

10.3.5.4 Fish surveys were performed in the coastal waters of Chiu Keng Wan in 2009 for the on-going LT Tunnel EIA study. A total of 12 fish species were recorded, mostly from coastal subtidal and intertidal areas while none from freshwater streams or estuarine areas. All species recorded are locally common and widespread in Hong Kong including *Siganus canaliculatus*, and *Bathygobius fuscus*.

10.3.5.5 In the present EIA study, fish surveys were performed to investigate the fish communities in the area. During the fish survey, the coastlines in the area were searched for stream courses and the nearby coastal waters were surveyed by baited traps and gill nets. A low diversity of fauna was recorded during the present fish survey in shallow waters. The two species of fish of concern were not recorded in the present study. No species of conservation importance was recorded during the survey. Details on the methodology, location, results and discussion are provided in **Appendix 10.4**.

10.4 Evaluation of Ecological Importance of Habitats and Species

10.4.1 Habitats

10.4.1.1 The ecological importance of different parts of the assessment areas are evaluated based primarily on the criteria set forth in Table 2, Annex 8 of the EIAO-TM:

(1) naturalness;

(2) size;

(3) diversity;

(4) rarity;

(5) re-creatability;

(6) fragmentation;

(7) ecological linkage;

(8) potential value;

(9) nursery/breeding ground;

(10) age; and

(11) abundance/richness of wildlife.

Table 10.2 Ecological value of different habitats within 500m from CBL

Criteria	Marine waters	Development Areas/Restored Landfills	Hard shore - Artificial seawalls	Hard shore - Rocky shore
Naturalness	Natural	Artificial	Artificial	Basically natural.
Size	166 ha	127ha	About 1.8 km	About 600m
Diversity	Low	Low	Low	Low
Rarity	Common habitat in Hong Kong	Common habitat in Hong Kong	Common habitat in Hong Kong	Common habitat in Hong Kong
Re-creatability	Not re-creatable.	Readily creatable	Readily creatable	Not re-creatable.
Fragmentation	Unfragmented.	Unfragmented.	Unfragmented.	Unfragmented.
Ecological linkage	Generally linked with the open sea.	No linkage is observed	Generally linked with the open sea.	Generally linked with the open sea.
Potential value	Low	Low	Low	Low.
Nursery/breeding ground	Potentially marine fauna breeding and/or spawning ground	No special nursery/breeding ground function observed	No special nursery/breeding ground function observed	No special nursery/breeding ground function observed
Age	N/A	Less than 30yrs.	N/A	N/A
Abundance/Richness of wildlife	Low	Low	Low	Low
Overall Ecological value	Low	Low	Low	Low

10.4.2 Species

General

10.4.2.1 In accordance with Table 3, Annex 8 of the EIAO-TM, the ecological value of species was assessed in terms of:

- Protection status,
- Species distribution, and
- Rarity.

10.4.2.2 Established coral communities of any size are regarded as important habitat types in Hong Kong as defined in Annex 8 of EIAO-TM.

10.4.2.3 Other than corals, there was no other species of conservation importance for the Project.

Table 10.3 Fauna Species of Conservation Importance

Species	Protection Status	Species Distribution	Rarity	Remarks
Oulastrea crispate ***Porites lutea*** ***Tubastrea*** sp.	Cap 586	On vertical seawall at the CBL landing area	Common and widespread in Hong Kong	Low coverage
Dendronephthya sp. ***Echinomuricea*** sp.	NA	On vertical seawall at the CBL landing area	Common and widespread in Hong Kong	Low coverage
Coral communities within Junk Bay	Cap 586	Mainly western coast of Junk Bay	Common and widespread in Hong Kong	Low coverage

10.5 Assessment Methodology

10.5.1 Identification of Impacts

10.5.1.1 The ecological impact assessment is aimed to protect, maintain and rehabilitate the natural environment.

10.5.1.2 The ecological impact assessment included:

(1) identification and quantification of any direct/indirect and on-site/off-site ecological impacts to foraging areas, breeding grounds, reduced survival of adult or juvenile wildlife;

(2) identification of parameters (e.g. water quality parameters) including any potential toxic contaminants released from the dredged sediment;

(3) evaluation of the identified impacts, caused by the construction and operation of the Project, such as habitat loss, water quality deterioration, underwater noise, bioaccumulation, marine collision, chemical spillage and disturbance;

(4) recommendations for mitigation measures; and

(5) review of the need for monitoring and to propose a monitoring and audit programme if needed.

10.5.1.3 The ecological impact assessment followed the criteria and guidelines for evaluating and assessing ecological impact as stated in Annexes 8 and 16 of the Technical Memorandum on Environmental Impact Assessment Process (EIAO-TM).

10.5.1.4 Potential aquatic and terrestrial and marine ecological impacts arising from the Project, including construction phase and operation phase, would be identified. Predicted impacts would be quantified as far as possible and evaluated with reference to the criteria in Annexes 8 and 16 of the EIAO-TM. Where significant negative impacts are predicted, based upon the priority of “avoid, minimize, and compensate”, the strategy followed the approaches as: the feasibility of modifications to the design, consideration of alternate sites or options, special controls on construction methods and schedule, or compensatory habitat creation or enhancement. The acceptability of residual impacts following mitigation was assessed. Finally, the assessment evaluated the need for ecological monitoring and audit, and prescribed in detail any required EM&A programme in accord with the Study Brief.

10.5.2 Criteria to Evaluate Impacts

10.5.2.1 The significance of ecological impacts was evaluated based primarily on the criteria set forth in Table 1, Annex 8 of the EIAO-TM:

(1) habitat quality;

(2) species affected;

(3) size/abundance of habitats/organisms affected;

(4) duration of impacts;

(5) reversibility of impacts; and

(6) magnitude of environmental changes.

10.5.2.2 The determination of the above first 3 items, namely "habitat quality", "species affected" and "size/abundance of habitats/organisms affected", made reference to the baseline conditions. "Duration of impacts" and "reversibility of impacts" are closely related to the nature of the impacts. Usually construction disturbance such as noise is regarded as a short-term impact. Temporary occupation of natural habitats can be reversible. In contrast, the occupation of space by the development itself is a permanent and irreversible impact. "Magnitude of environmental change" is determined by the scale of the projects, i.e. the extent of the works area and/or the degree of changes of the ambient environment. The abundance and/or distribution of the same kind of habitat in Hong Kong, or individuals of the same species, are also considered.

10.5.2.3 Impacts are generally ranked as "minor", "moderate" or "severe", although in a few cases a ranking of "insignificant" (less than "minor") may be given. The ranking of a given impact varies, based on the criteria listed above. Wherever possible, significance of impacts is quantified to allow ready appreciation of relative significance. Quantification is straight forward for certain types of impact, particularly habitat loss (usually measured in hectares).

10.5.2.4 Quantification of levels of ecological impact requires the application of professional judgement and value judgements, as noted in paragraph 5.3.1, Annex 16 of the EIAO-TM. Such judgements are often not amenable to quantification.

10.5.2.5 Nearby projects are assessed for potential cumulative impacts with the present project. The study team liaised with Mainland and Macao authorities, consultants of relevant feasibility studies, relevant departments/offices, and private and public organisations to address interfacing issues and cumulative environmental impacts.

10.5.3 Identification of Sensitive Receivers

10.5.3.1 Sensitive receivers of impacts are defined for this report as 1) species of conservation importance whose local, regional, or global populations would be expected to show the effects of reduced survivorship or productivity caused by the project. This implies that project-induced losses are predicted to exceed the range of fluctuation attributable to natural population variation; and 2) important habitats identified during the ecological baseline study to be within the study area, and have the potential to be affected indirectly by the project, for example, through deterioration of water quality. Such impact would normally be evaluated by the predicted magnitude of changes, e.g. extent of increase in suspended solids or other contaminants at the sensitive receivers.

10.5.4 Recommendation of Mitigation Measures

10.5.4.1 Impacts are assessed in the absence of mitigation. Efforts are made to identify feasible and practicable mitigation measures to reduce the severity of any significant negative impacts to acceptable levels. For the purposes of this EIA, "significant" is used to refer to impacts requiring mitigation and is applied to "moderate" and "severe" impacts, while "minor" and "insignificant” impacts do not require mitigation. Where significant negative impacts are predicted from the Project, mitigation responses are developed to “Avoid, Minimize and Compensate” for impacts in that order of priority. As stipulated in EIAO-TM, the study team, in consultation with the client, resolved impacts by first determining the feasibility to avoid impacts (modifications to project design, consideration of alternate sites or alignments). The second priority was to minimise impacts (refining the bridge design or alignment, special controls on construction methods and schedule). The third priority was to design measures to compensate for impacts (compensatory habitat creation or enhancement). Mitigation measures are provided in the ecological assessment to address the potential impacts identified. These measures are described in terms of their scope, programme, feasibility and financial implications during the construction and operation of the project. The acceptability of residual impacts following mitigation is assessed. Finally, the assessment evaluates the need for ecological monitoring and audit, and prescribes in detail any required EM&A programme in accord with the Study Brief.

10.5.4.2 Finally, the assessment concludes whether the mitigation measures envisaged could bring secondary impacts of the project and control them to within acceptable bounds. The acceptability of the overall residual ecological impacts is determined. Besides adverse impacts, potential benefits of the Project are also considered in the EIA.

10.6 Impact Identification and Evaluation

10.6.1 Construction Phase – Direct Impacts

Marine Habitat Loss (Soft substrate seabed and marine waters loss during construction)

10.6.1.1 The marine section of the CBL refers to the viaduct from the TKO-LT Tunnel to the shoreline of eastern Junk Bay. This section of viaduct is completely on open sea area and about 1.1km in length. No terrestrial or intertidal habitat will be affected by this section.

10.6.1.2 Furthermore, the dive survey and grab survey confirmed that the seabed in the open sea area is of soft substrate. Therefore no direct impact on coral communities on shallow subtidal hard substrate will be resulted from the open sea part of CBL.

10.6.1.3 The marine section CBL will be a viaduct supported by piers. Some physical loss of marine habitat (seabed and water column) will result from construction works at each location where piers are installed to support the bridge deck. The CBL marine section would be around 1.1km in length. There will be 12 pier sites, with the span ranging from 75m to 200m. At each pier site one single pier would be constructed for a y-shape column, to support the bridge deck.

10.6.1.4 At each pier site, piles would be bored through the seabed sediment to reach a solid (rock) substrate. Atop a concrete pile cap will be constructed (all pile caps would be above the seabed surface) to support the bridge pier. Each pile cap would be approximately 190 m^2 in size.

10.6.1.5 The size of the pile caps would be assumed as seabed loss in this assessment as a worst case; the actual footprint on the seabed will be piles supporting the piles above the seabed. The seabed area potentially lost at each pier location would be approximately 190 m^2. The total seabed loss due to the project footprint in the marine section of CBL would therefore be 12 piers x 190 m^2 = 2,280 m^2, i.e. 0.228 ha or less than 0.3 ha.

10.6.1.6 In addition to the loss of the seabed and water column due to the project footprint (these losses will become permanent habitat loss after completion of construction), works areas in each pier site will cause additional temporary loss of seabed and water column habitat.

10.6.1.7 To provide access for construction equipment and labour each pier construction site would include an area of works area which could be considered as temporary marine habitat loss: (i) 5m from the outer perimeter of the piers as a disturbance perimeter for coffer dam construction and silt curtain deployment. Thus the size of each pier construction site would be approximately (10.3+5+5 = 20.3m) x (18.4 +5+5 = 28.4m) = 576m^2. Of this pier-site works area, the area of temporary habitat loss would be 576 – 190 = 386m^2. The CBL marine section temporary marine habitat loss would be 12 pier sites x 386m^2 = 4,632m^2, i.e. 0.46 ha or less than 0.5ha.

10.6.1.8 The marine section of CBL would have small area of soft substrate seabed and marine waters loss (less than 0.3ha of permanent loss due to the footprint, and at any given time would not exceed 1ha). The results from the various previous studies and sampling in the present

EIA study indicated that the ecological values of the benthic communities on soft substrate seabed inside Junk Bay waters are similar, at low value. The marine habitat loss from the marine section of CBL is of small area and is scattered, thus the impact is considered as **insignificant**.

Marine Habitat Loss (Loss of Artificial Seawalls during construction)

10.6.1.9 After landing, CBL alignment will go alongside a section of 450m vertical artificial seawall on the eastern shore of Junk Bay in viaduct form or at-grade road form. It has been confirmed that on the vertical seawalls no direct encroachment will be caused by the viaduct and no improvement is needed for supporting the CBL, thus there will be no direct impact or loss on the intertidal fauna and the corals colonising the vertical seawalls.

10.6.1.10 No direct impact on the intertidal habitat or the corals would be expected on the vertical seawalls, and no mitigation is required.

Disturbance to benthic communities in the works areas

10.6.1.11 The areas of temporary marine habitat loss quantified above would not be occupied by the bridge structure after completion of construction. However, at these locations the seabed would be disturbed during construction and this could adversely affect benthic fauna.

10.6.1.12 Benthic communities are resilient to seabed disturbances. Whilst dredging destroys or degrades benthic habitats, recovery of benthos within several years, even months, after substrate disturbance is evident from many studies. Sampling station from previous marine borrow area (e.g. Station 24), showed relatively high species richness, numbers of individuals and biomass in the study commissioned by AFCD (CCPC 2002). This recovery is attributed to the rapid recolonisation of the disturbed area by nearby dominant and/or opportunistic benthic species. Because benthic communities are capable of quickly recovering after physical disturbance, this potential impact is considered **insignificant** in the present Project.

10.6.2 Construction Phase – Indirect Impacts

Marine Water Quality Deterioration

10.6.2.1 Large-scale dredging and filling works associated with reclamation are the major sources of water quality impacts in most marine projects. For the CBL however, there would be no reclamation and no dredging and thus significant water quality impacts have been avoided. Other activities/sources that may arise potential water quality impacts during the construction phase of the Project include:

(1) Pile excavation within cofferdam at pier construction sites; and

(2) Construction site runoff.

10.6.2.2 During pier construction works, the seabed sediment will be disturbed and sediment plume might form and release into the nearby waters. If the sediment plumes reach ecological sensitive receivers, there might be sedimentation and increase of suspended solid in these receivers, and/or reduction of DO due to the release of SS.

10.6.2.3 It is anticipated that the water quality impacts due to excavation works for CBL would be limited as the limited scale of the works for the Project (only 12 pier sites) and that no dredging will be carried out. In addition, pile excavation would be carried out within cofferdam using a closed-grab and silt curtain will be in place before the cofferdam is formed by sheet piling. The measures would effectively prevent any significant deterioration of water quality.

10.6.2.4 In the present EIA study, the water quality assessment considered both CBL project and the TKO-LT Tunnel project, which are connecting with each other, and the overlapping construction programme involving simultaneous marine works. Due to the nature of the marine works (TKO-LT Tunnel would involve reclamation), the two worst case scenarios were selected in the modelling (see **Section 8.5.3.6**) with major marine works of TKO-LT Tunnel (i.e. TKO-LT Tunnel reclamation only, as non-dredged method will be adopted in TKO-LT Tunnel). The marine works for TKO-LT Tunnel were considered the major contributing source of suspended solid.

10.6.2.5 The water quality assessment considered 16 water quality sensitive receivers (WSRs) relevant with marine ecology, including 13 for corals and 3 for amphioxus, representing records of coral communities and amphioxus. The modelling results showed that during the construction phase, none of these ecologically relevant WSRs would be adversely affected by suspended solid in both wet and dry season, including those closer to the Project Site such as CC1, CC2, CC3, CC4 and CC13) (see **Table 8.19** and **8.20**).

10.6.2.6 Besides SS, the WSRs on the western coast of Junk Bay (i.e. CC1, CC2, CC3, CC4 and CC13, closer to the TKO-LT Tunnel reclamation site) would also be subject to sedimentation (see **Table 8.21**, the predicted maximum daily sedimentation rates at major ecological sensitive receivers). It shows that the predicted rates at all these five receivers are much lower than the criterion of 100 $g/m^2/day$. Again, the major contribution of the sedimentation would be the other concurrent projects as Scenario 1a only showed very minor sedimentation. As the WSRs in Junk Bay would not exceed the criterion, other WSRs outside Junk Bay including the location with previous amphioxus in Tathong Channel (AM1) will not be impacted by sedimentation.

10.6.2.7 The oxygen depletion exerted by the SS elevation is calculated and presented in **Table 8-22**. It is anticipated that the oxygen depletion at most WSR including the five receivers for corals within Junk Bay will be less than 0.02 mg/L, which is less a detection limit of 0.1 mg/L. Thus the DO depletion of all sensitive receivers will be same as prevailing conditions.

10.6.2.8 Contaminants and nutrients might be released to the water column when sediment is contaminated and disturbed by marine construction works. Therefore, elutriate tests were conducted for CBL and TKO-LT Tunnel projects (see **Section 8.6.1.10** to **Section 8.6.1.15**). All the calculated concentrations of heavy metals, metalloid, TIN and UIA comply with the proposed criteria. Thus, adverse impacts due to release of contaminants on WSRs is not anticipated. As supported by the results from water quality modelling, the water quality impact on the hard and soft corals near the CBL alignment and other coral communities within Junk Bay is ranked as **Minor**.

10.6.2.9 Potential impacts to aquatic habitats and associated fauna from sedimentation due to surface runoff may also arise during the construction phase. Similarly in the case of dredging, elevated suspended solids levels caused by site runoff could increase the suspended solid load in the water bodies and could decrease dissolved oxygen levels. This may affect the survivorship of aquatic fauna, e.g. larvae of amphibian and dragonfly, or intertidal fauna. The result could be a temporary reduction in abundance of aquatic or intertidal life. However as there was only limited land-based construction works on eastern Junk Bay shore which lacks of aquatic/intertidal/subtidal habitats of ecological value, the potential impact from runoff to aquatic or marine communities would be **insignificant**.

10.6.2.10 There would be wastewater from construction activities, but there are requirements in site practice to ensure the proper collection and treatment of the wastewater. There is also an increased risk of small-scale oil or chemical (construction works solvent) spills from vessels due to the increased number of vessels working in the area. Because of the small volumes of such materials involved, this risk is considered **insignificant**.

Marine Traffic

10.6.2.11 Increased marine traffic during construction is not a concern for the Project as the Junk Bay area is not within the habitat range of the two resident cetaceans in Hong Kong, i.e. Chinese White Dolphin and Finless Porpoise. This potential impact is considered **insignificant**.

10.6.3 Operation Phase – Direct Impacts

Permanent Habitat Loss

10.6.3.1 After the construction of the Project, the temporary marine works areas will be self-restored, but the habitats occupied by the Project footprint would be permanently lost. The sizes of the permanent habitat losses have been calculated in the above sections for construction phase, i.e. less than 0.3 ha of seabed.

Marine Habitat Fragmentation

10.6.3.2 This impact is considered insignificant as CBL is in viaduct form and the pier foundations of CBL would only occupy a small proportion of sea area scattered along the bridge alignment. The pier foundations would not obstruct the movement of marine organisms across the bridge alignment as the span ranges from 75m to 200m and therefore would not cause fragmentation effects on them.

10.6.4 Operation Phase – Indirect Impacts

Changes in Hydrological Regime

10.6.4.1 As the marine viaduct of CBL will be a raised structure that would only slightly affect water flow, the bridge should not have any significant effect on the hydrodynamic regime of Junk Bay in general. The water quality of the area should not be significantly affected once construction is completed. The tidal flows simulations have been undertaken in order to obtain results for condition if the CBL and TKO-LT Tunnel had been built (i.e. “with” scenario), and if they were not implemented (i.e. “do-nothing” scenario) (see **Section 8.7.1.2**). By comparing the results from these simulations, the possible hydrodynamic impacts from CBL and TKO-LT Tunnel were assessed. The graphical presentations for flow velocity vectors and accumulated flows show an insignificant hydrodynamic impact with and without CBL and TKO-LT Tunnel. The water quality modelling results confirm that impact from the changes in hydrological regime due to the presence of CBL is ranked as **Insignificant**.

10.6.5 Cumulative impacts with other developments

TKO-LT Tunnel

10.6.5.1 The TKO-LT Tunnel project adjoins the CBL project and would involve construction works inside Junk Bay. There would be potential cumulative marine habitat loss and cumulative water quality impacts from this concurrent project.

10.6.5.2 The CBL water quality assessment has considered all concurrent projects, including both CBL project and the TKO-LT Tunnel project, and therefore has already included the cumulative water quality impact from TKO-LT Tunnel project.

10.6.5.3 TKO-LT Tunnel is a separate DP under the EIAO and hence a separate EIA study has been conducted by the project proponent to address all the impacts (including cumulative impacts) during both the construction and operational phases. Cumulative marine habitat loss impacts will thus also be addressed under the TKO-LT Tunnel EIA study.

10.6.5.4 According to the TKO-LT Tunnel EIA study report, direct marine ecological impacts during the construction phase of TKO LT-Tunnel include permanent loss of 3.6ha of seabed and temporary loss of 19ha of seabed. With the small area of seabed loss from CBL (less than 0.3 ha of permanent loss due to the footprint and 9.6 ha of temporary loss during a 9 month construction period), the cumulative marine habitat loss impacts caused by both CBL and TKO-LT Tunnel projects should be acceptable.

10.6.5.5 The water quality assessment undertaken for the CBL considered both CBL project and the TKO-LT Tunnel project, and has thus already considered the cumulative water quality impacts from TKO-LT Tunnel project. Accordingly, no further discussion on the cumulative water quality impacts is provided.

Other concurrent projects

10.6.5.6 Marine works due to Shatin Central Link, CLP Offshore Windfarm, Cruise Terminal, Trunk Road T2, and Submarine Gas Pipeline will be concurrent to the CBL and TKO-LT Tunnel projects.

10.6.5.7 According to the EIA Report for Submarine Gas Pipeline (EIA-182/2010) (Tables 3.20 and 3.21, Appendix B5), the plume envelope of cumulative impact due to Cruise Terminal, Trunk Road T2 and Submarine Gas Pipeline Relocation will not reach these WSRs. Therefore, that exceedance would be likely due to the concurrent marine works of Offshore Windfarm only. The cumulative suspended solid has been taken into account the Windfarm project (see **Section 8.6.1.3**) and the results are presented in **Tables 8.19** to **8.20**. A full compliance of SS levels at identified WSRs (including coral sites inside Junk Bay) was predicted due to CBL and TKO-LT Tunnel project and with cumulative projects.

Table 10.4 Construction and Operational Stage Impacts

Impact	Receiver	Habitat quality	Species affected	Size-abundance	Duration	Reversibility	Magnitude	Severity	Mitigation
Construction phase									
Soft substrate seabed and marine waters loss (Project footprint)	Seabed and Marine waters in Junk Bay	Low	Marine fauna	< 0.3 ha	Turn into permanent loss after completion	Irreversible	Small	Insignificant	No
Temporary soft substrate seabed and marine waters loss (works areas)	Seabed and Marine waters in Junk Bay	Low	Marine fauna	< 0.5 ha	Temporary, only during construction	Reversible	Small	Insignificant	No, benthos able to self-recolonisation
Water quality	Hard and soft corals near CBL alignment and other corals in Junk Bay	Low & low to moderate	Coral communities	Low marine fauna abundance inside Junk Bay	Temporary	Reversible	Small	Minor to insignificant	There would be site practice to protect water quality
Marine traffic	Marine waters in Junk Bay	Low	Marine fauna	Low marine fauna abundance inside Junk Bay	Temporary	Reversible	Small	Insignificant	Not required
Operational phase									
Permanent habitat loss	Marine waters in Junk Bay	Low	Marine fauna	<0.3 ha	Permanent	Irreversible	Small	Addressed above	Not required
Habitat fragmentation	Marine waters in Junk Bay	Low	Marine fauna	12 pier sites	Permanent	Irreversible	Small	No	Not required
Changes in hydrological regime	Marine waters in Junk Bay	Low	Marine fauna	12 pier sites	Permanent	Irreversible	Small	Insignificant	Not required

10.7 Mitigations of Adverse Impacts

10.7.1 Minimization

10.7.1.1 The span of the piers for CBL ranges from 75m to 200m. This span is larger than the normal 50m span for bridge structure. With the larger span a smaller number of piers are required and thus the number of marine construction worksites would be reduced. Therefore, associated impacts on marine habitat loss and marine water quality have been be minimised.

10.7.2 Mitigations

Habitat Loss

10.7.2.1 No specific mitigation is required for the seabed and marine habitat loss inside Junk Bay as the impact was ranked as insignificant. These areas are all of low ecological value.

10.7.2.2 No direct loss of artificial seawall habitat on the eastern Junk Bay shore will be caused as no improvement of the existing seawalls is required, and thus no mitigation is needed.

Water quality

10.7.2.3 No reclamation would be needed for CBL. The water quality impact would range only from insignificant to minor. Therefore the site practices and regular site runoff control measures would be sufficient to protect water quality.

10.7.2.4 Good site practices: it is recommended that the integrity and effectiveness of all silt curtains should be regularly inspected. Effluent monitoring should be incorporated to make sure that the discharged effluent from construction sites meets the relevant effluent discharge guidelines.

10.7.2.5 Site runoff control: for works on land, standard site runoff control measures should be established and strictly enforced to ensure that any discharge of contaminated or silt-laden runoff into marine waters is minimised.

10.8 Residual Impacts

10.8.1.1 The residual environmental impacts refer to the net environmental impacts after the implementation of mitigation measures, taking into account the background environmental conditions and the impacts from existing, committed and planned projects.

10.8.1.2 In some instance, measures have been incorporated into the design and/or construction methods (e.g. larger bridge spans to reduce the number of pier foundations) to provide an additional degree of confidence that any residual impacts is not expected to have long term environmental implications.

10.8.1.3 The losses of less than 0.3ha of marine soft substrate seabed and marine waters are considered acceptable.

10.8.1.4 With good site practices and site runoff control properly implemented, there will be no residual impacts on the marine fauna inside Junk Bay due to water quality because the majority of marine habitats will remain intact.

10.9 Monitoring and Audit

10.9.1.1 The water quality programme could also serve the purposes to protect the marine communities inside Junk Bay. No species ecological monitoring programme is needed.

10.10 Conclusion

10.10.1.1 There are no recognised sites of conservation importance (e.g. SSSIs, Country Parks and Marine Parks) inside Junk Bay, and there are no ecological sensitive areas (e.g. high value coral communities) inside or close to the CBL alignment.

10.10.1.2 The CBL would cause only limited (< 0.3ha) soft substrate seabed and marine waters loss. These habitat loss impacts ranked as insignificant due to the small size and low ecological value of the habitats.

10.10.1.3 Only limited marine water quality impacts are anticipated as only 12 pier sites would be needed for the CBL project and no reclamation will be undertaken. Other impacts are also minor or insignificant.

10.10.1.4 The residual impacts, mainly habitat loss, are considered acceptable. No species ecological monitoring programme is needed.

10.10.1.5 It is therefore concluded that the ecological impacts identified by assessment according to Annex 18 of the EIAO-TM would comply with criteria provided by Annex 8.

10.11 References

CityU Professional Services Limited (2002). *Final Report. Consultancy Study on Marine Benthic Communities in Hong Kong. (Agreement No. CE 69/2000).* Submitted to Agricultural, Fisheries and Conservation Department

M2 Environmental. 2000. *Tseung Kwan O Port Development at Area 131. Further Ecological Study*. Submitted to Territory Development Department.

Maunsell Consultants Asia Ltd., 2007. *Final Environmental Monitoring and Audit Manual for Kai Tak Development cum Design and Construction of Advance Works – Investigation, Design and Construction*. Submitted to Civil Engineering and Development Department.

Maunsell Consultants Asia Ltd., 2007. *Final Environmental Monitoring and Audit Manual for Wan Chai Development Phase II and Central-Wan Chai Bypass*. Submitted to Civil Engineering and Development Department.

Maunsell Consultants Asia Ltd. 2005. *Approved Environmental Impact Assessment Report: Further Development of Tseung Kwan O Feasibility Study*. Prepared for Civil Engineering and Development Department.

Maunsell Consultants Asia Ltd. 2005. *Final Topical Study Report: Western Coast Road Volume 1 (Text) Further Development of Tseung Kwan O Feasibility Study*. Prepared for Civil Engineering and Development Department.

Milicich and Co Ltd. 2001. *Coral Survey Report for Further Development of Tseng Kwan O Feasibility Study*. Submitted to Civil Engineering and Development Department.

Oceanway Corporation. 2003. *Field Diving Surveys of Corals for the Engineering and Feasibility Assessment Studies (EEFS) in relation to the Way Forward for the Harbour Area Treatment Scheme (HATS) (with permission).* Submitted to Environmental Protection Department.

Ryan, P.A. 1986. A new species of *Stiphodon* (Gobiidae: Sicydiaphiinae) from Vanuata. In *Indo-Pacific Fish Biology: Proceedings of the Second International Conference on Indo-Pacific Fishes*. Uyeno, T., Arai, R., Taniuchi, T. and Matsuura, K. (eds.), pp. 655-662. Icthyological Society of Japan, Tokyo.

Scott Wilson. 2001. *Final Environmental Impact Assessment Report: Tseung Kwan O Development Phase III Road P2 connecting Town Centre and Western Coast Road*. Submitted to Territory Development Department.

11 Fisheries Impact

11.1 Legislation and Standards

11.1.1 The HKSAR ordinances and regulations relevant to fisheries impact assessment of this Project include the following:

(1) Environmental Impact Assessment Ordinance ("the EIAO", Cap. 499) and the associated EIAO-TM;

(2) Fisheries Protection Ordinance (Cap. 171) and its subsidiary legislation, the Fisheries Protection Regulations;

(3) Marine Fish Culture Ordinance (Cap. 353) and associated subsidiary legislation;

(4) Water Pollution Control Ordinance (Cap. 358) and its supporting regulations and statements; and

(5) Marine Parks Ordinance (Cap. 476).

11.2 Methodology for Baseline Establishment

11.2.1 Assessment Area

11.2.1.1 The assessment area for Fisheries Impact Assessment (FIA) is generally the same as the marine water quality impact assessment area, includes the following three Water Control Zones (WCZ) within HKSAR (see **Drawing no. 209506/EIA/FSH/001**) as well as any areas likely to be impacted by the Project:

- the Junk Bay Water Control Zone,
- the Eastern Buffer Water Control Zone, and
- the Victoria Harbour Water Control Zone.

11.2.2 Sensitive Receivers

11.2.2.1 Key issues of the FIA required special attention, as stipulated in the EIA Study Brief, include but not limited to the following:

Fish Culture Zone

11.2.2.2 Tung Lung Chau Fish Culture Zone is about 4.2 km from the Project Site. There was no other designated fish culture zone inside the Fisheries Assessment Area.

11.2.3 Collection and Review of Relevant Information

11.2.3.1 Information on the assessment area was reviewed. A review of Government and private sector reports, independent of Government published literature and academic studies was undertaken to determine the existing conditions of fisheries in the assessment area, and to identify practices, areas and species of potential fisheries importance which may be affected by the Project. This review included but was not limited to the following: Relevant literatures/publications on the ecological information of the marine and fisheries study area (i.e. the Junk Bay, the eastern buffer and the Victoria Harbour Water Control Zones) and nearby areas were reviewed. Findings of relevant studies/surveys were reviewed, including:

- Port Survey 2006;
- AFCD annual reports;
- Other relevant reports from private sectors or Government.
- Baseline survey information conducted in EIA study- Further Development of Tseung Kwan O Feasibility Study
- Feasibility Study on the Alternative Alignment for the Western Coast Road, Tseung Kwan O
- Harbour Area Treatment Scheme
- Southeast New Territories Landfill Extension
- Kai Tak Development
- Consultancy Study on Fisheries and Marine Ecological Criteria for Impact Assessment (CCPC 2001);
- Fisheries Resources and Fishing Operations in Hong Kong Waters (ERM 1998);

11.2.3.2 Port Survey is the most comprehensive fisheries study conducted by AFCD every a few years. Different from the approach adopted in previous Port Surveys in which Hong Kong waters were divided into “Fishing Areas” of various sizes, a uniform grid was overlaid on

Hong Kong's waters for Port Survey 2006 and the fisheries related information (e.g. production, vessel number, catch value) was presented in several categories. In this FIA, the fisheries resources within the assessment area were evaluated based upon the information from Port Survey.

11.2.3.3 AFCD's annual reports provide the most updated information on the development and trend in Hong Kong fisheries. The latest annual fisheries production is also provided.

11.2.3.4 The validity of the information compiled during the literature review has been assessed before it is adopted into the present FIA study.

Data Gap Identification

11.2.3.5 Relevant studies and existing information have been thoroughly reviewed, including EIA- Further Development of Tseung Kwan O Feasibility Study (EIA-111/2005). Fisheries resources of concern were identified based on background information on the study areas, literature review results, and consultation with relevant government authorities. Based on the review results, it was found that there was no data gap and there was no need for field survey, and a complete picture of the fisheries resources of the study area could be produced.

11.3 Fisheries Baseline Conditions

11.3.1 Marine Environments

11.3.1.1 The assessment area for fisheries impact assessment is the same as the assessment area for marine water quality which covers three WCZs. The Project Site is located inside Junk Bay, within the transitional central zone of Hong Kong marine waters, to the west of the oceanic eastern waters (Morton & Morton 1983).

11.3.1.2 While the fisheries assessment area covers 3 WCZs, the areas in the vicinity of the CBL alignment inside Junk Bay are considered more relevant with the impact assessment. As the Project includes construction of the marine section of CBL (in viaduct bridge form) across Junk Bay and its landing section at the artificial seawall at the eastern shore of Junk Bay, both marine waters and land areas are present in the vicinity of its alignment. But it should be noted that the construction works for the CBL would only be conducted in marine waters and the seawalls.

11.3.2 Sites of Fisheries Importance

11.3.2.1 Fishing grounds cover most of the open waters in Junk Bay, while a portion of Victoria Harbour WCZ and Eastern Buffer WCZ is shipping fairways. The Project is a marine base project involving bridge piers, and would cause loss of fishing grounds in Junk Bay waters.

11.3.2.2 Besides the fishing grounds in Junk Bay waters, the following sites of fisheries importance are located near the Project Site within the boundary of the Fisheries Assessment Area and are shown in **Drawing no. 209506/EIA/FSH/001**:

- Tung Lung Chau Fish Culture Zone

11.3.2.3 No other designated or recognized sites of fisheries importance lie within the fisheries assessment area.

11.3.3 Capture Fisheries

11.3.3.1 The local fishing industry makes an important contribution to Hong Kong marine fish supply. In 2011, it produced an estimated 170,720 tonnes of fisheries production valued at $2,358 million. The industry now consists of some 4,000 fishing vessels and some 8,500 fishermen working aboard and provides employment in ancillary sectors servicing the fishing industry, such as fish wholesale and retail marketing, fuel and fishing gear supply and ice manufacturing (information from AFCD website).

11.3.3.2 Detailed data on recent HKSAR capture fisheries in the fisheries assessment area were taken from the results of Port Survey 2006. Port Survey is the most comprehensive fisheries study conducted by AFCD every a few years. The Port Survey consisted of an interview programme. About 36% of the local fishing fleet which accounted for all homeports (i.e. places at which local fishing vessels are based, 38 ports) and vessel types (10 types, including stern trawler, pair trawler, shrimp trawler, hang trawler, gill netter, long liner, hang liner, purse seiner, sampan and miscellaneous craft) was interviewed. During the interviews, particulars (e.g. vessel length, type and its homeport) of the fishing vessels were recorded and information about their fishing operations and fisheries production in Hong Kong waters was collected.

11.3.3.3 In earlier Port Surveys, Hong Kong waters were divided into fishing areas of various sizes and shapes, and these fishing areas were further grouped into 12 sectors. In the latest Port Survey in 2006, a uniform grid of 720ha cell size was overlaid on Hong Kong waters and the fisheries related information (e.g. production, vessel number, catch value) was presented in several categories. For easy reference, in the present FIA study the rows and columns of the grid are named by number and alphabetic order respectively, and a reference number is assigned to each cell (**Drawing no. 209506/EIA/FSH/002** to **Drawing no. 209506/EIA/FSH/006**).

11.3.3.4 Within HKSAR waters, the highest yields for local fisheries were mainly derived from the eastern and southern coasts as indicated in the distribution of overall fisheries production on adult fish (see **Drawing no. 209506/EIA/FSH/002**), while the marine waters inside the Fisheries Assessment Area for the present EIA study were comparatively less productive.

11.3.3.5 Within the Fisheries Assessment Area, there are some areas of higher production, inside Victoria Harbour and the Eastern Buffer Water Control Zone. But all these areas are all outside Junk Bay, far away from the Project and unlikely to be influenced by the Project.

11.3.3.6 There are four areas of relatively higher fish production in the Fisheries Assessment Area, including:

- Grid Cell N14
- Grid Cell O13
- Grid Cells Q15 and Q16
- Grid Cell Q18

11.3.3.7 Although the fisheries assessment area covers the above mentioned extent, it is anticipated that the focal area for capture fisheries issues would be the footprint of the Project itself (the bridge alignment). The CBL bridge alignment is located at Junk Bay. The majority of it falls within Grid Cells P13 and Q13.

11.3.3.8 In Port Survey, grid cells are categorised into one of the 6 classes, i.e. > 0-50 kg/ha; 50-100 kg/ha; 100-200 kg/ha; 200-400 kg/ha; 400-600 kg/ha; and 600-1000 kg/ha, in accordance with their overall adult fish production. For CBL, as reported in the Port Survey 2006 (see **Drawing no. 209506/EIA/FSH/002** and AFCD website), the catches from Grid Cells P13 and Q13 (the direct impact grid cells) were ranked low to moderate in Hong Kong (100-200 kg/ha). These figures demonstrate that the direct impact cells are of low to moderate importance to capture fishing operations in Hong Kong.

11.3.3.9 The results of Port Survey 2006 indicated that fry collection has become very limited and localized throughout Hong Kong waters. Fish fry production was concentrated in the eastern waters (Mirs Bay, Tolo Harbour and Channel, Port Shelter and Po Toi), with a smaller contribution from the East Lamma Channel (**Drawing no. 209506/EIA/FSH/003**). No fish fry production was recorded in the entire Fisheries Assessment Area.

11.3.3.10 The fishing operation in grid cells is also categorized into 6 classes, i.e. > 0-10 vessels; 10-50 vessels; 50-100 vessels; 100-400 vessels; 400-700 vessels; and 700-1,000 vessels. The production is mainly contributed by larger fishing vessels (> 15m in length). There was no fishing vessels longer than 15m operated in Grid Cell P13 and Q13 (**Drawing no. 209506/EIA/FSH/004**). While the small vessels (<15m) were much more common in these two grid cells (100-400 vessels, see **Drawing no. 209506/EIA/FSH/005**). Therefore no production from vessels over 15m in these two cells (**Drawing no. 209506/EIA/FSH/006**). If only considering the vessels below 15m in length, the production would be 100-200 kg/ha (**Drawing no. 209506/EIA/FSH/007**), same as the overall production.

11.3.3.11 The values of fish production range from HK$2,000 – 5,000 per ha in P13 and Q13 (**Drawing no. 209506/EIA/FSH/008**).

11.3.3.12 The marine waters inside the Fisheries Assessment Area were not identified as important spawning grounds of fish and shrimp during a fisheries study in Hong Kong (ERM 1998).

11.3.4 Culture Fisheries

11.3.4.1 As the Project is a marine base project and no fishpond will be directly or indirectly affected by the Project, pond fish culture is not an issue for the present FIA, and the culture fisheries would only focus on mariculture. The predominant type of mariculture in Hong Kong is marine fish culture which involves rearing of marine fish from fry or fingerlings to marketable size in cages suspended from floating rafts usually in sheltered coastal areas. Common species under culture include green grouper, brown-spotted grouper, giant grouper, Russell's snapper, mangrove snapper, red snapper, star snapper and pompano (Information from AFCD website).

11.3.4.2 Marine fish culture is protected and regulated by the Marine Fish Culture Ordinance (Cap. 353), which requires all marine fish culture activity to operate under licence in designated fish culture zones. Currently, there are 26 fish culture zones occupying a total sea area of 209 ha with some 1,008 licensed operators. In 2011, the production from local marine fish culture was 1,185 tonnes (of value HK$94 million), constituting 8% of the local demand for live marine fish (Information from AFCD website).

11.3.4.3 Water quality within Marine FCZs is regulated under the WPCO and its supporting regulations and statements. Within Fish Culture Subzones, the dissolved oxygen level should not be less than 5 mg per litre for 90% of the sampling occasions during the year; values should be calculated as water column average (arithmetic mean of at least 3 measurements at 1 metre below surface, mid-depth and 1 metre above seabed). In addition, the concentration of dissolved oxygen should not be less than 2 mg per litre within 2 metres of the seabed for 90% of the sampling occasions during the year, and the annual geometric mean of E. coli should not exceed 610/100 ml.

11.3.4.4 There are no Fish Culture Zones (FCZs) within the footprint for the Project or in the vicinity. Of the 26 gazetted FCZs zones in Hong Kong, only one occurs within the fisheries assessment area, i.e. Tung Lung Chau Fish Culture Zone (Information from AFCD website). Tung Lung Chau FCZ is about 4.2km to the southeast of the Project Site.

11.3.5 Fisheries Sensitive Receivers

11.3.5.1 Identified fisheries sensitive receivers include the following:

- Tung Lung Chau Fish Culture Zone

11.3.5.2 This fisheries impact assessment aims at providing sufficient and accurate data to allow complete and objective prediction and evaluation of the potential fisheries impacts. Desk-top study has produced a complete picture of the fisheries resources of the assessment area. The Port Survey and the consultancy study on fisheries resources have provided information sufficient for fisheries impact assessments in most EIA studies in Hong Kong SAR, and were considered adequate for assessment of impacts of the present Project. No data gap in fisheries baseline was identified in terms of fisheries assessment and therefore no field survey for fisheries was needed.

11.4 Assessment Methodology

11.4.1 Identification of Sensitive Receivers

11.4.1.1 Sensitive receivers of impacts are defined for this report as resources or sites of fisheries importance and potentially affected directly or indirectly by the Project. This implies that project-induced impacts are predicted to exceed the range of fluctuation attributable to natural variation.

11.4.2 Impact Identification and Assessment

11.4.2.1 Impacts have been assessed in the absence of mitigation. The construction and operational phase impacts on capture fisheries and culture fisheries activities have been assessed individually, then cumulatively, in combination with other existing, committed and proposed developments.

11.4.2.2 The fisheries impact assessment includes:

(1) identification of parameters (e.g. water quality parameters) and areas (e.g. breeding/spawning grounds and nursery grounds) that are important to fisheries and will be affected;

(2) identification and quantification of direct/indirect and on-site/off-site impacts to fisheries (e.g. loss of fishing grounds, reduction of catch/productivity, deterioration of water quality and pollution, if any, caused by surface run-off to mariculture activity);

(3) evaluation of impacts and recommendations for environmental mitigation measures with details on justification, scope

description and programme, feasibility as well as manpower and financial implications including those related to subsequent management and maintenance requirements of the proposals; and

(4) review the need for monitoring during the construction and operation phases of the Project and, if necessary, propose a monitoring and audit programme.

11.4.2.3 As stipulated in the EIA Study Brief, the FIA follows the criteria and guidelines for evaluating and assessing fisheries impact as stated in Annexes 9 and 17 of the TM.

11.4.2.4 The assessment covers potential impact on both capture and culture fisheries during the construction and operation of the Project, and in combination with any cumulative impacts caused by projects implemented simultaneous with or prior to the Project.

(1) description of the physical environmental background;

(2) description and quantification of existing capture fisheries, culture fisheries and oyster farming activities;

(3) description and quantification as far as possible of the existing fisheries resources (e.g. major fisheries products and stocks);

(4) identification of parameters (e.g. water quality parameters) and areas (e.g. breeding/spawning grounds and nursery grounds) that are important to fisheries and could be affected;

(5) identification and quantification of direct/indirect and on-site/off-site impacts to fisheries (e.g. loss of fishing grounds, reduction of catch/productivity, deterioration of water quality and pollution, if any, caused by surface run-off to mariculture sites);

(6) evaluation of impacts and recommendations for environmental mitigation measures with details of justification, description of scope and programme, feasibility as well as manpower and financial implications including those related to subsequent management and maintenance requirements of the proposals; and

(7) review of the need for monitoring during the construction and operation phases of the Project and, if necessary, proposals for monitoring and audit programmes.

11.4.3 Criteria to Evaluate Impacts

11.4.3.1 The significance of fisheries impacts was evaluated based primarily on the criteria set forth in Annex 9 of the EIAO-TM:

(1) Nature of impact,

(2) Size of affected area,

(3) Loss of fisheries resources/production,

(4) Destruction and disturbance of nursery and spawning grounds,

(5) Impact on fishing activity, and

(6) Impact on aquaculture activity.

11.4.3.2 Impacts are generally ranked as "minor", "moderate" or "severe", although in a few cases a ranking of "insignificant" (less than "minor") may be given. The ranking of a given impact varies, based on the criteria listed above. Wherever possible, significance of impacts is quantified to allow ready appreciation of relative significance. Quantification is straight forward for certain types of impact, particularly fishing ground loss (usually measured in hectares). Quantification of other types of impact such as those on fishing and aquaculture activities requires the application of professional and value judgment. Such judgment may not be amenable to quantification.

11.4.3.3 In the present FIA, impacts on capture fisheries was assessed by the extent of fishing ground loss during construction and operational phases, and potential decline in productions due to loss of fishing ground, interferences on fishing operations, and loss of fisheries resources. Impacts on culture fisheries were mainly assessed by the levels of changes of marine water quality presented in the Water Quality Assessment for the present EIA study.

11.4.3.4 Efforts would also be made to identify feasible and practicable mitigation measures required, which might be developed to reduce the severity of any negative impacts identified. These measures would be described in terms of scope, programme, feasibility and financial implications during the construction and operation of the project.

11.4.3.5 Finally, the FIA would conclude whether the mitigation measures could bring the negative impacts caused by the Project and its components within acceptable bounds.

11.4.3.6 Besides adverse impacts, potential beneficial influences brought by the Project, such as the additional hard substrate surfaces brought by the artificial rubble-mount seawalls, bridge piers and the associated rock armour protection which could provide similar functions as artificial reefs, would also be considered in the assessment.

11.4.4 Recommendation of Mitigation Measures

11.4.4.1 Impacts are assessed in the absence of mitigation. Efforts are made to identify feasible and practicable mitigation measures required, that might be developed to reduce the severity of any significant negative impacts to acceptable levels. These measures would be described in terms of their scope, programme, feasibility and financial implications during the construction and operation of the project.

11.4.4.2 Finally, the assessment concludes whether the mitigation measures envisaged could limit the negative impacts of the project and its components to within acceptable bounds. The acceptability of the overall residual impacts is determined.

11.5 Impact identification and evaluation

11.5.1 Construction Phase – Direct Impacts

Temporary and Permanent Fishing Ground Loss

11.5.1.1 The marine section of the CBL refers to the viaduct from the TKO-LT Tunnel to the shoreline of eastern Junk Bay. This section of viaduct is completely on open sea area and about 1.1km in length. No terrestrial or intertidal habitat will be affected.

11.5.1.2 The marine section CBL will be a viaduct supported by piers. Some physical loss of marine areas will result from construction works at each location where piers are installed to support the bridge deck. The CBL marine section would be around 1.1km in length. There will be 12 pier sites, with the span ranging from 75m to 200m. At each pier site one single pier would be constructed for a y-shape column, to support the bridge deck.

11.5.1.3 At each pier site, piles would be bored through the seabed sediment to reach a solid (rock) substrate. Atop a concrete pile cap will be constructed (all pile caps would be beneath seabed surface to maintain the vessel traffic and sea water flow) to support the bridge pier. Each pier would be 10.3m x 18.4m in size (i.e. approximately 190 m2).

11.5.1.4 The size of the piers would be assumed a seabed loss in this assessment. The seabed area to be lost at each pier site approximately 190m^2. The total seabed loss due to the project footprint in the marine section of CBL would be 12piers x 190 m2 = 2,280m^2, i.e. 0.228ha or less than 0.3ha.

11.5.1.5 In addition to the loss of the seabed and water column due to the project footprint (these losses will become permanent fishing ground loss after completion of construction), works areas in each pier site will cause additional temporary loss of seabed and water column habitat.

11.5.1.6 During the construction stage, at any given time about two thirds of the 1.1km marine section will have a restricted zone on 50m on either side to provide access for construction equipment and labour, which does not allow vessels to enter. These areas (9.6ha, 37m of the bridge breadth and 50m either side of the bridge, along the 700m of viaduct) will be occupied as marine works areas. Within the marine works area, no type of fisheries activity including capture fisheries would be possible during the estimated 9 months bridge construction phase. This would constitute a temporary loss of fishing grounds. The CBL marine section temporary fishing ground loss would be 9.6ha. The 9.6ha of works area would constitute a temporary loss of about 0.0058% of the 1,651km^2 of Hong Kong total marine waters (EPD 2005) which are mostly available for fishing. Given the small percentage of area affected and the temporary nature, this represents an insignificant impact to the capture fisheries in Hong Kong.

11.5.1.7 The marine section of CBL would have small area of fishing ground loss (less than 0.3ha of permanent loss due to the footprint, and 9.6ha for a 9 month construction period). The results from the Port Survey indicated that the fisheries production inside Junk Bay is low to moderate (100-200kg/ha), and thus the maximum loss from the less than 9.6ha would be less than 1,920kg per year. The fishing ground loss from the marine section of CBL is of small area and is scattered, thus the impact is considered as **insignificant**.

11.5.2 Construction Phase – Indirect Impacts

Marine Water Quality Deterioration

11.5.2.1 Large-scale dredging and filling works associated with reclamation are the major sources of water quality impacts in most marine projects. In the present Project however, there will be no reclamation and thus significant water quality impacts have been avoided. Other activities/sources that may arise to potential water quality impacts during the construction phase of the Project include:

(1) Pier site excavation works; and

(2) Construction site runoff.

11.5.2.2 During excavation, the seabed sediment will be disturbed, and sediment plume might form and release into the nearby waters. If the sediment plumes reach fisheries sensitive receivers such as Tung Lung Chau Fish Culture Zone, there might be sedimentation and increase of suspended solid in these receivers, and/or reduction of DO due to the release of SS.

11.5.2.3 It is anticipated that the water quality impacts due to excavation would be limited as the limited scale of excavation works for the Project (only 12 pier sites). In addition, closed-grab excavator and silt curtain for the excavation and filling would also be used. The measures would effectively prevent any significant deterioration of water quality. In the present EIA study, the water quality assessment considered both CBL project and the TKO-LT Tunnel project, which are connecting with each other and the construction programmes would therefore overlap. Thus, some of their marine works would be performed simultaneously. Due to the nature of the marine works (TKO-LT Tunnel would involve reclamation), the two worst case scenarios selected in the modelling (see **Section 8.5.3.6**) both involve major marine works of TKO-LT Tunnel (i.e. TKO-LT Tunnel reclamation only, as non-dredged method will be adopted in TKO-LT Tunnel). The water quality assessment considered 2 water quality sensitive receivers (WSRs) relevant with fisheries including Tung Lung Chau Fish Culture Zone and the much faraway Po Toi O Fish Culture Zone (it is outside the Fisheries Assessment Area), representing fish culture operations. The modelling results showed that during the construction phase, even the other WSRs closer to the Project Site (such as the coral sites inside Junk Bay) would not experience elevations of suspended solid in both wet and dry seasons even at the maximum value (see Table 8-19 & 8-20). And thus none of these fisheries relevant WSRs would be affected by suspended solid. During the excavation activities for CBL project and the reclamation for TKO-LT Tunnel project, contaminants and nutrients may be released to water column when sediment is contaminated and disturbed by marine construction works. Therefore, elutriate tests were conducted (see Section 8.6.1.10 to Section 8.6.1.15). All the calculated concentrations of heavy metals, metalloid TIN and UIA comply with the proposed criteria. Thus adverse impacts due to release of contaminants on WSRs is not anticipated. The water quality impact due to dredging is ranked as **Insignificant**.

11.5.2.4 Potential impacts to aquatic habitats and associated fisheries species from sedimentation due to surface runoff may also arise during the construction phase. Similar in the case of dredging, elevated suspended solids levels caused by site runoff could increase the suspended solid load in the water bodies, and could decrease dissolved oxygen levels. This may affect the survivorship of fisheries species. The result could be a temporary reduction in fisheries production. However as there was only limited land-based construction works on eastern Junk Bay shore, the potential impact from runoff to fisheries resources would be **Insignificant**.

11.5.2.5 There would also be wastewater from construction activities, but there are requirements in site practice to ensure the proper collection and treatment of the wastewater. There is also an increased risk of small-scale oil or chemical (construction works solvent) spills from vessels due to the increased number of vessels working in the area. Because of the small volumes of such materials involved, this risk is considered **Insignificant**.

Disturbance on Fishing Operation due to Marine Traffic

11.5.2.6 In the vicinity of the works areas, fishing operation might be disturbed by the increased marine traffic of working vessels for the Project. The disturbance impact however would be temporary. As the majority of fishing vessels operating in the vicinity are small-sized vessels (fishing vessels less than 15m in length), these small vessels would have higher flexibility in their operations and less sensitive to disturbance from marine traffic. Given the low fishing production in the vicinity, this temporary impact would be insignificant. No mitigation is required.

11.5.3 Operation Phase – Indirect Impacts

Changes in Hydrological Regime

11.5.3.1 As the marine viaduct of CBL will be a raised structure that will only slightly affect water flow, the bridge should not have any significant effect on the hydrodynamic regime of Junk Bay in general. The water quality of the area should not be significantly affected once construction is completed. The tidal flows simulations have been undertaken in order to obtain results for condition if the CBL and TKO-LT Tunnel had been built (i.e. "with" scenario), and if they were not implemented (i.e. "do-nothing" scenario) (see **Section 8.7.1.2**). By comparing the results from these simulations, the possible hydrodynamic impacts from CBL and TKO-LT Tunnel were assessed. The graphical presentations for flow velocity vectors and accumulated flows show an insignificant hydrodynamic impact with and without CBL and TKO-LTT. The water quality modelling results confirm that impact from the changes in hydrological regime due to the presence of CBL is ranked as **Insignificant**.

Restrictions on Fishing Activities

11.5.3.2 During operational phase, as there will be no marine restricted area for the CBL, fishing operations are basically not restricted by the operation of the Project. The spacing of the piers would be about 100m and would not restrict the operations of small fishing vessels dominated in the area.

11.5.4 Cumulative impacts with other developments

TKO-LT Tunnel

11.5.4.1 The TKO-LT Tunnel will adjoin the CBL and would also require construction works inside Junk Bay. There would be potential on cumulative fishing ground loss and cumulative water quality impacts from this concurrent project.

11.5.4.2 The CBL EIA study water quality assessment has considered all concurrent projects including both CBL project and the TKO-LT Tunnel project. Accordingly, cumulative water quality impact from the TKO-LT Tunnel project has been included.

11.5.4.3 TKO-LT Tunnel project is a separate DP under the EIAO and hence a separate EIA Study would be conducted by the respective project proponent to address all the impacts (including cumulative impacts) during both the construction and operational phases.

11.5.4.4 In accordance with the TKO-LT Tunnel EIA report, direct fisheries impacts during the construction phase of TKO-LT Tunnel include permanent loss of 3.6 ha of fishing ground and temporary loss of 19ha of fishing ground. There will be a small area of fishing ground loss due to CBL (less than 0.3 ha of permanent loss due to the footprint, and 9.6 ha of temporary loss during a 9 month construction period) and the cumulative fishing ground loss impacts caused both by CBL and TKO-LT Tunnel should be acceptable.

Other concurrent projects

11.5.4.5 Marine works due to Shatin Central Link, CLP Offshore Windfarm, Cruise Terminal, Trunk Road T2 and Submarine Gas Pipeline will be concurrent with the CBL and TKO-LT Tunnel projects.

11.5.4.6 According to the EIA Report for Submarine Gas Pipeline (EIA-182/2010) (Tables 3.20 and 3.21, Appendix B5), the plume envelope of cumulative impact due to Cruise Terminal, Trunk Road T2 and Submarine Gas Pipeline Relocation will not reach these WSRs. Therefore, that exceedance would be likely due to the concurrent marine works of Offshore Windfarm only. The cumulative suspended solid has been taken into account the Windfarm project (see **S8.6.1.3**) and the results are presented in **Tables 8-19** to **8-20**. A full compliance of SS levels at identified WSRs was predicted due to CBL and TKO-LT Tunnel project and with cumulative projects.

11.6 Mitigations of Adverse Impacts

11.6.1 Minimization

11.6.1.1 The span of the piers for CBL ranges from 75m to 200m. This span is larger than the normal 50m span for bridge structure. With the larger span, a smaller number of piers are required and thus the number of construction works would be reduced. Associated impacts on marine habitat loss and marine water quality would therefore be minimised.

11.6.2 Mitigations

Water quality

11.6.2.1 No reclamation would be needed for CBL. The water quality impact would range only from insignificant to minor. Therefore the site practices and regular site runoff control measures would be sufficient to protect water quality.

11.6.2.2 Good site practices: it is recommended that the integrity and effectiveness of all silt curtains should be regularly inspected. Effluent monitoring should be incorporated to make sure that the discharged effluent from construction sites meets the relevant effluent discharge guidelines.

11.6.2.3 Site runoff control: for works on land, standard site runoff control measures should be established and strictly enforced to ensure that any discharge of contaminated or silt-laden runoff into marine waters is minimised.

11.7 Residual Impacts

11.7.1.1 The residual environmental impacts refer to the net environmental impacts after the implementation of mitigation measures, taking into account the background environmental conditions and the impacts from existing, committed and planned projects.

11.7.1.2 In some instance, measures have been incorporated into the design and/or construction methods (e.g. larger bridge spans to reduce the number of pier foundations) to provide an additional degree of confidence that any residual impact would not be expected to pose long term environmental implications.

11.7.1.3 The loss of less than 0.3ha of fishing ground loss of low to moderate production is considered acceptable.

11.7.1.4 With good site practices and site runoff control properly implemented there would be no significant residual impacts on the fisheries resources and fishing operations inside Junk Bay due to water quality because the majority of marine habitats will remain intact.

11.8 Monitoring and Audit

11.8.1.1 The water quality programme could also serve the purposes to protect the marine communities inside Junk Bay. No specific fisheries monitoring programme is needed.

11.9 Conclusion

11.9.1.1 There is no fish culture zone or spawning and nursery grounds for fisheries species inside Junk Bay, or inside or close to the CBL alignment.

11.9.1.2 The CBL would cause only limited (< 1ha) loss of fishing ground of low to moderate production. These habitat loss impacts ranked as insignificant to minor due to the small size and low ecological value of the habitats.

11.9.1.3 Only limited marine water quality impacts are anticipated as only 12 pier sites are needed for the project and no reclamation will be performed. Other impacts are also minor or insignificant.

11.9.1.4 The residual impacts, fishing ground loss, are considered acceptable. No specific fisheries monitoring programme is needed.

11.9.1.5 It is therefore concluded that the limited fisheries impacts identified by assessment according to Annex 17 of the EIAO-TM would comply with criteria provided by Annex 9.

11.10 References

AFCD 2006. Port Survey 2006.

AFCD 2003. Artificial Reefs and Reef Fish in Hong Kong.

Arup 2002. Shenzhen Western Corridor – Investigation

CCPC 2001. Consultancy Study on Fisheries and Marine Ecological Criteria for Impact Assessment.

EPD 2005. 20 years of marine water quality monitoring in Hong Kong.

ERM 1998. Fisheries Resources and Fishing Operations in Hong Kong Waters.

ERM 2000. Study on Sustainable Development for the 21st Century: Environmental Baseline Survey on Terrestrial Habitat Mapping and Ranking Based on Conservation Value. Final Report to the Planning Department.

ERM 2005. New Contaminated Mud Marine Disposal Facility at Airport East / East Sha Chau Area.

Morton, R & B. Morton 1983. Seashore Ecology of Hong Kong. Hong Kong University Press.

12 Cultural Heritage Impact

12.1 Legislation and Standards

12.1.1 As the eastern end of the CBL will be constructed on the reclaimed land of Area 86A, there will be no land based cultural heritage impact. This study focuses on the marine archaeological impact.

12.1.1.1 In accordance with the EIA Study Brief, a Marine Archaeological Investigation (MAI) was commissioned to cover the seabed which would be impacted by the construction of the CBL. The aim of the MAI was to locate and assess the significance of any underwater cultural heritage which may be present on the seabed in the areas that will be impacted by the construction of the CBL and associated facilities, and recommend mitigation measures if found to be necessary.

12.1.1.2 The MAI covered the study area shown in **Figure 1** (in **Appendix 12.1**) marked as the alignment corridor. This included a significant buffer zone to allow for possible changes to the alignment and the impact of working vessels during construction.

12.2 Legislation and Standards

12.2.1 The following legislation is applicable to the assessment of archaeological and historic resources in Hong Kong.

(a) Antiquities and Monuments Ordinance
(b) Environmental Impact Assessment Ordinance
(c) Technical Memorandum on Environmental Impact Assessment Process
(d) Guidelines for Marine Archaeological Investigation

12.2.2 Antiquities and Monuments Ordinance

12.2.2.1 Legislation relating to antiquities is set out in the Antiquities and Monuments Ordinance (Chapter 53 of the Laws of Hong Kong), which came into force on 1 January 1976. The Antiquities and Monuments Ordinance provides statutory protection against the threat of development on Declared Monuments, historical buildings and archaeological sites to enable their preservation for posterity.

12.2.2.2 The Ordinance contains the statutory procedures for the Declaration of Monuments. The legislation applies equally to sites on land and underwater. The purpose of the Ordinance is to prescribe controls for the discovery and protection of antiquities in Hong Kong. A summary of the key aspects of the legislation relevant to the current study is presented below.

12.2.2.3 Human artefacts, relics and built structures may be gazetted and protected as monuments. The Antiquities Authority may, after consultation with the Antiquities Advisory Board (AAB) and with the Chief Executive's approval, declare any place, building, site or structure which the Antiquities Authority considers to be of public interest by reason of its historical, archaeological or palaentological significance.

12.2.2.4 The discovery of an Antiquity, as defined in the Ordinance must be reported to the Antiquities Authority (the Authority), or a designated person. The Ordinance also provides that the ownership of every relic discovered in Hong Kong after the commencement of this Ordinance shall vest in the Government from the moment of discovery.

12.2.2.5 No archaeological excavation may be carried out by any person, other than the Authority and the designated person, without a licence issued by the Authority. A licence will only be issued if the Authority is satisfied that the applicant has sufficient scientific training or experience to enable him to carry out the excavation and search satisfactorily, is able to conduct, or arrange for, a proper scientific study of any antiquities discovered as a result of the excavation and search and has sufficient staff and financial support.

12.2.2.6 Once declared a site of public interest, no person may undertake acts which are prohibited under the Ordinance, such as to demolish or carry on building or other works, unless a permit is obtained from the Antiquities Authority.

12.2.2.7 The Ordinance defines an antiquity as a relic (a moveable object made before 1800) and a place, building, site or structure erected, formed or built by human agency before the year 1800. Archaeological sites are classified into two categories, as follows:

- Declared Monument – those that are gazetted in accordance with Cap. 53 by the Antiquities Authority and are to be protected and conserved at all costs; and
- Recorded Archaeological Sites – those have not been declared but recorded by the AMO under administrative protection.

12.2.2.8 It should also be noted that the discovery of an antiquity under any circumstances must be reported to the authority, i.e. the Secretary for Development or designated person. The authority may require that the antiquity or suspected antiquity is identified to the authority and that any person who has discovered an antiquity or suspected antiquity should take all reasonable measures to protect it.

12.2.3 The Environmental Impact Assessment Ordinance

12.2.3.1 Since the introduction of the 1998 EIAO (Cap. 499, S16), the Antiquities and Monuments Office (AMO) have the power to request a MAI for development affecting the seabed. Its purpose is to avoid, minimise and control the adverse impact on the environment of designated projects, through the application of the EIA process and the Environmental Permit system. The EIAO stipulates that consideration must be given to issues associated with cultural heritage and archaeology as part of the EIA process. Annexes 10 and 19 of the EIAO-TM outline the criteria for evaluating the impacts on sites of cultural heritage and guidelines for impact assessment, respectively.

12.2.3.2 The EIAO-TM identifies a general presumption in favour of the protection and conservation of all sites of cultural heritage and requires impacts upon Sites of Cultural Heritage to be ‘kept to a minimum’. There is no quantitative standard for determining the relative importance of sites of cultural heritage, but in general sites of unique, archaeological, historical or architectural value should be considered as highly significant.

12.2.4 Technical Memorandum on Environmental Impact Assessment Process

12.2.4.1 The general criteria and guidelines for evaluating and assessing impacts to Sites of Cultural Heritage are listed in Annexes 10 and 19 of the EIAO-TM. It is stated in Annex 10 that all adverse impacts to Sites of Cultural Heritage should be kept to an absolute minimum and that the general presumption of impact assessment should be in favour of the protection and conservation of all Sites of Cultural Heritage. Annex 19 provides the details of scope and methodology for undertaking Cultural Heritage Impact Assessment, including baseline study, impact assessment and mitigation measures.

12.2.5 Guidelines for Marine Archaeological Investigation

12.2.5.1 The AMO have issued Guidelines for MAI which detail the standard practice, procedures and methodology which must be undertaken in determining the marine archaeological potential, presence of archaeological artefacts and defining suitable mitigation measures. The methodology set out in the Guidelines has been followed for this investigation.

12.3 Description of Existing Environment

12.3.1 At the commencement of the project there were no known underwater archaeological resources within the study area which is called the alignment corridor. There are two accurately located modern shipwrecks within Tseung Kwan O Bay, but these are outside the study area and of no archaeological significance.

12.4 Cultural Heritage Resources

12.4.1 There are no cultural heritage resources on the seabed within the study area.

12.5 Assessment Methodology

12.5.1 In accordance with Antiquities and Monuments Office (AMO) Guidelines, the MAI comprised six tasks:

- Task 1: Marine Archaeological Review of previous studies relevant to this project;
- Task 2: Baseline Review to assess the archaeological potential of the study area from a desk based review of existing literature;
- Task 3: Geophysical Survey data analysis to obtain detailed information about the seabed and sub-surface sediments;

- Task 4: Establish archaeological potential and assess the location and significance of any seabed features requiring further investigation and evaluation;
- Task 5: Diver inspection of seabed features;
- Task 6: Assess the impact of the construction of the Cross Bay Link on archaeological resources, if present, and recommend a mitigation strategy, if necessary.

12.5.2 Marine Archaeological Review

12.5.2.1 Extensive research was conducted to locate all previous studies relevant to the MAI.

12.5.3 Baseline Review

12.5.3.1 The aim of the Baseline Review is to compile a comprehensive inventory of cultural heritage resources in the Study Area. It is not an exhaustive chronological history of the area.

12.5.3.2 The Review established the historical profile and potential for cultural heritage sites and included:

- Publications on local historical, architectural, anthropological, archaeological and other cultural studies
- Unpublished papers, records, archival and historical documents held in local libraries and other government departments

12.5.4 Archive Search

12.5.4.1 All archives holding information on shipwrecks in Hong Kong and UK were explored for relevant data.

12.5.5 Geophysical Survey

12.5.5.1 The Geophysical Survey was conducted in 2003 by the Institute of Geophysical and Geochemical Exploration. As the previous survey covered the present study area, it was possible to re-use the data. **Figure 2** (in **Appendix 12.1**) shows the survey coverage and the CBL MAI study area. **Figure 3** (in **Appendix 12.1**) shows the 2004 MAI study area.

12.5.5.2 SDA Marine returned to the original report and extracted the data relevant to this study rather than use the interpretation presented in the 2004 MAI.

12.5.6 Survey Specifications

12.5.6.1 The following equipment was deployed:

- DF32000MK II Echo Sounder
- Valeport VLR740 Automatic Tide Logger
- NT-s00D DGPS Differential Signal Receiver
- Season TRACKER Navigation System
- Delph Seismic Reflection System
- EPC-1086 Printer
- Bar Check Plate
- Side Scan Sonar System – Edge Tech 560A

The survey equipment was used to survey a grid 25m x 25m which ensured 100% coverage of the study area.

12.5.7 Visual Diver Survey

12.5.7.1 The aim of the diver inspection was to locate 8 seabed targets and establish their archaeological potential. The diver survey was completed on the 28th and 29th September and 10th and October 2009.

12.5.7.2 A team of four divers worked from a sampan. Each target was located using Differential Global Positioning (DGPS). The boat was positioned above each target and a shot weight was placed on the seabed marked by a buoy on the surface as shown in **Figure 4** (in **Appendix 12.1**). The drop position was checked against the target position on a digital chart. The diver then used this shot weight as the centre point of circular searches at 0m, 3m, 5m, 10m, 15m and 20m radius from the shot weight.

12.5.7.3 The diver was equipped with a hand held video camera to record the contact and associated seabed features. A metal probe was used to look for buried objects. The video had a remote TV monitor in the boat's wheelhouse which displayed the video footage in real time. This facilitated managing the diver from the surface via the through water communications.

12.6 Construction Phase Assessment

12.6.1 Marine Archaeological Review

12.6.1.1 The following reports were examined in detail to extract the data directly relevant to the current study and define the scope of additional work needed.

2000. Marine Archaeological Investigation. Road P2 of Tseung Kwan O Development. Prepared for the Antiquities and Monuments Office. SDA Marine Ltd.

12.6.1.2 A comprehensive MAI was completed. The Baseline Review established high potential for shipwrecks based on documented historical evidence. The results can be applied to the current study as they cover the whole of Tseung Kwan O Bay.

12.6.1.3 The Geophysical Survey data was not relevant to the current study as it only covered a small section in the North West corner of Tseung Kwan O Bay which is outside the alignment corridor.

2003. Further Development of Tseung Kwan O Feasibility Study. Geophysical Surveys and Water Sampling (Term Contract). Contract No. GE/2001/20. Agreement CE87/2001 (GE). Institute of Geophysical and Geochemical Exploration, MCR, PRC.

12.6.1.4 IGGE were appointed by GEO to complete the Site Investigation. The objectives of the survey were 'to determine the sub-seabed stratum to map features (anomalies), manmade objects on or beneath the seabed within the study area' (Page 1).

12.6.1.5 The study area is shown in Figure 2 (in **Appendix 12.1**) and the alignment corridor for the Cross Bay Link has been added to show that there is 100% coverage of the current study area.

12.6.1.6 The survey included echo sounding, side scan sonar and seismic profiling. The data was of sufficiently high resolution to be used for the MAI.

2004. Further development at Tseung Kwan O – Feasibility Study. Agreement Number CE 87/2001. Marine Archaeological Investigation. Assessment of Archaeological Potential. Task 3. Archaeo-environments Ltd.

12.6.1.7 This study was commissioned in 2004 to cover the Cross Bay Link and Western Coast Road projects. The study area is shown in **Figure 3** (in **Appendix 12.1**). As it includes the current study area the results can be directly applied to this project.

12.6.1.8 The MAI comprised a Baseline Review and analysis of Geophysical Survey data to establish archaeological potential.

12.6.1.9 The Baseline Review confirmed high archaeological potential based on historical evidence. The review is mostly a summary of the 2000 SDA Marine Report for Road P2 which is summarised in Section 12.6.2 below.

12.6.1.10 The analysis of the geophysical survey concluded that there were a number of unidentified objects which the report recommended should be inspected by divers. The inspection was not carried out.

12.6.2 Baseline Review

12.6.2.1 The Baseline Review completed in 2000 by SDA Marine Ltd for Road P2 of Tseung Kwan O Development under contract to the Antiquities and Monuments Office covers the same study area as the current project. It is therefore possible to re-use this information and a summary is provided below.

Maritime Activity in the Vicinity the Study Area

12.6.2.2 Tseung Kwan O, also known as Junk Bay, is located at the eastern entrance to Victoria Harbour. The entrance is sometimes called Fat Tong Mun (Temple Entrance or Temple Gate). The area got its name due its popularity as a resort for Chinese junks and sampans in the past, because of its relatively sheltered position during typhoons. The villages that formerly skirted the coast of Junk Bay, Hang Hau (Stream Mouth), Yau Yue Wan (Cuttlefish Bay), Tseung Kwan O (Military General’s Rocky Entrance), Pak Shing Kok (Hundred

Victories Cape) now far inland, were all at one time on the coast. Junk Bay was originally much larger and more extensive than it is today as reclamations have filled in the bay (Davis, 1949).

Early Maps of Junk Bay

12.6.2.3 In pre-British times Junk Bay was shown (as Fat Tong Mun) in the Cheng Ho navigation map of the China coast in 1425 AD. This map is believed to be based on the earlier map Mau K'un map executed from 1422-1430 AD by his grandson Mau Yuen-I, published in a book called Mo Pei Chi (Notes on Military Preparation, published in 1621 (Empson, 1992)). The map indicates the routes taken by vessels of a 15th century Imperial Chinese fleet under the command of Admiral Cheng Ho.

12.6.2.4 There are references to Junk Bay in a 1723 map of Kwang Tung produced by Chiang Ting Sik in his book called Ku Kam To Shu Chap Sing. It is also positioned in 'Map of the entire coastline' by Chan Lun Kwing in his book Hoi Kwok Man Kin Luk (A Record of the Countries of the Sea, printed in Ngai Hoi Chu Chan in 1744 (Figure 5 in Appendix 12.1) (Empson, 1992).

12.6.2.5 The Kang Hsi Emperor commissioned the Jesuit Fathers to undertake a detailed map of China, which was reprinted in part in 1737. The Jesuit map relies heavily on pre-existing Chinese maps of coastal waters. Hong Kong waters are charted in this map, found in Nouvelle Atlas de la Chine, published in Paris in 1737. Further reference appears in the San On Yuen Chi a cartogram from the 1819 Directory of San On County, wherein Hong Kong is located (Figure 6 in Appendix 12.1). Another Chinese map of Kwangtung Province, dated from 1820, reportedly the work of a Taoist priest, clearly identifies Junk Bay (Empson, 1992).

12.6.2.6 A good subsequent Chinese map that records the south-eastern waters of Victoria Harbour is of San On District, in the 1864 edition of the Sun On Gazetteer (**Figure 7** in **Appendix 12.1**).

12.6.2.7 These maps are particularly important as they indicate that Junk Bay was established as a known coastal settlement from the 15th century.

Although there is no documentary material recording what took place there the fact it merited mapping is significant.

12.6.2.8 The first map which clearly depicts Hong Kong harbour in detail is an 1810 marine chart (**Figure 8** in **Appendix 12.1**). This chart was prepared for the East India Company by Daniel Ross and Philip Maughan, Lieutenants of the Bombay Marine.

12.6.2.9 On the signing of the Treaty of Chuen-pi in 1841, HMS Sulphur, commanded by Captain Sir Edward Belcher, was commissioned to undertake a hydrographic survey of Hong Kong Island and the surrounding waters. Produced in the meticulous style typical of the Royal Navy, this chart is remarkable for its accuracy and detail. It takes into account depth soundings in a number of areas, which still form the basis of charts in unchanged areas (Morse, 1926). In this map, Junk Bay is clearly detailed up to the further reaches of Tseung Kwan O which remain uncharted. Junk Island is clearly delineated, and Joss House Bay is likewise charted (**Figure 9** in **Appendix 12.1**).

Pirate Activity in Junk Bay

12.6.2.10 Piracy was a persistent problem in Hong Kong waters. Detailed documentary material provides evidence for intense activity in the Junk Bay (Lo, 1963). Of particular relevance to the current study are the activities of the pirate leader Chêng Lien-ch'ang. He and his brother, based on Lantau, had been part of a pirate force that gained a victory over government troops at Kwangtung in 1619 AD. Following this victory Chêng Lien-ch'ang entrenched himself in the hills behind Lei Yue Mun. 'Because of his devilish cunning and his love of fighting' (Lo, 1963), the hill where Chêng Lien-ch'ang encamped came to be called Devil's Peak. He also built on the shore of Lei Yue Mun a Tin Hau temple which is still in active use today. Behind the temple was a secret cave in Devil's Hill used as the hiding place for his plunder.

12.6.2.11 Historical documents record that all of the seven sons of Chêng Lien-ch'ang followed his father's profession of piracy. After his death the eldest son, Chêng I, assumed leadership, sharing with Kuo P'o-tai and Wu Shih-êrh the title of 'The Three Buccaneers of the South Seas'. Eventually Chêng I encountered a typhoon while crossing the sea to attack lands to the south and was drowned. The six hundred ships based at Lei Yue Mun passed into the hands of his wife, who continued to resist the combined action of the Imperial Navy and the Portuguese fleet based at Macau. Eventually she was forced to yield to the mercy of the Government when both Kuo P'o-tai and Chang Pao-tsai surrendered to the Imperial Authority (Murray, 1987).

Maritime Trade

12.6.2.12 The whole Junk Bay area has a long history as a shipping corridor and trade route. From the Sung Dynasty (960-1279) onwards, a constant and rich traffic of trading junks sailed along the coast of Guangdong province carrying goods from the ports of northern China to Guangzhou at the mouth of the Pearl River. The strait between Tung Lung Island and the mainland is called Fat Tong Mun or Buddha Temple Entrance. This was one of the main entrances to the harbour and during the Sung Dynasty, a stone pagoda was built to guide ships (Lo, 1963).

12.6.2.13 Another important indicator of the intensity of shipping and piracy activities is the fort on Tung Lung Island overlooking the Fat Tong Mun Channel (Lui, 1990). The Ching Dynasty (1644-1911) naval station of Tung Lung is situated on the north east of Tung Lung Island. Tung Lung is also known as Tam Long Chau or Southern Temple Island and there are temples both to the north and south of Fat Tong Mun (Williams, 1976).

12.6.2.14 The Tung Lung fort was one of a number of garrisons established during the late Ming and early Ching dynasty to protect coastal shipping from pirates. The fort itself was built during the Kang Hsi period (1662-1722) as part of the anti-Ming loyalist anti-pirate activity of that period (Nixon, 1980).

12.6.2.15 Piracy remained an active threat in Hong Kong waters during the 19th Century. L.C. Arlington, who spent six years between 1893-9 in charge of a Customs Station on Kowloon, wrote in his autobiography:

> *'During my time in Kowloon territory piracies were so common that we regarded it as extraordinary if a day passed without one. Indeed, it was the daily routine for junk masters to report at the Customs Station that they had been pirated and all their cargo looted'* (Hayes, 1983).*'*

Chinese Maritime Customs Station

12.6.2.16 In the Qing Dynasty (1644-1911), vessels passing through Fat Tong Mun and Tathong Channels stopped at a customs station on Fat Tong Chau or Junk Island, before proceeding west to the Pearl River delta. It is located with strategic significance at the eastern exit of the harbour. In April 1979, following the recovery of pieces of a broken pillar, the Antiquities and Monuments Office undertook a brief survey of the area (Bard, 1980). Broken stones, rubble, tiles and grey bricks were found and granite-slab steps with remains of door hinges were uncovered. At the south end two column bases were discovered. This material indicated that an imposing structure had stood on the site. Large boulders, clearly deliberately aligned, were observed at low tide about the centre of the beach. It was suggested that these could be the remains of a large wooden pier or slipway.

12.6.2.17 After the signing of the Treaty of Tientsin in 1858, Chinese Maritime Customs Stations were established at Ma Wan, Cheung Chau, Lai Chi Kok and at Junk Island. Armed Maritime Customs cruisers regularly patrolled the waters nearby looking for contraband (Sayer, 1975). The Maritime Customs station was closed, along with the others in the immediate vicinity of Hong Kong, after the Second Convention of Peking in 1898. The Maritime Customs Station buildings gradually fell into disrepair after they were abandoned.

12.6.3 Archive Search

12.6.3.1 The UK Hydrographic Office (UKHO) holds a database of surveyed shipwrecks in Hong Kong, including those not shown on Admiralty Charts.

12.6.3.2 Admiralty Chart number 3279 (**Figure 10** in **Appendix 12.1**) shows two shipwrecks close to the study area. Further information about these wrecks was obtained from the (UKHO) who undertook the original surveys of the wrecks.

12.6.3.3 At position 22o 17' 07.4" N, 114o 14' 47.6" E there is a shipwreck (Hydrographic Office reference number 111303151) in 15 m of water with wreckage standing up to 5.1 m above the seabed. The origin of the wreck is unknown. The site was surveyed in October 1997.

12.6.3.4 At position 22o 16' 59.7" N, 114o 14' 46.4" E there is a shipwreck (Hydrographic Office reference number 111303138) in 21.8 m of water with wreckage standing 8.2 m above the seabed. The origin of the wreck is unknown. The site was surveyed in October 1997.

12.6.3.5 Although these wrecks lie just outside the study area, their presence could be significant. Both wrecks had considerable amounts of material still present on the seabed. This indicates that the seabed environment has not caused the wrecks to break up despite the fast currents in the area and their proximity to the main shipping lane. There are only 49 charted shipwrecks in Hong Kong waters and it is significant to note that two lie close to the study area.

12.6.3.6 The UK Hydrographic Office was contacted again in June 2009 to get an update on the status of the wrecks. Both wrecks have now been cleared as they represented a possible navigation hazard.

12.6.3.7 The UKHO holds old navigation charts of the study area. The 1907 chart is presented as **Figure 11** (in **Appendix 12.1**). This chart is particularly interesting as it shows the study area before any reclamation has taken place.

12.6.4 Geophysical Survey

12.6.4.1 The results presented below are from a new interpretation of the data and are not the same as the results presented in the 2004 Archaeo-Environments report. This was to ensure that the results were directly relevant to this study.

Side Scan Sonar Data

12.6.4.2 A total 18 unidentified objects were found during the survey. Of these, five are situated within the alignment corridor.

12.6.4.3 The details are set out in the table below and a copy of the data showing each object is presented in **Figures 12 to 15** (in **Appendix 12.1**). The descriptions of the objects on the data were made by IGGE and are from a site investigation rather than archaeological perspective. It was not possible to make an accurate identification until a diver survey was carried out.

Table 12.1 Unidentified Objects from Side Scan Sonar Survey

Unidentified Object No.	Easting	Northing	Size (m x m)
601	845449.11	817003.99	17.2 × 18.5
1601	845266.47	817219.21	3.8 × 2.2
1603	845044.54	817212.27	1.8 × 2.2
1801	844545.68	817316.71	12.3 × 16.7
Target 1	844670.34	817300.21	Described in the 2004 MAI as an isolated debris field. No dimensions were given.

12.6.4.4 Target 1 is a feature that was identified by Archaeo-environments as having archaeological potential. The survey data for this feature was not available or included in the Archaeo-environments report. As it was highlighted to have archaeological significance and it is within the study area, it was included in the list of targets and was inspected by the diving team.

Seismic Profiler Data

12.6.4.5 A total of 19 unidentified objects were located within the survey area of which 3 are within the alignment corridor. The details of each one are set out in the table below and the data is presented as **Figures 16-18** (in **Appendix 12.1**). On the data, the descriptions were provided by IGGE and are from a site investigation rather than archaeological perspective.

Table 12. 2 Unidentified Objects from Seismic Profiler Survey

Unidentified Objects No.	Easting	Northing
EW06-38	844900.7754	816995.04
EW09-36	845124.1938	817068.70
EW26-29	844635.9042	817490.44

Seabed Stratigraphy

12.6.4.6 Most of the surface sediments are mud and fine sand with some evidence for dumped construction debris. **Figure 13** (in **Appendix**

12.1) shows some of these materials and **Figure 14** (in **Appendix 12.1**) shows evidence for anchor scars.

12.6.4.7 Geological analysis of the seabed sediments indicates the presence of a good preservation environment for archaeological resources. At 200m from the western edge of the survey area the Marine Deposit is 10m thick increasing to 13m in the centre of the bay. The maximum thickness of the Marine Deposit is 18m towards the eastern end of the study area. The Marine Deposit is called the Hang Hau Formation and consists of very soft silty mud in which archaeological resources could be buried.

12.6.4.8 The top of the Alluvium throughout the rest of the study area is relatively flat with two linear north-south running depressions identified in the centre and eastern part of the study area. These may be evidence of Pleistocene watercourses.

12.6.4.9 **Figure 19** (in **Appendix 12.1**) shows a section across a vibro core which was taken from within the study area which demonstrates the seabed stratigraphy.

12.6.5 Archaeological Potential

12.6.5.1 The location of each of the unidentified objects was plotted onto the alignment corridor. This is presented as **Figure 20** (in **Appendix 12.1**). It can be seen clearly that 8 of the unidentified objects are located within the alignment corridor. A diver inspection was required of each one within the study area to establish its archaeological significance.

12.6.6 Visual Diver Survey

12.6.6.1 The diving team successfully located every target. They were all identified as being modern dumped rock, identical to that seen in the rubble mound seawalls surrounding the study area.

12.6.6.2 The seismic profiler contacts EW09-36 and EW06-38 were located using the probe. The divers were able to assess that each object was a stone block.

12.6.6.3 Additional surveys were made of sonar contacts SN35-75, EW02-31 and EW-2-24. These all lie outside the MAI study area but could be impacted if there was a significant change to the alignment. They were therefore inspected as a precaution. Each of them was also found to be modern dumped rock.

12.7 Operational Phase Assessment

12.7.1.1 As the MAI did not locate any evidence for underwater cultural heritage resources there will be no impact arising during the operational phase.

12.8 Residual Environmental Impacts

12.8.1.1 There will be no residual environmental impacts.

12.9 Conclusion

12.9.1.1 A comprehensive Marine Archaeological Investigation was completed which followed exactly the methodology set out by the Antiquities and Monuments Office and Annexes 10 and 19 of the TM-EIAO. The study did not locate any cultural heritage resources. The diver survey indicated that in many areas the seabed had been disturbed by previous construction work.

12.9.1.2 Therefore, there is no further action or mitigation required.

13 Landscape and Visual

13.1.1 Introduction

13.1.1.1 This chapter outlines the landscape and visual impact assessment associated with the CBL.

13.1.1.2 The assessment includes:

- a definition of the scope and contents of the study, including a description of the assessment methodology;
- a review of the relevant planning and development control framework;
- a review of comments received during earlier public consultations and how these comments have been addressed in the design;
- a baseline study providing a comprehensive and accurate description of the baseline landscape resources, landscape character areas and visual sensitive receivers (VSRs);
- identification of the potential landscape and visual impacts and prediction of their magnitude and potential significance, before and after the mitigation measures;
- recommendation of appropriate mitigation measures and associated implementation programmes; and
- an assessment of the acceptability or otherwise of the predicted residual impacts, according to the five criteria set out in Annex 10 of the EIAO-TM.

13.1.1.3 The landscape and visual impact assessment follows the criteria and guidelines as stated in Annexes 10 and 18 of the EIAO TM. Colour photographs showing baseline conditions, and photomontages and illustrative materials supporting conclusions are provided and the locations of all key viewpoints shall be clearly mapped. Photomontages at representative locations provide comparison between existing views, proposals on day 1 after completion without mitigation measures, on day 1 after completion with mitigation measures, and in year 10 after completion with mitigation measures in accordance with EIAO Guidance Note No. 8/2010.

13.1.1.4 In accordance with Consultancy Brief Clause 6.24.4, the Working Paper on Landscape and Visual Impact Assessment was circulated in September 2010 to facilitate early resolution of critical issues and preparation of the draft EIA report which is circulated for comment on 28 April 2011 and 12 November 2012 under letter ref. 209506/5.13/SYC/PC/HL-561 and 209506/5.13/SYC/EL/CN-826 respectively. Meeting also undertaken on 14 December 2012 to discuss various comments and issue has been addressed in the EIA report and updated in this chapter.

13.2 Legislation, Standards and Guidelines

13.2.1.1 The methodology for undertaking the landscape and visual impact assessment is in accordance with Annex 10 and 18 of the Technical Memorandum on Environment Impact Assessment Process, the EIAO Guidance Note No. 8/2010 and the EIA Study Brief No. ESB-196/2008. Legislation, standards and guidelines applicable to this assessment are as follows:

- Environmental Impact Assessment Ordinance (Cap.499.S.16) and the Technical Memorandum on Environmental Impact Assessment Process (TM), particularly Annexes 10 and 18;
- Hong Kong Planning Standards and Guidelines (HKPSG) (Ch. 4, 10 & 11)
- EIAO Guidance Note No. 8/2010 on Preparation of Landscape and Visual Impact Assessment under the EIAO;
- WBTC No. 7/2002 - Tree Planting in Public Works;
- ETWB TCW No. 3/2006 – Tree Preservation;
- ETWB TCW No. 29/2004 – Registration of Old and Valuable Trees, and Guidelines for their Preservation;
- ETWB TCW No. 11/2004 – Cyber Manual for Greening;
- ETWB TCW No. 2/2004 – Maintenance of Vegetation and Hard Landscape Features;
- WBTC No. 25/92- Allocation of Space for Urban Street Trees;
- WBTC No. 36/2004- Advisory Committee on the Appearance of Bridges and Associated Structures (ACABAS);
- ETWB TCW No. 10/2005- Planting on Footbridges and Flyovers;
- ETWB TCW No. 34/2003 on Community Involvement in Greening Works

- ETWB TCW No. 5/2005 on Protection of natural streams/rivers from adverse impacts arising from construction works
- Town Planning Ordinance and Town Planning (Amendment) Ordinance (Cap.131);
- Country Park Ordinance (Cap. 208)
- Forests and Countryside Ordinance (Cap.96)
- Protection of Endangered Species of Animals And Plants Ordinance (Cap 586)
- Related Statutory Plans, e.g. Outline Zoning Plans;
- Landscape Value Mapping Study in Hong Kong.

13.3 Assessment Methodology

13.3.1.1 Landscape and visual impacts have been assessed separately for the construction and operation phases.

13.3.1.2 The assessment of landscape impacts has involved the following procedures:

- ***Identification of the baseline landscape resources and landscape character areas found within the study area.*** This is achieved by site visit and desktop study of topographical maps, information databases and photographs.
- ***Assessment of the degree of sensitivity of the landscape resources and landscape character areas and the classification (rating) of sensitivity and each landscape resources and landscape character area.*** This is influenced by a number of factors including:
  - quality and maturity of landscape resources/characters;
  - importance and rarity of special landscape elements;
  - whether the landscape resources are considered to be of local, regional, national or global importance;
  - whether there are any statutory or regulatory limitations/requirements relating to the landscape resources/characters; and
  - ability of the landscape resources/characters to accommodate change.

13.3.1.3 The sensitivity of each landscape resource and character area is classified as follows:

High:	Important landscape or landscape resource of particularly distinctive character or high importance, sensitive to relatively small changes.
Medium:	Landscape or landscape resource of moderately valued landscape characteristics reasonably tolerant to change.
Low:	Landscape or landscape resource of low valued landscape characteristics highly tolerant to change.

- ***Identification of potential sources of landscape impacts during construction and operation phases.*** These are the various elements of the construction works and operation procedures that would generate landscape impacts.
- ***Identification of the magnitude of change and the classification (rating) of the magnitude of change for all landscape resources and landscape character areas.*** The magnitude of the impact (or magnitude of change) depends on a number of factors including:

scale of development;

– compatibility of the project with the surrounding landscape;

– duration of impacts, i.e. whether it is temporary (short, medium or long term), under construction and operation phases; and

– reversibility of change.

13.3.1.4 The magnitude of landscape impacts is classified as follows:

Large:	The landscape or landscape resource would suffer major change. (beneficial or adverse)
Intermediate:	The landscape or landscape resource would suffer moderate change. (beneficial or adverse)
Small:	The landscape or landscape resource would suffer slight or barely perceptible change. (beneficial or adverse)
Negligible:	The landscape or landscape resource would suffer no discernible change.

- ***Significant threshold of potential landscape impact (before mitigation) during construction and operation.*** By synthesising the magnitude of the various impacts and the sensitivity of the various landscape resources it is possible to categorise impacts in a logical, well-reasoned and consistent fashion. **Table 3.1** shows the rationale for dividing the degree of significance into four thresholds, namely insubstantial, slight, moderate, and substantial, depending on the combination of a negligible-small-intermediate-large magnitude of impact and a low-medium-high degree of sensitivity of landscape resource/character.

Table 3.1 Relationship between Receptor Sensitivity and Impact Magnitude in Defining Impact Significance

<table>
<tr><td rowspan="6">Magnitude of Impact (Both beneficial and adverse impact are assessed)</td><td>Large</td><td>Moderate</td><td>Moderate / Substantial</td><td>Substantial</td></tr>
<tr><td>Intermediate</td><td>Slight / Moderate</td><td>Moderate</td><td>Moderate / Substantial</td></tr>
<tr><td>Small</td><td>Slight</td><td>Slight / Moderate</td><td>Moderate</td></tr>
<tr><td>Negligible</td><td>Insubstantial</td><td>Insubstantial</td><td>Insubstantial</td></tr>
<tr><td rowspan="2"></td><td>Low</td><td>Medium</td><td>High</td></tr>
<tr><td colspan="3">Receptor Sensitivity (of Landscape Resource, Landscape Character Area or VSR)</td></tr>
</table>

- ***Identification of potential landscape mitigation measures.*** Mitigation measures may take the form of
  - adopting alternative design or revisions to the basic engineering or architectural design to prevent and/or minimize adverse impacts;
  - remedial measures such as colour and textural treatment of physical, engineering and building features; and
  - compensatory measures such as the implementation of landscape design measures (e.g. tree planting, creation of new open space etc) to compensate for unavoidable adverse impacts and to attempt to generate potentially beneficial long term impacts.

13.3.1.5 A programme for the mitigation measures is provided and discussed in Section 13.7. The agencies responsible for the funding, implementation, and maintenance of the mitigation measures are proposed in Table 7.1 and Table 7.2.

- ***Significant threshold of residual impact after the implementation of the mitigation measures during Construction and Operation: Day 1 and Year 10.*** The level of residual impact is derived from the magnitude of change which the proposed works will cause to the existing landscape resources or landscape character areas and the ability of the LRs and LCAs to tolerate change, i.e. the quality and sensitivity of the LRs and LCAs, taking into account the beneficial effects of the proposed mitigation measures. The significance threshold is derived from the matrix shown in **Table 3.1**.
- ***Prediction of Acceptability of Impacts.*** An overall assessment of the acceptability, or otherwise, of the impacts according to the five criteria set out in Annex 10 of the EIAO TM as below:

Beneficial	The proposed works will complement the landscape and visual character of its setting, follow the relevant planning objectives, and improve overall and visual quality.
Acceptable	There will be no significant effects on the landscape, no significant visual effects, and no interference with the key views due to the proposed works.
Acceptable with Mitigation Measures	There will be some adverse effects due to the proposed works, but the adverse effects can be eliminated, reduced or offset to a large extent by the proposed mitigation measures.
Unacceptable	There will be the adverse effects that are considered too excessive and are unable to mitigate practically.
Undetermined	Significant adverse effects are likely, but the extent to which they may occur or may be mitigated cannot be determined from the study. Further detailed study will be required for the specific effects in question.

13.3.1.6 The assessment of visual impacts has involved the following:

- ***Identification of Zones of Visual Influence (ZVIs) during the construction and operation phase of the project.*** This is achieved by site visit and desktop study of topographic maps and photographs, and preparation of cross-section to determine the visibility of the project from various locations.
- ***Identification of Visual Sensitive Receivers (VSRs) within the Zone of Visual Influence (ZVIs) at construction and operation***

phases. These are the people who would reside within, work within, play within, or travel through, the ZVIs.

- ***Assessment of the degree of Sensitivity of the VSRs.*** Factors considered include:
  - the type of VSRs, which is classified according to whether the person is at home, at work, at school, at play, or travelling. Those who view the impact from their homes are considered to be highly sensitive as the attractiveness or otherwise of the outlook from their home will have a substantial effect on their perception of the quality and acceptability of their home environment and their general quality of life. Those who view the impact from their workplace and at school are considered to be only moderately sensitive as the attractiveness or otherwise of the outlook will have a less important, although still material, effect on their perception of their quality of life. The degree to which this applies depends on whether the workplace is industrial, retail or commercial. Those who view the impact whilst taking part in an outdoor leisure activity may display varying sensitivity depending on the type of leisure activity. Those who view the impact whilst travelling on a public thoroughfare will also display varying sensitivity depending on the speed of travel.
  - other factors which are considered (as required by EIAO GN 8/2010) include the number of individuals, value and quality of existing views, the availability and amenity of alternative views, the duration or frequency of view, and the degree of visibility.

13.3.1.7 The sensitivity of VSRs is classified as follows:

High:	The VSRs are highly sensitive to any change in their viewing experience.
Medium:	The VSRs are moderately sensitive to any change in their viewing experience.
Low:	The VSRs are only slightly sensitive to any change in their viewing experience.

- ***Identification of relative numbers of VSRs.*** This is expressed in term of whether there are few, medium or many VSRs in any one category of VSR.

- ***Identification of potential sources of visual impacts.*** These are the various elements of the construction works and operation procedures that would generate visual impacts.
- ***Assessment of the potential magnitude of visual impacts.*** Factors considered include
  - the compatibility with the surrounding landscape;
  - the duration of the impact;
  - the reversibility of the impact;
  - the scale of the impact and distance of the source of impact from the viewer; and
  - potential blockage of view.

13.3.1.8 The magnitude of visual impacts is classified as follows:

Large:	The VSRs would suffer major change in their viewing experience.
Intermediate:	The VSRs would suffer moderate change in their viewing experience.
Small:	The VSRs would suffer small change in their viewing experience.
Negligible:	The VSRs would suffer no discernible change in their viewing experience.

- ***Identification of potential visual mitigation measures.*** These may take the form of adopting alternative designs or revisions to the basic engineering and architectural design to prevent and/or minimise adverse impacts, remedial measures such as colour and textural treatment of building features, landscape and visual enhancement and tree planting to screen the roads and associated bridge structures. A programme for the mitigation measures is provided and discussed in **Section 7**. The agencies responsible for the funding, implementation, maintenance of the mitigation measures are identified and their approval-in-principle has been sought.
- ***Prediction of the significance of visual impacts before and after the implementation of the mitigation measures.*** By synthesising the magnitude of the various visual impacts and the sensitivity of the VSRs, and the numbers of VSRs that are affected, it is possible to categorise the degree of significance of the impacts in a logical, well-reasoned and consistent fashion. **Table 3.1** shows the

rationale for dividing the degree of significance into four thresholds, namely, insubstantial, slight, moderate and substantial, depending on the combination of a negligible-small-intermediate-large magnitude of impact and a low-medium-high degree of sensitivity of VSRs.

13.3.1.9 The significance of visual impacts is categorised as follows:

Substantial:	Adverse / beneficial impact where the proposal would cause significant deterioration or improvement in existing visual quality.
Moderate:	Adverse / beneficial impact where the proposal would cause noticeable deterioration or improvement in existing visual quality.
Slight:	Adverse / beneficial impact where the proposal would cause barely perceptible deterioration or improvement in existing visual quality.
Insubstantial:	No discernible change in the existing visual quality.

- ***Prediction of Acceptability of Impacts.*** An overall assessment of the acceptability, or otherwise, of the impacts according to the five criteria set out in Annex 10 of the EIAO TM as below.

Beneficial	The proposed works will complement the landscape and visual character of its setting, follow the relevant planning objectives, and improve overall and visual quality.
Acceptable	There will be no significant effects on the landscape, no significant visual effects, and no interference with the key views due to the proposed works.
Acceptable with Mitigation Measures	There will be some adverse effects due to the proposed works, but the adverse effects can be eliminated, reduced or offset to a large extent by the proposed mitigation measures.
Unacceptable	There will be the adverse effects that are considered too excessive and are unable to mitigate practically.
Undetermined	Significant adverse effects are likely, but the extent to which they may occur or may be mitigated cannot be determined from the study. Further detailed study will be required for the specific effects in question.

13.3.1.10 It is assumed that funding, implementation and maintenance agency of the mitigation measures can be satisfactorily resolved according to the principles in ETWB 3/2006. All mitigation measures in this report are practical and achievable within the known parameters of funding, implementation and maintenance agency. The suggested agencies for the funding and implementation (and subsequent maintenance, if applicable) are indicated in Table 7.1 and 7.2. Approval-in-principle to the implementation and maintenance of the proposed mitigation measures is being sought from the appropriate authorities.

13.4 Scope and Content of the Study

13.4.1 Limits of the Study Area

13.4.1.1 The study area for the landscape impact assessment will include all areas within 500m from the works boundary as indicated in Drawing no. 209506/EIA/LV/1101. If landscape resources at distance of about 500m are identified to be affected by the construction and operation of the project, the assessment area will be expanded to include LRs further outside the proposed area. In such case, the extent of the expanded assessment area will be agreed with EPD separately.

13.4.1.2 The area for the visual impact assessment shall be defined by the visual envelope of the Project and associated works during the construction and operation phases. The defined visual envelope is illustrated in Drawing no. 209506/EIA/LV/1101.

13.4.2 Project Description

13.4.2.1 CBL is a dual two-lane carriageway of approximately 1.8 km long across Junk Bay to connect the proposed TKO-LTT in the west and Area 86 developments in the east, mainly on viaduct, and connecting TKO-LTT to Wan Po Road at the south eastern part of TKO. CBL will form a vital alternative route between southeast TKO and Kowloon via TKO-LTT, by-passing TKO town centre. The viaduct section of CBL has a cycle track and a footpath in addition to the road carriageway. The proposed CBL is in relatively close proximity to the proposed Northern Bridge (NB) and Southern Bridge (SB), which will be located at the Eastern Channel of TKO. The project details, implementation programme, alignment options and construction descriptions are discussed in Chapter 1-4 of the draft EIA report, which is submitted for comments on 28 April 2011 and 8 November

2012 under letter ref. 209506/5.13/SYC/PC/HL-561 and 209506/5.13/SYC/CN-822. This assessment will cover the CBL main bridge only.

13.4.2.2 CBL will be a prominent feature seen by the developments around Junk Bay including Area 86 and TKO town centre south, the latter being one of the locations where the next phase of development in TKO will take place. The Feasibility Study for Further Development of Tseung Kwan O concluded that future development would implement a reduced development density and the building profile will be stepped towards the waterfront.

13.4.2.3 Junk Bay is a quiet bay located to the east of Victoria Harbour. In addition to CBL two new footbridges located at the Eastern Channel, Southern Bridge (SB) and Northern Bridge (NB), are being planned. Since CBL is in close proximity to SB and NB, the three bridges could be viewed as a family of bridges and the coherency in their design will greatly enhance the townscape of the area.

13.4.2.4 The design of CBL main bridge was selected out of several alternative design scenarios by competition and public consultation progress. The criterion for the selection was based on aesthetic quality, functional requirements, buildability, operation performance and maintainability, creativity, and environmental impact purpose. The bridge design options are described in chapter 3 of the EIA report. There is an opportunity for the public to design CBL as a feature bridge and a future landmark structure at TKO. The Design Ideas Invitation Event was undertaken in year 2009. Please note for a more detailed description of the public Design Ideas Invitation Event refer to the http://www.cbl-tko.hk/CBL-invitation/eng/

13.4.2.5 Based on the result found from Stage 3 Public Consultation held on 2012, there is good support of the public stakeholders to the CBL project and there are public voices for implementation of the project as quickly as possible.

13.4.3 Review of Planning and Development Control Framework

13.4.3.1 A review of the existing and planned development framework for the proposed works and for the surroundings and the north-eastern part of Hong Kong Island has been considered. It aims at identifying issues for the neighbouring planned land uses, identifying potential resources and sensitive receivers, and ensuring a high compatibility between the proposed project and the surroundings. A desk-top study has been undertaken of the current planning context of the waterfront portion along the northeast part of the Hong Kong Island, in which the development along the waterfront are the most representative group of VSRS in the study area, as it is closest of the Hong Kong Island VSRS and will have direct view to CBL. It is noticed that the current coastal portion of Chai Wan and Siu Sai Wan are currently occupied by the private residential developments, such as Heng Fa Chuen on top of and adjacent to the MTR depot and Island Resort is Siu Sai Wan.

There are no known planned new development or redevelopment along the waterfront portion of the Chai Wan and Siu Sai Wan that shall result in a new group of VSRS.

13.4.3.2 The Study Area for the Landscape Impact Assessment is covered by:

- Approved Tseung Kwan O Outline Zoning Plan no. S/TKO/20 (27/04/2012).

The zoning within the study area included:

- Other Specificed Uses (OU) – Proposed toll plaza, ventilation building and associated facilities for the Tseung Kwan O – Lam Tin Tunnel in Area 128.
- Other Specificed Uses (OU) – Sport and Recreational Club
- Other Specificed Uses (OU) – Industrial Estate
- Other Specificed Uses (OU) – Sewage Treatment Works
- Open Space (O) - Open Space, including Area 105 and western side of Area 68
- Green Belt (GB) – Green Belt, including Area 103 and Area 128
- Comprehensive Development Area - CDA site in Area 86 is intended to facilitate comprehensive development including a MTR depot, a MTR station, associated property development and supporting community facilities.
- Government, Institution or Community (6) - G/IC(6) A site in Area 77, which is reserved for the development of a sewage pumping station
- Government, Institution or Community (9) - G/IC(9) A site in Area 85 reserved for a new Radio Television Hong Kong broadcasting house and future GIC uses.
- Residential Group E - R(E)
- Recreational (REC) - Recreational developments for the use of general public, development of active and/or passive recreation and tourism/eco-tourism are encouraged.

13.4.3.3 The review of OZP has not only included a review of the plans, but also the Notes which form part of plan and the Explanatory Statements which accompany the plan. Based on the Notes of the OZP para 7.4 (m), the key feature of the new development areas proposed under the urban design framework is the development of Cross Bay Link in the form of a landmark feature bridge.

13.4.3.4 There are natural woodland, scrubland and natural rocky shoreline of high landscape value found within the study boundary. The proposed work will not encroach in any Amenity Area (A), Conservation Area (CA), Green Belt (GB) and Country Park (CP). The CBL will not affect the edge of the Clear Water Bay Country Park (Drawing no. 209506/EIA/LV/1101 & 1102).

13.4.3.5 Study on South East New Territories Development Strategy will be reviewed and considered. It aims to review the overall planning strategy of South East New Territories included Tseung Kwan O district, to ensure the cultural heritage site will not be affected.

Table 4.1 Review of OZP

	Changes of Zoning / Land Uses	Sources of Impact	Potential Landscape and Visual Impact
1	Green Belt in Chiu Keng Wan (approx. 0.25 ha)	Toll Plaza and tunnel portal of TKO-LTT (interface project)	Moderate impact due to loss of Green belt
2	Existing abandoned waterfront area along Wan O Road	CBL	Slight impact due to loss of vegetation

13.4.3.6 The development of CBL in the form of a landmark feature bridge is identified under the “Feasibility Study for Further Development of Tseung Kwan O”, which undertaken by CEDD in 2002 and study completed in 2005, hence, it is considered that the proposed development and associated works are in principle following the planning intentions for the study areas as set out in the OZPs and the Urban Design framework identified in the study. This project, therefore, is in accordance with the planning goals and objectives for the study area.

13.4.3.7 Several recreational facilities were also proposed in the feasibility study, to further enhance the living environment of the TKO residents. These include a riverside park along the Eastern Channel, a waterfront promenade in town centre south, a water sports centre and boating facilities at the TKO Stage I Landfill site, and the construction of more cycle tracks in the new developments. CBL will provide a new cycle track which will be connected to the existing and other planned cycle tracks to form a complete loop in TKO.

13.4.4 Tentative Programme

13.4.4.1 The CBL project is currently targeted for commissioning by 2020. To meet this target the tentative commencement year for the construction of the CBL would be end 2016 and would take approximately 4 years for completion (see chapter 4 for further discussion on construction programme).

13.4.5 Concurrent Projects

13.4.5.1 The potential concurrent projects are identified as follows and their details are briefly discussed in the following section (refer to section 1.9.1 for comprehensive list of concurrent projects).

- TKO-LT Tunnel
- “Government, Institution or Community” (“G/IC”) development in Area 85 and Area 86
- Proposed residential development R(E) zone in area 85
- Hong Kong Offshore Wind Farm in Southeastern Waters
- TKO Town Centre South Development
- Northern & Southern Bridges across Eastern Channel
- Cycle tracks and promenade developments around TKO Bay
- industrial development in Tseung Kwan O (TKO) industrial estates in Area 87 should be considered as concurrent projects

Tseung Kwan O – Lam Tin Tunnel (PWP item 823TH)

13.4.5.2 With reference to the Project Profile and the EIA Study Brief (ESB-195/2008) on TKO-LT Tunnel, the project is to construct a dual two-lane highway connecting TKO at Po Yap Road in the east with Trunk Road T2 in Kai Tak Development in the west and Lei Yue Mun Road Underpass. The project involves a 4.8km long highway with about 3km of the highway is in the form of tunnel. The TKO-LT Tunnel will connect CBL to form a new external road link to meet the anticipated traffic flow in connection with the further population intake and development in TKO New Town. CBL project is to be implemented in parallel with TKO-TL Tunnel Project. Cumulative landscape and visual impact due to the construction works of TKO-LT Tunnel associated with proposed CBL will be assessed.

13.4.5.3 The TKO-LT Tunnel is to be implemented in parallel with the CBL. The works is tentatively scheduled to commence in 2016 and be completed by 2020. The project is anticipated in 2021.

TKO Area 86 Comprehensive Development

13.4.5.4 Area 86 is practically being developed. According to the latest information from MTRCL on 11 May 2009, residential and educational premises are going to be developed in that area. Hence, these residential and educational premises may become sensitive receivers in different construction and operational phases. In addition, the construction in Area 86 will also have cumulative impact on those receivers. Hence, the latest construction schedule, plant inventory and master layout plan will be obtained from the respective engineer of MTRCL before the commencement of the EIA to identify the likely construction impact. A promenade along the Area 86 Development is proposed by MTRC. The cycle track is preliminary designed to 4.5m wide. Construction of the promenade is scheduled to commence in 2017.

Hong Kong Offshore Wind Farm in Southeastern Waters

13.4.5.5 With reference to the Project Profile and the EIA Study Brief (ESB-146/2006), the Project is to construct and operate a wind farm at Southeastern water of Hong Kong. The Project component includes an installation of up to 67 wind turbines, an offshore transformer platform, sub-sea collection and transmission cables, and Research Mast. There will be a landing cable area and proposed cable at the west of Junk Bay connecting the collection cables from the turbines and the CLP existing grid connection programme. The landing point for the south of the Ocean Shores proposed location currently falls within an area zoned “Open Space” (“O”) on the approved Tseung Kwan O Outline Zoning Plan No. S/TKO/20. Subject to the detailed submission of the landing point, it may require planning approval from the Town Planning Board undertaken by the CLP. Since this project is out of scope of CBL assessment boundary, landscape impact arising from the construction work for landing cable and laying of cable route in Junk Bay to the landscape impact for CBL is not expected. The cumulative landscape impact during construction is unlikely and therefore will not be included in this landscape and visual impact assessment.

Northern & Southern Bridges across Eastern Channel

13.4.5.6 In addition to CBL, a new cycle path cum footbridge and a new footbridge both located at the Eastern Channel, namely existing Northern Bridge (NB) and proposed Southern Bridge (SB) respectively. Since CBL is in close proximity to NB and SB, the three bridges could be viewed as a family of bridges and the coherency in their design will greatly enhance the environment in the area.

It is a recommendation by ACABAS that the aesthetic design, appearance and structural form of CBL are coherent with those of SB and NB. The design of NB is outside this consultancy. NB will be procured with a design and build contractor with construction due to start by end 2009. The reference design, already prepared by HyD, show that NB will be a girder bridge with arch-shaped elevation. SB being located between NB and CBL, the design of SB is approved by ACABAS and the detail information are shown in Appendix 13.2.

Cycle tracks and promenade developments around TKO Bay

13.4.5.7 CEDD is planning to develop a comprehensive cycle track network in new development areas of TKO, including a cycle track loop along the waterfront of Junk Bay and the CBL with its implementation in sections in tandern with the following infrastructure work packages or development. It includes a 5m wide cycle track on Cross Bay Link in approximate 1.8km long on CBL to TKO town side; and at grade section cycle track of TKO-LTT from the CBL interface to Po Yap Road that will carry a cycle track as a continuation form that on CBL; and approximate 1.6km long cycle tracks connecting from TKO Area 65 to Tiu Keng Leng along waterfront at Town Centre South including adjoining footpaths and cycle parking areas with hard and soft landscaping works; and a cycle track cum footbridge across Eastern Channel.

Tseung Kwan O Town Centre South Development

13.4.5.8 A town centre is planned in the central area near Tseung Kwan O Bay. The major facilities being provided there will serve Tseung Kwan O as well as the Sai Kung hinterland. The land-uses in the Town Centre are systematically arranged in successive layers of housing, major government, institution or community (GIC) facilities, commercial facilities and open space. The layering pattern is superimposed by a cruciform plan of GIC and commercial facilities, in form of a central north-south running GIC/open space spine and a east-west running commercial spine of inter-linked podium structures. A town park and a civic square are planned to the eastern fringe and near the waterfront of the Town Centre respectively.

Tseung Kwan O Town Centre South Development in Area 65 and 66 is currently under construction. The area will be primarily residential and will generate VSRs in large numbers. It is anticipated phases of the development will be in operation between 2017 and 2018.

Future Expansion of the Tseung Kwan O Industrial Estate

13.4.5.9 Tseung Kwan O Industrial Estate is located in Area 87 in the south-eastern part of the New Town. It is mainly intended for industries with new or improved technology and processes which cannot operate in multi-storey factory buildings. Further south, special industries requiring marine access for vessels of deep draught or with potential hazards are planned in Area 137 at Fat Tong O, to take advantage of the deep waterfront and ease of marine access via the Tathong Channel.

13.5 Baseline Study

13.5.1 Physical Landscape Resources

13.5.1.1 The study area includes the region around the Comprehensive Development in Area 86, Industrial Estate in Area 87, sea area where the TKO-LTT created. The proposed alignment of CBL is mainly located on the Junk Bay, surrounded by the waterfront vegetation and extensive reclaimed flatland for future residential development. Small portion of grassland (with tall shrubs) located at shoreline of the surrounding Green Belt are included within the LR assessment. The Project also covers the adjacent water bodies (Drawing no. 209506/EIA/LV/1201).

13.5.1.2 The baseline landscape resources that will be affected during the Construction Phase and Operation Phase, together with their

Sensitivity, are described in Table 5.1. The locations of baseline landscape resources are mapped in Drawing no. 209506/EIA/LV/1201. Photo views illustrating the landscape resources within the study area are illustrated in Drawing no. 209506/EIA/LV/1211-1213. For the ease of reference and co-ordination between text, Tables and figures, each landscape resource is given an identity number.

13.5.2 Landscape Character Areas

13.5.2.1 Landscape character zones have been identified within the Study Area in accordance with the Study on Landscape Value Mapping of Hong Kong. These are described in Table 5.1 and illustrated in Drawing no. 209506/EIA/LV/1301. Photo views illustrating the landscape character areas within the study area are illustrated in Drawing no. 209506/EIA/LV/1311-1312.

Table 5.1 Landscape Resources / Landscape Character Areas and Their Sensitivity

ID. No.	Landscape Resources / Landscape Characters	Sensitivity (Low, Medium, High)
LR01	Sea Waterbody The sea waterbody, together with the artificial shoreline, is valuable physical resources and is one of the key elements that generates an important landscape and visual identity and character of Junk Bay. It is very sensitive to any reclamation. However, the sea waterbody is of medium rarity of the region and is not under any statutory or regulatory limitations / requirements. The waterbody within the study area is approx. 162 ha. Based on the importance and medium rarity of the sea waterbody and shoreline, the sensitivity of this LR is consider as medium.	Medium
LR02	Landscaped Area and Plantation within High-rise Residential Development in Area 86 (Lohas Park) This is a high-rise residential development. In the CDA plannting, there are approx. 50 no tower for a planned population of approx 58,000. Lohas Park's total site area is approx. 33ha, in which the greening ratio is over 30%. There are 3 phase involved within the Lohas Park, namely, Phase 1 – The Capital, Phase 2 – Le Prime &	Medium

ID. No.	Landscape Resources / Landscape Characters	Sensitivity (Low, Medium, High)
	Le Prestige and Phase 3 – the Capital. The club house facilities which are mainly for residents' enjoyment and leisure are barbecue area, ball court, children playground, planting area and seating area for passive and active recreation. The LR02 within the study area is approx. 8.4 ha. Based on the amenity value and quality of these landscape gardens, the sensitivity of this LR is considered as medium.	
LR03	Vegetation along Wan O Road (including promenade, Road D9, Wan O Road) There are approximately 600 trees along this abandoned waterfront area, in which approx. 60% of the species is weedy species *Leucaena leucocephala* 銀合歡. Most of the trees of *Leucaena leucocephala* 銀合歡 are in poor form and health due to dense competition with the trees of the same species. In addition, due to its fast growing habit, the wood of this species is brittle and susceptible to damage by strong wind, therefore many trees of this species was found to have broken or damaged branch(es) and/or trunk(s). Other nearby tree species are also found in poor health condition due to dense competition growing with *Leucaena leucocephala* within the seashore peripheral planting area, most of these trees ranged from poor to fair both in health condition and form of tree. Other species surveyed included *Acacia confuse* 台灣相思, *Archontophoenix alexandrae* 假檳榔, *Ficus virens* 大葉榕, *Khaya senegalensis* 非洲楝, *Livistona chinensis* 蒲葵, they are all commonly planted species used for ornamental purpose or as roadside trees. The LR03 within the study area is approx. 4 ha. Based on the low to medium amenity of trees, the sensitivity of this landscape resource is considered as medium.	Medium
LR04	Plantation within Vacant Land There are several trees at the vacant land in the junction of Wan O Road and Wan Po Road. The LR04 within the study area is approx. 17ha. Dominant species is *Leucaena leucocephala* 銀合歡. There are other common trees such as *Macaranga tanarius* 血桐 and *Melia azedarach* 苦楝. Based on the low to medium amenity of trees, the	low

ID. No.	Landscape Resources / Landscape Characters	Sensitivity (Low, Medium, High)
	sensitivity of this landscape resource is considered as low.	
LR05	Plantation within Industrial Building Plantation within the commercial and industrial building site which is approx. 7 ha. These trees are of small to medium size and of low to medium amenity value. Common trees identified such as *Khaya senegalensis* 非洲楝, *Chrysalidocarpus lutescens* 散尾葵, *Lagerstraemia speciosa* 大葉紫薇. Based on the low to medium quality of trees, the sensitivity of this landscape resource is considered as low.	low
LR06	Woodland at Foothill and Hillside The hillside woodland next to Tseung Kwan O Preliminary Sewage Treatment Works is approx. 7 ha, while the woodland at the shore of Chiu Keng Wan is approx 1 ha. The trees are of mature to medium size and of high landscape value. Based on the high to medium value of hillside vegetation, the sensitivity of this landscape resource is considered as high.	High
LR07	Grassland and Scrubland at Hillside The area consists of grassland and scrubland along the O King Road. The area is approx. 0.6 ha within the study area. Dominant Shrub species are Rhodomyrtus tomentosa 崗棯, Lantana camara 馬纓丹 and Rhaphiolepis indica車輪梅. Based on the low to medium value of hillside vegetation, the sensitivity of this landscape resource is considered as medium.	Medium
LR08	Vegetation of clustered newly planted trees and shrubs scattered on Tseung Kwan O Stage II and III Landfill Area The area consist of tall shrubs and hillside plantation. The area is approx. 12.7 ha. The trees are of small to medium size and of low to medium value. Dominant species is Acacia mangium of medium value. There are other common trees such as Acacia auriculaeformis 耳果相思, Acacia confusa 台灣相思 and Casuarina equisetifolia 木麻黃. Based on the low to medium value of hillside vegetation, the sensitivity of this landscape resources is considered as medium.	Medium

ID. No.	Landscape Resources / Landscape Characters	Sensitivity (Low, Medium, High)
LR09	Natural Rocky and Sand Shoreline The natural rocky shoreline along the Chiu Keng Wan and till the Lei Yue Mun Point is one of the character of Junk Bay. The LR09 within the study area is approx.0.8ha.	High
LR10	Plantation at Wasteland / Construction Area There are some fragmented grassland / shrubland over the platform above the rocky shore. The LR10 within the study area is approx. 0.9ha.	Low
LR11	Vegetation along the Coastline Adjacent to Lohas Park Road Fragment vegetation on the northern side of Tseng Kwan O Salt Water Pumping Station. Dominant species is Acacia confusa 台灣相思 and Casuarina equisetifolia 木麻黃. The LR11 within the study area is approx. 1ha.	Low
LR12	Roadside Planting Roadside planting along the Wan Po Road and the Lohas Park Road. Dominant species is Acacia confusa 台灣相思, Casuarina equisetifolia 木麻黃, Hibiscus tiliaceus 黃槿, and Khaya senegalensis 非洲楝. The LR12 within the study area is approx. 1.3ha.	Medium
LR13	Seawall Man-made seawall along the Tseung Kwan O Industrial Estate. Since the seawall is not accessible to the public, the space cannot be enjoyed by the public. The LR13 within the study area is approx. 0.1 ha.	Low
LCA01	Junk Bay Coastal Landscape These landscapes consist of areas of inshore water, found around the coastline of Junk Bay, which are enclosed to a significant degree, by landform on three sides. The result is a coastal landscape with a distinct sense of enclosure, characterized by the visual interlock of land and sea. Whilst these landscapes consist predominantly of water, they may also include small islands, occasional vessels, fish farms and marine activities such as waterborne recreational activity. Each Bay Landscape is given its particular	Medium

ID. No.	Landscape Resources / Landscape Characters	Sensitivity (Low, Medium, High)
	character by a combination of its physical enclosure, the character of its shoreline (and small islands or rocks offshore) and by any marine activities. Examples of this type of landscape are Cheung Sha in Lantau Island and Tai Long Wan in Sai Kung Junk Bay provides positive and valuable views to adjacent receivers from Eastern District Hong Kong coastline across to Tseung Kwan O New Town South, Chiu Keng Wan, Area 86 Comprehensive development area, adjacent coastal waterfront area and hiker of the country park and the peak Given the urbanized nature of the Junk Bay area, and the artificial shoreline in Area 86, the sensitivity of this area is considered as medium.	
LCA02	Reclamation/Ongoing Major Development Landscape Comprehensive Development in Area 86, approx 27.5ha, consist of on-going residential development (LOHAS Park), future comprehensive development of residential, commercial, recreational open space, school and waterfront public park in reclaimed lowland area. Given the urbanized and reclaimed nature of the Area 86, the sensitivity of this area is considered as low.	Low
LCA03	Tseung Kwan O Industrial Urban Landscape The low or medium rise built-up and on-going Industrial building development in Area 87, which is approx. 25.7 ha. These developments include Tseung kwan O Industrial Estate in Area 87 on the western side of Wan Po Road. Given the urbanized nature of the area and the low to medium amenity value of the vegetation, the sensitivity of this reclaimed area is considered as low.	Low
LCA04	Chiu Keng Wan Coastal Upland and Hillside Landscape Lowland foothill of natural rocky shoreline of Chiu Keng Wan Shan with tall shrubs and vegetation. This scrub area with the natural rocky shoreline area predominantly undeveloped land use. The area is dominated with shrubby grassland and patches of secondary woodland. The site is within the Green Belt area, which create a greenery backdrop to the coastal area in Chiu Keng Wan. Given the undeveloped nature of the rocky shoreline, the sensitivity of this natural area is considered as	High

ID. No.	Landscape Resources / Landscape Characters	Sensitivity (Low, Medium, High)
	high.	
LCA05	Tseung Kwan O Landfill Landscape (Stage II and Stage III) The Tseung Kwan O Landfill Stages II and III at Area 105 have been disused and closed in 1994 and are under restoration and is in the succession to the woodland habitat. The surface of the landfills is landscaped with various species of plant, which is approx. 15 ha within the study area. Given the scale of the area and the maturity of vegetation, the sensitivity of this landfill is considered as high.	High
LCA06	Tseung Kwan O Miscellaneous Urban Fringe Landscape The low or medium rise built-up and on-going Industrial building development in Area 85, which is approx. 11.6 ha. These developments include Tseung kwan O Preliminary Sewage Treatment Works in Area 85, and bus depot. Given the urbanized nature of the area and the low amenity value of the vegetation, the sensitivity of this reclaimed area is considered as low.	Low
LCA07	High Junk Peak Coastal Upland and Hillside Landscape The hillside woodland next to Tseung Kwan O Preliminary Sewage Treatment Works is approx. 5.5 ha, and the trees are of mature to medium size and of high landscape value. Based on the maturity of the landscape characters and the quality of hillside vegetation, the sensitivity of this LCA is considered as high.	High
LCA08	Residential Urban Fringe Landscape This is a high-rise residential development of Lohas Park Phase 1 – the Capital and the Loha Park phase 2 – La Splendeur, Le Prime and Le Prestige. This LCA is approx. 8.5ha, in which the greening ratio is over 30%. The manmade landscape includes the landscape garden, residential club house facilities which is mainly for residents' enjoyment and leisure are barbecue area, ball court, children playground, planting area and seating area for passive and active recreation.	Medium

ID. No.	Landscape Resources / Landscape Characters	Sensitivity (Low, Medium, High)
	Based on the amenity value and the rarity of these landscape gardens, the sensitivity of this LCA is considered as medium.	

13.5.3 Tree Survey Methodology

13.5.3.1 To minimize conflicts with existing vegetation, a full tree survey within the CBL main alignment and landing point has been undertaken in February 2010 in accordance with ETWB TCW No. 3/2006, and the Final Tree Survey Report & Tree Removal Application is under Appendix 13.1.

13.5.3.2 Within the designated site boundary, all living trees with a stem diameter over 95mm measured at a point 1.3m above the ground level (hereafter referred to as the DBH) are included in the Tree Survey as defined in the Nature Conservation Practice Note No. 02 (Rev. June 2006) issued by AFCD.

13.5.3.3 This is to allow the fine-tuning of the design for the landscape and ensure that any significant trees would where possible, be protected during both the design and construction periods.

13.5.4 Visual Envelope

13.5.4.1 Visual Envelope of the project is bounded by the ridgeline from High Junk Peak (Tiu Yue Yung) to the east; Mount Parker, Pottinger Peak and Mount Collinson to the south; Lei Yue Mun and Chiu Keng Wan Shan to the west; and the high rise residential development to the north. The ZVI adopts a cut-off at the Tathong Channel as the only potential VSRs beyond this would be on Sung Kong and Waglan Island from which visual impacts would be negligible due to their distant location. The Visual Envelope of the project is illustrated in Drawing no. 209506/EIA/LV/1401.

13.5.5 Visually Sensitive Receivers (VSRs)

13.5.5.1 VSRs are the people who would reside within, work within, play within or travel through within the visual envelope. Within the Visual Envelope, a number of key VSRs have been identified and key VSRs are mapped in Drawing no. 209506/EIA/LV/1402-1405. They are listed, together with their baseline assessment and sensitivity, in Table 5.2. Photo views illustrating the VSRs within the study area are shown in Drawing no. 209506/EIA/LV/1411-1424.

13.5.5.2 **At the Strategic level,** VSRs **include:**

- Visitors of Lei Yue Mun Park and Hong Kong Museum of Coastal Defence (S1)
- Hikers along High Junk Peak (Tiu Yue Yung) in Clear Water Bay Country Park (S2)
- Travellers along Lei Yue Mun and Tathong Channel(S3)
- Visitors/Hikers along Wilson Trail (near Devil's Peak of Lei Yue Mun (S4)
- Visitors/Hikers at Mount Parker (S5)
- Visitors/Hikers at Pottinger Peak (S6)
- Visitors/Hikers at Mount Collinson (S7)
- Visitors/Hikers at Black Hill (S8)

13.5.5.3 There are no vantage points identified in the Urban Design Guidelines under Hong Kong Planning Standards and Guidelines.

13.5.5.4 **At the district level,** VSR **Groups are identified within the following districts:**

- Heng Fa Chuen Residential Area (D1)
- Island Resort Residential Area and visitor in Siu Sai Wan Promenade and Sports Ground (D2)
- Tseung Kwan O Industrial Estate (D3)
- Logistics Centre and Preliminary Treatment Works and Cargo Handling Basin (D4)

13.5.5.5 **At the local level, VSRs include:**

- Residents or workers in Tsueng Kwan O Comprehensive Development Area 86 (CDA1)
- Workers of Tseung Kwan O Sewage Treatment Works, Bus depot in TKO Area 85 and Tseung Kwan O Stage II and III Landfill area (GIC1)

- Users of Tseung Kwan O Methodist Primary School and Evangel College (GIC2)
- Users of P.O.H. 80th Anniversary Tang Ying Hei College, C.&M. A. Sung Kei secondary School, Yan Chai Hospital Wong Wah San Secondary School and Yan Oi Tong Tin Ka Ping Primary School (GIC3)
- Users of Hong Kong Design Institute Campus (GIC4)
- Users of Creative Secondary School (GIC5)
- Workers at Hong Kong Movie City (GIC9)
- Residents of Bauhinia Garden (R1)
- Residents of Ocean Shores (Phase I to Phase III) (R2)
- Residents of Metro Town (R3)
- Residents of Park Central (R4)
- Residents of The Grandiose and Tseung Kwan O Plaza (R5)
- Residents of Oscar By the Sea (R6)
- Travellers of Wan Po Road (T1)
- Travellers of Tseung Kwan O Station and Public Transport Interchange in the junction of Tong Tak Street and Tong Chun Street (T2)
- Visitor of Junk Bay Chinese Permanent Cemetery (OU1)
- VSR GIC 8 – Planned high-rise residential uses along Shek Kok Road in Area 85. (VSRs in developments planned to be completed before operation of CBL).
- VSR-R7 – Planned Residential area of TKO Area 65, 66 and 67. (VSRs in developments planned to be completed before operation of CBL).
- OU2 – Planned visitor and residents in commercial development with PT1. (VSRs in developments planned to be completed before operation of CBL).

13.5.5.6 **At the local level, planned** VSRs **include:-**

- VSR GIC6 - Planned GIC development of TKO area 67, Area 72 and Area 74. Area 72 is reserved for proposed sub-divisional fire station, ambulance depot, general clinic and police station while part of the Area 74 (i.e. to the west of the HK Design Institute Campus) is planned for an open space with the provision of a sports centre together with a library
- VSR GIC7 – Planned Fire Services Training School cum Driving School, and the proposed private hospital in Area 78
- VSR GIC 8 – Planned high-rise residential uses along Shek Kok Road in Area 85

- VSR O1-Planned “Central Avenue” in Town Centre South near the promenade in open space of TKO Area 68 and the promenade user in the former TKO Stage I Landfill site ,
- VSR O2 - Planned visitors along the waterfront near the Eastern Channel in open space of TKO Area 68
- VSR O3 - Planned visitors at the proposed Open Space in Area 74
- R7 - Planned Residential area of TKO Area 65, 66 and 67
- T3- Planned Travellers of Cross Bay Link and Tseung Kwan O – Lam Tin Tunnel
- OU2 - Planned visitor and residents in commercial development with Public Transport Interchange
- REC1 - Planned recreational users in TKO Stage I Landfill
- I1 - Planned Tseung Kwan O Industrial Estate Extension

13.5.5.7 These VSRs are mapped in Drawing no. 209506/EIA/LV/1401-1405. Baseline viewpoints from Key VSRs at district level illustrating the quality of existing views are shown in Drawing no. 209506/EIA/LV/ 1411-1415. The baseline assessment of VSRs at district level is shown in Table 5.2.

13.5.5.8 Some of the VSRs only have partial view to the proposed CBL works as their views are blocked by the residential blocks along the Chui Ling Road. Some of the VSRs at the higher-level have open full sea view to the Junk Bay.

13.5.5.9 The type of VSRs is classified according to whether the person is at home, at work, at play, or travelling. Those who view the impact from their homes are considered to be highly sensitive as the attractiveness or otherwise of the outlook from their home will have a substantial effect on their perception of the quality and acceptability of their home environment and their general quality of life. Those who view the impact from their workplace are considered to be only moderately sensitive as the attractiveness or otherwise of the outlook will have a less important, although still material, effect on their perception of their quality of life. The degree to which this applies depends on whether the workplace is industrial, retail or commercial. Those who view the impact whilst taking part in an outdoor leisure activity may display varying sensitivity depending on the type of leisure activity. Those who view the impact whilst travelling on a public thoroughfare will generally have low sensitivity.

13.5.5.10 The sensitivity of the VSRs shall also be determined by numbers of the individuals within the VSR category, the quality of existing views, availability of alternative views, amenity of alternative views, degree of visibility, duration of view and frequency of view.

13.5.6 Visual Resources

13.5.6.1 The ridgeline of the High Junk Peak (Tiu Yue Yung), Miu Tsai Tun, Sheung Yeung Shan provides a dramatic natural backdrop to the Tseung Kwan O, which forms the valuable natural visual resources as viewed from Tseung Kwan O Town center. The backdrop of the Junk Bay is the 615-hectare Clearwater Bay Country Park which takes in a wide rugged terrain in the Southeastern New Territories. The green backdrop boundaries extend southwards from Hang Hau to the undulating mountain range that screens Joss House Bay, and continue eastwards to the hillocks around Lung Ha Wan. Surrounding hillsides of Tiu Yue Yung and the Chiu Keng Wan Shan create a nice picturesque scene and the long distance views to the Tathong channel is visually pleasing.

13.5.6.2 Tathong Channel and Lei Yue Mun is a unique public asset and natural visual resource of Tseung Kwan O, providing an open seascape along the south coast of Tseung Kwan O.

13.5.6.3 The visual amenity of the Junk Bay variable. The western portion of the Junk Bay is characterised by the Chiu Keng Wan Shan, Devil’s Peak and Lei Yuen Mun Point. The Northern and Eastern Portion of Junk Bay, however, suffers from the large scale urban development and infrastructure of the Tseung Kwan O New Town. These introduce incoherent colours, patterns and rhythms into views. Besides, these visual qualities are being gradually degraded by the incoherent visual features such as landfill, Tseung Kwan O depot and incoherent residential development in Area 86. For this reason, any infrastructure development on the eastern portion of Junk Bay will not likely to have a significant impact on the visual system.

13.5.6.4 The western portion of Junk Bay is almost undeveloped in which the only development is Tseung Kwan O Chinese Permanent Cemetery, and is characterised by the visual interfaces between Chiu Keng Wan Shan ridgelines with sky and between seashore and sea. For this reason, any infrastructure development on the western portion of Junk

Bay will likely to have a significant impact on visual character and its visual sensitivity is therefore high.

Table 5.2 Visual Sensitive Receivers (VSRs), Their Sensitivity, and Their Magnitude of Change

VSR Type & ID.	Key VSR	Number of Individuals (Many/ Medium/ Few/)	Quality of Existing View (Good/ Fair/ Poor)	Availability of Alternative Views (Yes/ No)	Amenity of Alternative Views (Good/ Fair/ Poor)	Degree of Visibility (Full/ Partial/ Glimpse)	Duration of View (Long/ Medium/ Short)	Frequency of View (Frequent/ Occasional/ Rare)	Sensitivity (Low, Medium, High)	
									Construction	Operation
	VSRs at Strategic Level									
S1	Visitors of Lei Yue Mun Holiday Village and Lei Yue Mun Park, and Hong Kong Museum of Coastal Defence	Many	Good	Yes	Good	Full	Long	Frequent	Medium	Medium
S2	Hikers along High Junk Peak (Tiu Yue Yung) in Clear Water Bay Country Park	Few	Good	Yes	Good	Full	Short	Occasional	Low	Low
S3	Travellers along Lei Yue Mun and Tathong Channel	Medium	Good	Yes	Good	Full	Short	Occasional	Low	Low
S4	Visitors/hikers along Wilson Trail (near Devil's Peak of Lei Yue Mun)	Medium	Good	Yes	Good	Full	Short	Occasional	Low	Low
S5	Visitors/Hikers at Mount Parker	Few	Good	Yes	Good	Full	Short	Occasional	Low	Low
S6	Visitors/Hikers at Pottinger Peak	Few	Good	Yes	Good	Full	Short	Occasional	Low	Low
S7	Visitors/Hikers at Mount Collinson	Few	Good	Yes	Good	Full	Short	Occasional	Low	Low
S8	Visitors/Hikers at Black Hill	Few	Good	Yes	Good	Full	Short	Occasional	Low	Low
	VSR Groups at District Level									

VSR Type & ID.	Key VSR	Number of Individuals (Many/ Medium/ Few/)	Quality of Existing View (Good/ Fair/ Poor)	Availability of Alternative Views (Yes/ No)	Amenity of Alternative Views (Good/ Fair/ Poor)	Degree of Visibility (Full/ Partial/ Glimpse)	Duration of View (Long/ Medium/ Short)	Frequency of View (Frequent/ Occasional/ Rare)	Sensitivity (Low, Medium, High)	
									Construction	Operation
D1	Heng Fa Chuen Residential Area	Many	Good	Yes	Good	Full	Long	Frequent	High	High
D2	Island Resort Residential Area and visitor in Siu Sai Wan Promenade and Sports Ground	Many	Good	Yes	Good	Full	Long	Frequent	High	High
D3	Tseung Kwan O Industrial Estate	Many	Fair	Yes	Good	Partial	Long	Occasional	Low	Low
D4	Logistics Centre and Preliminary Treatments works and Cargo Handling Basin	Many	Good	Yes	Good	Full	Medium	Occasional	Medium	Medium
	VSRs at Local Level									
CDA1	Residents or workers in Tsueng Kwan O Comprehensive Development Area 86	Many	Good	Yes	Good	Full	Long	Frequent	High	High
GIC1	Workers of Tseung Kwan O Sewage Treatment Works, Bus depot in TKO Area 85 and Tseung Kwan O Stage II and III Landfill area	Few	Fair	Yes	Good	Partial	Short	Occasional	Low	Low
GIC2	Users of Tseung Kwan O Methodist Primary School and Evangel College	Medium	Fair	Yes	Good	Full	Short	Occasional	Low	Low
GIC3	Users of P.O.H. 80th	Many	Fair	Yes	Good	Glimpse	Short	Occasional	Low	Low

VSR Type & ID.	Key VSR	Number of Individuals (Many/ Medium/ Few/)	Quality of Existing View (Good/ Fair/ Poor)	Availability of Alternative Views (Yes/ No)	Amenity of Alternative Views (Good/ Fair/ Poor)	Degree of Visibility (Full/ Partial/ Glimpse)	Duration of View (Long/ Medium/ Short)	Frequency of View (Frequent/ Occasional/ Rare)	Sensitivity (Low, Medium, High)	
									Construction	Operation
	Anniversary Tang Ying Hei College, C.&M. A. Sung Kei secondary School, Yan Chai Hospital Wong Wah San Secondary School and Yan Oi Tong Tin Ka Ping Primary School									
GIC4	Users of Hong Kong Design Institute Campus	Many	Fair	Yes	Good	Partial	Short	Occasional	Low	Low
GIC5	Users of Creative Secondary School	Medium	Fair	Yes	Good	Partial	Short	Occasional	Low	Low
GIC9	Workers at Hong Kong Movie City	Many	Good	Yes	Good	Full	Medium	Occasional	Medium	Medium
R1	Residents of Bauhinia Garden	Many	Good	Yes	Good	Full	Long	Frequent	Medium	Medium
R2	Residents of Ocean Shores (Phase I to Phase III)	Many	Good	Yes	Good	Full	Long	Frequent	High	High
R3	Residents of Metro Town	Many	Fair	Yes	Good	Partial	Long	Frequent	Medium	Medium
R4	Residents of Park Central	Many	Fair	Yes	Good	Full	Long	Frequent	Medium	Medium
R5	Residents of The Grandiose and Tseung Kwan O Plaza	Many	Fair	Yes	Good	Full	Long	Frequent	Medium	Medium
R6	Residents of Oscar By the Sea	Many	Fair	Yes	Good	Full	Long	Frequent	Medium	Medium

VSR Type & ID.	Key VSR	Number of Individuals (Many/ Medium/ Few/)	Quality of Existing View (Good/ Fair/ Poor)	Availability of Alternative Views (Yes/ No)	Amenity of Alternative Views (Good/ Fair/ Poor)	Degree of Visibility (Full/ Partial/ Glimpse)	Duration of View (Long/ Medium/ Short)	Frequency of View (Frequent/ Occasional/ Rare)	Sensitivity (Low, Medium, High)	
									Construction	Operation
T1	Travellers of Wan Po Road	Many	Fair	Yes	Good	Partial	Short	Occasional	Low	Low
T2	Travellers of Tseung Kwan O Station and Public Transport Interchange in the junction of Tong Tak Street and Tong Chun Street	Many	Fair	Yes	Good	Partial	short	Occasional	Low	Low
OU1	Visitor of Junk Bay Chinese Permanent Cemetery	Medium	Good	Yes	Good	Full	Short	Rare	Low	Low
	Planned VSRs									
GIC6	Planned GIC development of TKO area 67, Area 72 and Area 74	Many	Fair	Yes	Good	Partial	Medium	Occasional	-	Medium
GIC7	Planned Fire Services Training School cum Driving School, and the proposed private hospital in Area 78	Medium	Fair	Yes	Good	Partial	Medium	Occasional	-	Medium
GIC8	Planned high-rise residential uses along Shek Kok Road	Medium	Fair	Yes	Good	Partial	Medium	Occasional	Medium	Medium
O1	Planned “Central Avenue” in Town Centre South near the	Medium	Good	Yes	Good	Full	Medium	Occasional	-	High

VSR Type & ID.	Key VSR	Number of Individuals (Many/ Medium/ Few/)	Quality of Existing View (Good/ Fair/ Poor)	Availability of Alternative Views (Yes/ No)	Amenity of Alternative Views (Good/ Fair/ Poor)	Degree of Visibility (Full/ Partial/ Glimpse)	Duration of View (Long/ Medium/ Short)	Frequency of View (Frequent/ Occasional/ Rare)	Sensitivity (Low, Medium, High)	
									Construction	Operation
	promenade in open space of TKO Area 68 and the promenade user in the former TKO Stage I Landfill site (O1)									
O2	Planned visitors along the waterfront near the Eastern Channel in open space of TKO Area 68	Medium	Good	Yes	Good	Partial	Medium	Occasional	-	High
O3	Planned visitors at the proposed Open Space in Area 74	Medium	Fair	Yes	Good	Partial	Medium	Occasional	-	Low
R7	Planned Residential area of TKO Area 65, 66 and 68	Many	Fair	Yes	Good	Full	Medium	Frequent	High	High
T3	Planned Travelers of Cross Bay Link and Tseung Kwan O – Lam Tin Tunnel	Many	Fair	Yes	Good	Full	Short	Occasional	-	Low
OU2	Planned visitor and residents in commercial development with Public Transport Interchange	Many	Fair	Yes	Good	Partial	Short	Occasional	Medium	Medium
REC1	Planned recreational users in TKO Stage I Landfill	Medium	Fair	Yes	Good	Partial	Short	Occasional	-	Medium
I 1	Planned Tseung Kwan	Medium	Fair	Yes	Good	Full	Short	Occasional	-	Low

VSR Type & ID.	**Key VSR**	**Number of Individuals (Many/ Medium/ Few/)**	**Quality of Existing View (Good/ Fair/ Poor)**	**Availability of Alternative Views (Yes/ No)**	**Amenity of Alternative Views (Good/ Fair/ Poor)**	**Degree of Visibility (Full/ Partial/ Glimpse)**	**Duration of View (Long/ Medium/ Short)**	**Frequency of View (Frequent/ Occasional/ Rare)**	**Sensitivity (Low, Medium, High)**	
									Construction	**Operation**
	O Industrial Estate Extension									

* C = commercial, CA = conservation area or countryside conservation area, CDA = comprehensive development area, C/R = commercial / residential, GIC = government/institution/community, I = industrial, O = open space, OU = other specific use, R = residential, T = transport related.

* VSR type & ID S1, S2, S3, S4, S5, S6, S7, S8, D1, D2, D3, D4, CDA1, GIC1, GIC2, GIC3, GIC4, GIC5, GIC9, R1, R2, R3, R4, R5, R6, T1, T2, OU1, GIC6, GIC7, GIC8, O1, O2, O3, R7, T3, OU2, REC1 and I1 do not represent for the landuse zone.

* VSRs (GIC8, R7 and OU2) in developments planned to be completed before operation of CBL.

Table 5.3 Magnitude of Impacts on Visual Sensitive Recievers (VSRs) during Construction and Operation

VSR Type & ID.	Key VSR	Blockage of View (Full/ Partial/ Glimpse/ Nil)	Approximate Closest Viewing Distance(m) to Proposed CBL	Scale of Development (Large/ Medium/ Small)	Compatibility with Surrounding Landscape (Good /Fair /Poor)	Reversibility of Change (Reversible/ Irreversible)	Duration of Impact (Temporary [Short/Medium term], Permanent [Long])		Magnitude of impacts (Large / Intermediate/small/negligible)	
							Construction	Operation	Construction	Operation
VSRs at Strategic Level										
S1	Visitors of Lei Yue Mun Holiday Village and Lei Yue Mun Park, and Hong Kong Museum of Coastal Defence	Glimpse	2000	Medium	Fair	Irreversible	Medium	Long	Small	Small
S2	Hikers along High Junk Peak (Tiu Yue Yung) in Clear Water Bay Country Park	Nil	2000	Medium	Good	Irreversible	Medium	Long	Small	Small
S3	Travellers along Lei Yue Mun and Tathong Channel	Partial	1600	Medium	Fair	Irreversible	Medium	Long	Small	Small
S4	Visitors/hikers along Wilson Trail (near Devil's Peak of Lei Yue Mun)	Glimpse	1000	Medium	Fair	Irreversible	Medium	Long	Small	Small
S5	Visitors/Hikers at Mount Parker	Nil	4500	Small	Good	Irreversible	Medium	Long	Small	Small
S6	Visitors/Hikers at Pottinger Peak	Nil	4300	Small	Good	Irreversible	Medium	Long	Small	Small
S7	Visitors/Hikers at Mount Collinson	Nil	5000	Small	Good	Irreversible	Medium	Long	Small	Small
S8	Visitors/Hikers at Black Hill	Glimpse	2300	Small	Good	Irreversible	Medium	Long	Small	Small
VSR Groups at District Level										

VSR Type & ID.	Key VSR	Blockage of View (Full/ Partial/ Glimpse/ Nil)	Approximate Closest Viewing Distance(m) to Proposed CBL	Scale of Development (Large/ Medium/ Small)	Compatibility with Surrounding Landscape (Good /Fair /Poor)	Reversibility of Change (Reversible/ Irreversible)	Duration of Impact (Temporary [Short/Medium term], Permanent [Long])		Magnitude of impacts (Large / Intermediate/small/negligible)	
							Construction	Operation	Construction	Operation
D1	Heng Fa Chuen Residential Area	Nil	2400	Medium	Fair	Irreversible	Medium	Long	Small	Small
D2	Island Resort Residential Area and visitor in Siu Sai Wan Promenade and Sports Ground	Nil	2800	Medium	Fair	Irreversible	Medium	Long	Small	Small
D3	Tseung Kwan O Industrial Estate	Partial	1500	Medium	Fair	Irreversible	Medium	Long	Small	Small
D4	Logistics Centre and Preliminary Treatment Works and Cargo Handling Basin	Partial	2400	Large	Good	Irreversible	Medium	Long	Small	Small
VSRs at Local Level										
CDA1	Residents or workers in Tsueng Kwan O Comprehensive Development Area 86	Nil	10m	Large	Good	Irreversible	Medium	Long	Large	Large
GIC1	Workers of Tseung Kwan O Sewage Treatment Works, Bus depot in TKO Area 85 and Tseung Kwan O Stage II and III Landfill area	Partial	20m	Medium	Good	Irreversible	Medium	Long	Intermediate	Intermediate
GIC2	Users of Tseung Kwan O Methodist Primary School and Evangel College	Partial	750m	Medium	Good	Irreversible	Medium	Long	Intermediate	Small

VSR Type & ID.	Key VSR	Blockage of View (Full/ Partial/ Glimpse/ Nil)	Approximate Closest Viewing Distance(m) to Proposed CBL	Scale of Development (Large/ Medium/ Small)	Compatibility with Surrounding Landscape (Good /Fair /Poor)	Reversibility of Change (Reversible/ Irreversible)	Duration of Impact (Temporary [Short/Medium term], Permanent [Long])		Magnitude of impacts (Large / Intermediate/small/negligible)	
							Construction	Operation	Construction	Operation
GIC3	Users of P.O.H. 80th Anniversary Tang Ying Hei College, C.&M. A. Sung Kei secondary School, Yan Chai Hospital Wong Wah San Secondary School and Yan Oi Tong Tin Ka Ping Primary School	Partial	1000m	Medium	Good	Irreversible	Medium	Long	Small	Negligible
GIC4	Users of Hong Kong Design Institute Campus	Partial	800m	Medium	Good	Irreversible	Medium	Long	Intermediate	Small
GIC5	Users of Creative Secondary School	Glimpse	1050m	Medium	Good	Irreversible	Medium	Long	Small	Small
GIC9	Workers at Hong Kong Movie City	Partial	700m	Large	Fair	Irreversible	Medium	Long	Intermediate	Small
R1	Residents of Bauhinia Garden	Partial	850m	Medium	Good	Irreversible	Medium	Long	Large	Intemediate
R2	Residents of Ocean Shores (Phase I to Phase III)	Nil	550m	Large	Good	Irreversible	Medium	Long	Large	Large
R3	Residents of Metro Town	Partial	800m	Medium	Good	Irreversible	Medium	Long	Large	Intemediate
R4	Residents of Park Central	Partial	900m	Medium	Good	Irreversible	Medium	Long	Large	Small
R5	Residents of The Grandiose and Tseung Kwan O Plaza	Partial	1000m	Large	Good	Irreversible	Medium	Long	Large	Small

VSR Type & ID.	Key VSR	Blockage of View (Full/ Partial/ Glimpse/ Nil)	Approximate Closest Viewing Distance(m) to Proposed CBL	Scale of Development (Large/ Medium/ Small)	Compatibility with Surrounding Landscape (Good /Fair /Poor)	Reversibility of Change (Reversible/ Irreversible)	Duration of Impact (Temporary [Short/Medium term], Permanent [Long])		Magnitude of impacts (Large / Intermediate/small/negligible)	
							Construction	Operation	Construction	Operation
R6	Residents of Oscar By the Sea	Nil	1000m	Large	Good	Irreversible	Medium	Long	Large	Intermediate
T1	Travellers of Wan Po Road	Partial	350m	Small	Good	Irreversible	Medium	Long	Intermediate	Intermediate
T2	Travellers of Tseung Kwan O Station and Public Transport Interchange in the junction of Tong Tak Street and Tong Chun Street	Nil	900m	Small	Good	Irreversible	Medium	Long	Intermediate	Intermediate
OU1	Visitor of Junk Bay Chinese Permanent Cemetery	Partial	500m	Medium	Good	Irreversible	Medium	Long	Intermediate	Intermediate
Planned VSRs										
GIC6	Planned GIC development of TKO area 67, Area 72 and Area 74	Partial	650m	Medium	Good	Irreversible	Medium	Long	-	Intermediate
GIC7	Planned Fire Services Training School cum Driving School, and the proposed private hospital in Area 78	Partial	1100m	Medium	Good	Irreversible	Medium	Long	-	Intermediate
GIC8	Planned high-rise residential uses along Shek Kok Road in Area 85	Partial	350m	Medium	Good	Irreversible	Medium	Long	Intermediate	Intermediate

VSR Type & ID.	Key VSR	Blockage of View (Full/ Partial/ Glimpse/ Nil)	Approximate Closest Viewing Distance(m) to Proposed CBL	Scale of Development (Large/ Medium/ Small)	Compatibility with Surrounding Landscape (Good /Fair /Poor)	Reversibility of Change (Reversible/ Irreversible)	Duration of Impact (Temporary [Short/Medium term], Permanent [Long])		Magnitude of impacts (Large / Intermediate/small/negligible)	
							Construction	Operation	Construction	Operation
O1	Planned "Central Avenue" in Town Centre South near the promenade in open space of TKO Area 68 and the promenade user in the former TKO Stage I Landfill site (O1)	Nil	500m	Medium	Good	Irreversible	Medium	Long	-	Large
O2	Planned visitors along the waterfront near the Eastern Channel in open space of TKO Area 68	Partial	700m	Medium	Good	Irreversible	Medium	Long	-	Intermediate
O3	Planned visitors at the proposed Open Space in Area 74	Partial	850m	Small	Good	Irreversible	Medium	Long	-	Small
R7	Planned Residential area of TKO Area 65, 66 and 68	Nil	600m	Large	Fair	Irreversible	Medium	Long	Intermediate	Large
T3	Planned Travellers of Cross Bay Link and Tseung Kwan O – Lam Tin Tunnel	Nil	10m	Large	Good	Irreversible	Medium	Long	-	Large

VSR Type & ID.	**Key VSR**	**Blockage of View (Full/ Partial/ Glimpse/ Nil)**	**Approximate Closest Viewing Distance(m) to Proposed CBL**	**Scale of Development (Large/ Medium/ Small)**	**Compatibility with Surrounding Landscape (Good /Fair /Poor)**	**Reversibility of Change (Reversible/ Irreversible)**	**Duration of Impact (Temporary [Short/Medium term], Permanent [Long])**		**Magnitude of impacts (Large / Intermediate/small/negligible)**	
							Construction	**Operation**	**Construction**	**Operation**
OU2	Planned visitor and residents in commercial development with Public Transport Interchange	Partial	950m	Medium	Good	Irreversible	Medium	Long	Intermediate	Intermediate
REC1	Planned recreational users in TKO Stage I Landfill	Nil	350m	Large	Good	Irreversible	Medium	Long	-	Large
I 1	Planned Tseung Kwan O Industrial Estate Extension	Partial	100m	Large	Good	Irreversible	Medium	Long	-	Large

* VSRs (GIC8, R7 and OU2) in developments planned to be completed before operation of CBL.

13.6 Landscape Impact Assessment

13.6.1 Potential Sources of Impacts

- The nature and scope of works are described in chapter 1-4. Sources of impacts of CBL during the construction phase are described below while the impacts of these potential sources on each LRs and LCAs are provided in Table 6.1.

Direct Impacts:

- A dual 2-lane carriageway of approximately 1.8 km long across Junk Bay, mainly on viaduct, with the associated slip roads and junction improvements;
- Associated civil, structural, marine, ship impact protection, geotechnical, landscape, fire services installation, lighting (including road lighting and architectural lighting), traffic control and surveillance system, signing, traffic aids, electrical & mechanical, and environmental protection and mitigation works, and other related works;
- Cycle track and footpath along Wan O Road
- Road D9, approach viaduct and noise mitigation measures, namely noise barrier or noise enclosure
- Piers of CBL

Indirect Impacts:

- construction traffic,
- the laying of utilities, including water, drainage and power,
- temporary site access areas, site cabins and heavy machinery,
- increased road traffic congestion,
- after dark lighting and welding, and
- dust during dry weather.

13.6.2 **Prediction of Significance of Landscape Impacts**

- The magnitude of the impacts, before implementation of mitigation measures, on the landscape resources and landscape character areas that would occur in the construction phase and operation phase are described below and tabulated in Table 6.1.

Table 6.1 Landscape Impacts of the Proposed Works during Construction Phase

Id No.	Landscape Resources/ Landscape Character Areas	Source of Impact	Description of Impacts	Magnitude of impact (Construction)	Magnitude of impact (Operation)
Landscape Resources					
LR01	Sea Waterbody	• 10 No. approach piers • 2 No. main bridge piers	• Approx. 0.05% (800 sq.m. out of 1,621,900 sq.m.) sea water body will be lost due to the construction of piers for CBL bridge	small	small
LR02	Landscaped Area and Plantation within High-rise Residential Development in Area 86 (Lohas Park)	• none	• N.A.	Negligible	Negligible
LR03	Vegetation along Wan O Road (including promenade, Road D9, Wan O Road)	• Road D9, approach viaduct and noise mitigation measures, namely noise barrier or noise enclosure • Cycle track and footpath along Wan O Road	Approximately 308 no. of trees will be affected, of which approximately 58 no. are proposed to be transplanted, and approximately 250 no. trees are proposed to be felled (including 190 no. Leucaena leucocephala and 60 no. common trees).	Large	Large
LR04	Plantation within Vacant Land	• none	• N.A.	Negligible	Negligible
LR05	Plantation within Industrial Building	• none	• N.A.	Negligible	Negligible
LR06	Woodland at Foothill and Hillside	• none	• N.A.	Negligible	Negligible

Id No.	Landscape Resources/ Landscape Character Areas	Source of Impact	Description of Impacts	Magnitude of impact (Construction)	Magnitude of impact (Operation)
LR07	Grassland and Scrubland at Hillside	• none	• N.A.	Negligible	Negligible
LR08	Vegetation of clustered newly planted trees and shrubs scattered on Tseung Kwan O Stage II and III Landfill Area	• none	• N.A.	Negligible	Negligible
LR09	Natural Rocky and Sand Shoreline	• none	• N.A.	Negligible	Negligible
LR10	Plantation at Wasteland / Construction Area	• none	• N.A.	Negligible	Negligible
LR11	Vegetation along the Coastline Adjacent to Lohas Park Road	• none	• N.A.	Negligible	Negligible
LR12	Roadside Planting	• none	• N.A.	Negligible	Negligible
LR13	Seawall	• none	• N.A.	Negligible	Negligible
Landscape Character Area					
LCA01	Junk Bay Coastal Landscape	• Piers of the CBL	• Approx. 0.05% of Sea water body will be lost due to the construction of piers for CBL bridge	small	small

Id No.	Landscape Resources/ Landscape Character Areas	Source of Impact	Description of Impacts	Magnitude of impact (Construction)	Magnitude of impact (Operation)
LCA02	Reclamation/Ongoing Major Development Landscape	• Road D9, approach viaduct and noise mitigation measures, namely noise barrier or noise enclosure • Cycle track and footpath along Wan O Road	• Approximately 308 no. of trees will be affected, of which approximately 58 no. are proposed to be transplanted, and approximately 250 no. trees are proposed to be felled (including 190 no. Leucaena leucocephala and 60 no. common trees)	small	small
LCA03	Tseung Kwan O Industrial Urban Landscape	• none	• N.A.	Negligible	Negligible
LCA04	Chiu Keng Wan Coastal Upland and Hillside Landscape	• none	• N.A.	Negligible	Negligible
LCA05	Tseung Kwan O Landfill Landscape (Stage II and Stage III)	• none	• N.A.	Negligible	Negligible
LCA06	Tseung Kwan O Miscellaneous Urban Fringe Landscape	• none	• N.A.	Negligible	Negligible
LCA07	High Junk Peak Coastal Upland and Hillside Landscape	• none	• N.A.	Negligible	Negligible
LCA08	Residential Urban Fringe Landscape	• none	• N.A.	Negligible	Negligible

13.6.2.1 Tree Survey plan and tree assessment schedule for the areas where study has been completed are shown in Appendix 13.1.

13.7 Mitigation Measures

13.7.1.1 The previous sections have identified the potential landscape and visual impacts due to the CBL. A series of mitigation measures have been formulated in order to alleviate some of the effects of these impacts where possible, while some mitigation measures are targeted to provide the potential landscape visual enhancement.

13.7.1.2 The proposed landscape and visual mitigation measures for the CBL are listed in Table 7.1 and 7.2. Generally, all mitigation measures are to be implemented as early as possible and many of these mitigation measures perform multiple functions.

Table 7.1 Construction Phase Mitigation Measures for Cross Bay Link

ID No.	Construction Phase Mitigation Measures	Funding Agency	Implementation Agency
CM01	The construction area and contractor's temporary works areas should be minimised to avoid impacts on adjacent landscape, and the reliance on off-site construction	CEDD	CEDD
CM02	Reduction of construction period to practical minimum.	CEDD	CEDD
CM03	Topsoil, where identified, should be stripped and stored for re-use in the construction of the soft landscape works, where the soil material meets acceptable criteria and where practical. The Contract Specification shall include storage and reuse of topsoil as appropriate.	CEDD	CEDD
CM04	Existing trees on boundary of the Project Area shall be carefully protected during construction. Detailed Tree Protection Specification shall be provided in the Contract Specification. Under this specification, the Contractor shall be required to submit, for approval, a detailed working method statement for the protection of trees prior to undertaking any works adjacent to all retained trees, including trees in contractor's works areas. (Tree	CEDD	CEDD

ID No.	Construction Phase Mitigation Measures	Funding Agency	Implementation Agency
	protection measures will be detailed at Tree Removal Application stage).		
CM05	Trees unavoidably affected by the works shall be transplanted where practical. Trees should be transplanted straight to their final receptor site and not held in a temporary nursery. A detailed Tree Transplanting Specification shall be provided in the Contract Specification, if applicable. Sufficient time for necessary tree root and crown preparation periods shall be allowed in the project programme.	CEDD	CEDD
CM06	Advance screen planting to proposed roads and associated structures.	CEDD	CEDD
CM07	Hydroseeding or sheeting of soil stockpiles with visually unobtrusive material (in earth tone).	CEDD	CEDD
CM08	Screening of construction works by hoardings/noise barriers around works area in visually unobtrusive colours, to screen Works.	CEDD	CEDD
CM09	Control night-time lighting and glare by hooding all lights.	CEDD	CEDD
CM10	Ensure no run-off into water body adjacent to the Project Area.	CEDD	CEDD
CM11	Avoidance of excessive height and bulk of buildings and structures, namely, use of longer span pier design to reduce the number of piers	CEDD	CEDD

Table 7.2 Operation Phase Mitigation Measures for Cross Bay Link

ID No.	Operation Phase Mitigation Measures	Funding Agency	Implementation Agency	Maintenance/ Management Agency
OM1	Compensatory tree planting for all felled trees shall be provided to the satisfaction of relevant Government departments. Required numbers and locations of compensatory trees shall be determined and agreed separately with Government during the Tree Felling Application process under ETWBTC 3/2006.	CEDD	CEDD	CEDD/ LCSD
OM2	A continuous belt of screen planting along the roads. Planting of the belt of trees shall be carried out as advance works ahead of other site formation and building works.	CEDD	CEDD	CEDD/LCSD
OM3	Maximise soft landscape of the site, Where space permits, roadside berms /slope treatment works should be created.	CEDD	CEDD	CEDD/LCSD
OM4	During detailed design, refine structure layout to create a planting strips along the roads to enhance greenery.	CEDD	CEDD	CEDD/LCSD
OM5	Use appropriate (visually unobtrusive and non-reflective) building structural materials and colours, and aesthetic design in built structures.	CEDD	CEDD	CEDD

ID No.	Operation Phase Mitigation Measures	Funding Agency	Implementation Agency	Maintenance/ Management Agency
OM6	Streetscape elements (e.g. paving, signage, street furniture, railing etc.) shall be sensitively designed in a manner that responds to the local context, and minimises potential negative landscape and visual impacts. Lighting units should be directional and minimise unnecessary light spill.	CEDD	CEDD	CEDD
OM7	Avoidance of excessive height and bulk of buildings and structures	CEDD	CEDD	CEDD

13.7.1.3 An indicative list of species appropriate for mitigation planting is provided in Table 7.3.

Table 7.3 Operation Phase Mitigation Measures for CBL

Compensatory Tree Species Botanical Name	Chinese Common Name	Size
Callistemon viminalis	串錢柳	Heavy Standard tree
Cassia surattensis	黃槐	Heavy Standard tree
Celtis sinensis	朴樹	Heavy Standard tree
Cinnamomum camphora	樟	Heavy Standard tree
Crateva unilocularis	魚木	Heavy Standard tree
Hibiscus tiliaceus	黃槿	Heavy Standard tree
Lagerstroemia speciosa	紫薇	Heavy Standard tree
Sapium discolor	山烏桕	Heavy Standard tree
Terminalia mantaly	細葉欖仁	Heavy Standard tree
Livistona chinensis	蒲葵	Heavy Standard tree

13.7.1.4 The master landscape plans show the preliminary soft landscape treatment to the CBL are shown in Drawing no. 209506/EIA/LA/1801-1803. The Photomontages of the proposed project without and with mitigation measures at Day 1 and Year 10, illustrating the appearance of the proposed works, and the locations of viewpoints, are shown in Drawing no. 209506/EIA/LA/1700-1709.

13.7.1.5 The potential significance of landscape impacts during the construction and operation phases are tabulated in Table 7.4. All impacts are adverse unless otherwise stated.

Table 7.4 Significance threshold of residual impact before and after mitigation: Operation Day 1 and Year 10 (Note: All impacts are Adverse unless otherwise noted as Beneficial).

ID. No.	Landscape Resources / Landscape Characters	Sensitivity (Low, Medium, High)	Magnitude of Change (Negligible, Small, Intermediate, Large)*		Impact Significance Threshold BEFORE Mitigation (Insubstantial, Slight, Moderate, Substantial)		Recommended Mitigation Measures	Residual Impact Significance Threshold AFTER Mitigation (Insubstantial, Slight, Moderate, Substantial)		
			Construction	Operation	Construction	Operation		Construction	Operation	
									DAY 1	YEAR 10
	Existing Landscape Resources									
LR01	Sea Waterbody	Medium	small	small	Slight	Slight	CM1, CM2, CM10	Slight	Slight	Slight
LR02	Landscaped Area and Plantation within High-rise Residential Development in Area 86 (Lohas Park)	Medium	Negligible	Negligible	Insubstantial	Insubstantial	CM1 to CM6, OM1 to OM4	Insubstantial	Insubstantial	Insubstantial
LR03	Vegetation along Wan O Road (including promenade, Road D9, Wan O Road)	Medium	Large	Large	Moderate	Moderate	CM1 to CM6, OM1 to OM4	Slight	Slight	Insubstantial
LR04	Plantation within Vacant Land	low	Negligible	Negligible	Insubstantial	Insubstantial	CM1 to CM5, OM1 to OM4	Insubstantial	Insubstantial	Insubstantial
LR05	Plantation within Industrial Building	low	Negligible	Negligible	Insubstantial	Insubstantial	Not required	Insubstantial	Insubstantial	Insubstantial

ID. No.	Landscape Resources / Landscape Characters	Sensitivity (Low, Medium, High)	Magnitude of Change (Negligible, Small, Intermediate, Large)*		Impact Significance Threshold BEFORE Mitigation (Insubstantial, Slight, Moderate, Substantial)		Recommended Mitigation Measures	Residual Impact Significance Threshold AFTER Mitigation (Insubstantial, Slight, Moderate, Substantial)		
			Construction	Operation	Construction	Operation		Construction	Operation	
									DAY 1	YEAR 10
LR06	Woodland at Foothill and Hillside	High	Negligible	Negligible	Insubstantial	Insubstantial	CM1 to CM5, OM1 to OM4	Insubstantial	Insubstantial	Insubstantial
LR07	Grassland and Scrubland at Hillside	Medium	Negligible	Negligible	Insubstantial	Insubstantial	CM1 to CM5, OM1 to OM4	Insubstantial	Insubstantial	Insubstantial
LR08	Vegetation of clustered newly planted trees and shrubs scattered on Tseung Kwan O Stage II and III Landfill Area	Medium	Negligible	Negligible	Insubstantial	Insubstantial	CM1 to CM5, OM1 to OM4	Insubstantial	Insubstantial	Insubstantial
LR09	Natural Rocky and Sand Shoreline	High	Negligible	Negligible	Insubstantial	Insubstantial	CM1 to CM5, OM1 to OM4	Insubstantial	Insubstantial	Insubstantial
LR10	Plantation at Wasteland / Construction Area	Low	Negligible	Negligible	Insubstantial	Insubstantial	CM1 to CM5, OM1 to OM4	Insubstantial	Insubstantial	Insubstantial
LR11	Vegetation along the Coastline Adjacent to Lohas Park Road	Low	Negligible	Negligible	Insubstantial	Insubstantial	CM1 to CM5, OM1 to OM4	Insubstantial	Insubstantial	Insubstantial
LR12	Roadside Planting	Medium	Negligible	Negligible	Insubstantial	Insubstantial	CM1 to CM5, OM1 to OM4	Insubstantial	Insubstantial	Insubstantial

ID. No.	Landscape Resources / Landscape Characters	Sensitivity (Low, Medium, High)	Magnitude of Change (Negligible, Small, Intermediate, Large)*		Impact Significance Threshold BEFORE Mitigation (Insubstantial, Slight, Moderate, Substantial)		Recommended Mitigation Measures	Residual Impact Significance Threshold AFTER Mitigation (Insubstantial, Slight, Moderate, Substantial)		
			Construction	Operation	Construction	Operation		Construction	Operation	
									DAY 1	YEAR 10
LR13	Seawall	Low	Negligible	Negligible	Insubstantial	Insubstantial	CM1 to CM5, OM1 to OM4	Insubstantial	Insubstantial	Insubstantial
	Existing Landscape Character Areas									
LCA01	Junk Bay Coastal Landscape	Medium	small	small	Slight	Slight	CM1 to CM7, CM11, OM1 to OM4, OM7	Slight	Slight	Slight
LCA02	Reclamation/Ong oing Major Development Landscape	Low	small	small	Slight	Slight	CM1 to CM7, CM11, OM1 to OM4, OM7	Slight	Slight	Insubstantial
LCA03	Tseung Kwan O Industrial Urban Landscape	Low	Negligible	Negligible	Insubstantial	Insubstantial	CM1 to CM7, CM11, OM1 to OM4, OM7	Insubstantial	Insubstantial	Insubstantial
LCA04	Chiu Keng Wan Coastal Upland and Hillside Landscape	High	Negligible	Negligible	Insubstantial	Insubstantial	CM1 to CM7, CM11, OM1 to OM4, OM7	Insubstantial	Insubstantial	Insubstantial
LCA05	Tseung Kwan O Landfill Landscape (Stage II and Stage III)	High	Negligible	Negligible	Insubstantial	Insubstantial	CM1 to CM7, CM11, OM1 to OM4, OM7	Insubstantial	Insubstantial	Insubstantial

ID. No.	Landscape Resources / Landscape Characters	Sensitivity (Low, Medium, High)	Magnitude of Change (Negligible, Small, Intermediate, Large)*		Impact Significance Threshold BEFORE Mitigation (Insubstantial, Slight, Moderate, Substantial)		Recommended Mitigation Measures	Residual Impact Significance Threshold AFTER Mitigation (Insubstantial, Slight, Moderate, Substantial)		
			Construction	Operation	Construction	Operation		Construction	Operation	
									DAY 1	YEAR 10
LCA06	Tseung Kwan O Miscellaneous Urban Fringe Landscape	Low	Negligible	Negligible	Insubstantial	Insubstantial	CM1 to CM7, CM11, OM1 to OM4, OM7	Insubstantial	Insubstantial	Insubstantial
LCA07	High Junk Peak Coastal Upland and Hillside Landscape	High	Negligible	Negligible	Insubstantial	Insubstantial	CM1 to CM7, CM11, OM1 to OM4, OM7	Insubstantial	Insubstantial	Insubstantial
LCA08	Residential Urban Fringe Landscape	Medium	Negligible	Negligible	Insubstantial	Insubstantial	CM1 to CM7, CM11, OM1 to OM4, OM7	Insubstantial	Insubstantial	Insubstantial

*The magnitude of change for construction stage and operation stage is the same unless stated otherwise

13.8 Visual Impact Assessment

13.8.1 Potential Sources of Visual Impacts

13.8.1.1 The sources of visual impacts due to the Project would create varying levels of visual impact during the construction and operation phases. Potential impacts would result from the elements stated in Section 6.1.

13.8.2 Nature and Magnitude of Unmitigated Visual Impacts in Construction and Operation Phase

13.8.2.1 The magnitude of the impacts, before implementation of mitigation measures, on the VSRs that would occur in the construction and operation phase are described below and tabulated in Table 5.2. All impacts are adverse unless otherwise stated. The residual impact significant threshold during construction, Day 1 operation, and Year 10 operation phase are tabulated in Table 8.1.

13.8.2.2 During the construction phase, the unmitigated visual impacts are adverse in nature and mainly include blockage of views to the landscape resources, degrading of visual quality of existing views and visual incompatibility of the construction works with the surroundings. For most of the VSRs in strategic and district levels, the magnitude of impacts is considered to be small or negligible for the distance between the VSRs and the CBL developments is long and the degree of visibility remains low.

13.8.2.3 For VSRs at local level, the magnitude of impacts in construction phase varies with visual sensitivity. In general, the closer the VSRs to the development, the larger the magnitude of visual impacts as there will be higher potential that views from these VSRs will be fully/partially blocked by the construction activities.

13.8.2.4 The magnitude of impacts is also considered to be large for the residential developments along the Po Yap Road, namely, Residents of Park Central (R4), Residents of The Grandiose and Tseung Kwan O Plaza (R5) and Residents of Ocean Shores (Phase I to Phase III) (R2), as there will be direct adverse impacts.

13.8.2.5 During the operation phase, the nature of unmitigated visual impacts could be adverse. Adverse impacts will be resulted from the blockage of views to the landscape resources and permanent loss of panoramic seaviews. The magnitude of adverse visual impacts is large for the highly sensitive VSRs located in close proximity to TKO Area 65, 66, and 68 where the proposed CBL will induce blockage of views and permanent loss of panoramic seaviews that some of these VSRs would enjoy.

13.8.2.6 The major source of visual impacts will be the approach viaduct and the navigation bridge from the Wan Po Road to connect to the TKO-LTT at Chiu Keng Wan. Mitigation measures will include aesthetic design such as the use of visually unobtrusive colours and avoidance of excessive height and bulk of structures. Due to the high sensitivity of the VSRs located in close proximity to TKO Area 65, 66, and 68 itself, the impact significant threshold before mitigation will be moderate. With the implementation of mitigation measures, it will still suffer from slight visual impact of the CBL.

13.8.2.7 During the night time, lighting provisions on the connecting roads and the lighting glare emitted by vehicles will cause adverse impact. Therefore, the lighting design of the main bridge will be designed to minimize the glare at night.

13.8.2.8 In general, magnitude of adverse impacts will be reduced as the distance between VSRs and the developments increases. Whilst the VSRs at strategic and district levels are not that sensitive to changes in visual context induced by the developments, the magnitude of impacts will remain small or negligible.

Table 8.1 Significance of Visual Impacts in the Construction and Operation Phases (Note: All impacts are adverse unless otherwise noted with beneficial)

VSR Type & ID.	Key Visually Sensitive Receiver (VSR)	Magnitude of Impact (Negligible, Small, Intermediate, Large)		Receptor Sensitivity (Low, Medium, High)		Impact Significance Threshold Before Mitigation (Insubstantial, Slight, Moderate, Substantial)		Recommended Mitigation Measures	Residual Impact Significance Threshold After Mitigation (Insubstantial, Slight, Moderate, Substantial)		
									Construction	Operation	
		Construction	Operation	Construction	Operation	Construction	Operation			DAY 1	YEAR 10
VSRs at Strategic Level											
S1	Visitors of Lei Yue Mun Holiday Village and Lei Yue Mun Park, and Hong Kong Museum of Coastal Defence	Small	Small	Medium	Medium	Slight/ Moderate	Slight/ Moderate	CM1, CM2, CM8, CM9, CM11, OM5 to OM7	Slight	Slight	Slight
S2	Hikers along High Junk Peak (Tiu Yue Yung) in Clear Water Bay Country Park	Small	Small	Low	Low	Slight	Slight	CM1, CM2, CM8, CM9, CM11, OM5 to OM7	Slight	Slight	Insubstantial
S3	Travellers along Lei Yue Mun and Tathong Channel	Small	Small	Low	Low	Slight	Slight	CM1, CM2, CM8, CM9, CM11, OM5 to OM7	Slight	Slight	Slight
S4	Visitors/hikers along Wilson Trail (near Devil's Peak of Lei Yue Mun)	Small	Small	Low	Low	Slight	Slight	CM1, CM2, CM8, CM9, CM11, OM5 to OM7	Slight	Slight	Slight
S5	Visitors/Hikers at Mount Parker	Small	Small	Low	Low	Slight	Slight	CM1, CM2, CM8, CM9, CM11, OM5 to OM7	Slight	Slight	Insubstantial
S6	Visitors/Hikers at Pottinger Peak	Small	Small	Low	Low	Slight	Slight	CM1, CM2, CM8, CM9, CM11, OM5 to OM7	Slight	Slight	Insubstantial

VSR Type & ID.	Key Visually Sensitive Receiver (VSR)	Magnitude of Impact (Negligible, Small, Intermediate, Large)		Receptor Sensitivity (Low, Medium, High)		Impact Significance Threshold Before Mitigation (Insubstantial, Slight, Moderate, Substantial)		Recommended Mitigation Measures	Residual Impact Significance Threshold After Mitigation (Insubstantial, Slight, Moderate, Substantial)		
									Construction	Operation	
		Construction	Operation	Construction	Operation	Construction	Operation			DAY 1	YEAR 10
S7	Visitors/Hikers at Mount Collinson	Small	Small	Low	Low	Slight	Slight	CM1, CM2, CM8, CM9, CM11, OM5 to OM7	Slight	Slight	Insubstantial
S8	Visitors/Hikers at Black Hill	Small	Small	Low	Low	Slight	Slight	CM1, CM2, CM8, CM9, CM11, OM5 to OM7	Slight	Slight	Insubstantial
VSRs at District Level											
D1	Heng Fa Chuen Residential Area	Small	Small	High	High	Moderate	Moderate	CM1, CM2, CM8, CM9, CM11, OM5 to OM7	Slight	Slight	Slight
D2	Island Resort Residential Area and visitor in Siu Sai Wan Promenade and Sports Ground	Small	Small	High	High	Moderate	Moderate	CM1, CM2, CM8, CM9, CM11, OM5 to OM7	Slight	Slight	Slight
D3	Tseung Kwan O Industrial Estate	Small	Small	Low	Low	Slight	Slight	CM1, CM2, CM8, CM9, CM11, OM5 to OM7	Slight	Slight	Insubstantial
D4	Logistics Centre and Preliminary Treatments Works and Cargo Handling Basin	Small	Small	Medium	Medium	Slight/ Moderate	Slight/ Moderate	CM1, CM2, CM8, CM9, CM11, OM5 to OM7	Slight	Slight	Slight
VSRs at Local Level											
CDA1	Residents or workers in Tsueng Kwan O Comprehensive Development Area 86	Large	Large	High	High	Substantial	Substantial	CM1, CM2, CM6 to CM9, CM11, OM2 to OM7	Moderate	Moderate	Moderate

VSR Type & ID.	Key Visually Sensitive Receiver (VSR)	Magnitude of Impact (Negligible, Small, Intermediate, Large)		Receptor Sensitivity (Low, Medium, High)		Impact Significance Threshold Before Mitigation (Insubstantial, Slight, Moderate, Substantial)		Recommended Mitigation Measures	Residual Impact Significance Threshold After Mitigation (Insubstantial, Slight, Moderate, Substantial)		
									Construction	Operation	
		Construction	Operation	Construction	Operation	Construction	Operation			DAY 1	YEAR 10
GIC1	Workers of Tseung Kwan O Sewage Treatment Works, Bus depot in TKO Area 85 and Tseung Kwan O Stage II and III Landfill area	Intermediate	Intermediate	Low	Low	Slight/ Moderate	Slight/ Moderate	CM1, CM2, CM6 to CM9, CM11, OM2 to OM7	Slight	Slight	Slight
GIC2	Users of Tseung Kwan O Methodist Primary School and Evangel College	Intermediate	Small	Low	Low	Slight / Moderate	Slight	CM1, CM2, CM6 to CM8, CM11, OM2 to OM7	Slight	Slight	Slight
GIC3	Users of P.O.H. 80th Anniversary Tang Ying Hei College, C.&M. A. Sung Kei secondary School, Yan Chai Hospital Wong Wah San Secondary School and Yan Oi Tong Tin Ka Ping Primary School	Small	Negligible	Low	Low	Slight	Insubstantial	CM1, CM2, CM8, CM11, OM5 to OM7	Slight	Slight	Slight
GIC4	Users of Hong Kong Design Institute Campus	Intermediate	Small	Low	Low	Slight / Moderate	Slight	CM1, CM2, CM6 to CM8, CM11, OM2 to OM7	Slight	Slight	Slight
GIC5	Users of Creative Secondary School	Small	Small	Low	Low	Slight	Slight	CM1, CM2, CM6 to CM8, CM11, OM2 to OM7	Slight	Slight	Slight
R1	Residents of Bauhania Garden	Large	Intermediate	Medium	Medium	Moderate / Substantial	Moderate	CM1, CM2, CM6 to CM9, CM11, OM2 to OM7	Slight	Slight	Slight

VSR Type & ID.	Key Visually Sensitive Receiver (VSR)	Magnitude of Impact (Negligible, Small, Intermediate, Large)		Receptor Sensitivity (Low, Medium, High)		Impact Significance Threshold Before Mitigation (Insubstantial, Slight, Moderate, Substantial)		Recommended Mitigation Measures	Residual Impact Significance Threshold After Mitigation (Insubstantial, Slight, Moderate, Substantial)		
		Construction	Operation	Construction	Operation	Construction	Operation		Construction	Operation DAY 1	Operation YEAR 10
GIC9	Workers at Hong Kong Movie City	Intermediate	Small	Medium	Medium	Moderate	Slight/ Moderate	CM1, CM2, CM6 to CM9, CM11, OM2 to OM7	Slight	Slight	Slight
R2	Residents of Ocean Shores (Phase I to Phase III)	Large	Large	High	High	Substantial	Substantial	CM1, CM2, CM6 to CM9, CM11, OM2 to OM7	Moderate	Moderate	Moderate
R3	Residents of Metro Town	Large	Intemediate	Medium	Medium	Moderate/ Substantial	Moderate	CM1, CM2, CM6 to CM9, CM11, OM2 to OM7	Slight	Slight	Slight
R4	Residents of Park Central	Large	Small	Medium	Medium	Moderate/ Substantial	Slight/ Moderate	CM1, CM2, CM6 to CM9, CM11, OM2 to OM7	Slight	Slight	Slight
R5	Residents of The Grandiose and Tseung Kwan O Plaza	Large	Small	Medium	Medium	Moderate/ Substantial	Slight/ Moderate	CM1, CM2, CM6 to CM9, CM11, OM2 to OM7	Slight	Slight	Slight
R6	Residents of Oscar By the Sea	Large	Intermediate	Medium	Medium	Moderate/ Substantial	Moderate	CM1, CM2, CM6 to CM9, CM11, OM2 to OM7	Slight	Slight	Slight
T1	Travellers of Wan Po Road	Intermediate	Intermediate	Low	Low	Slight / Moderate	Slight / Moderate	CM1, CM2, CM6 to CM9, CM11, OM2 to OM7	Slight	Slight	Insubstantial
T2	Travellers of Tseung Kwan O Station and Public Transport Interchange in the junction of Tong Tak Street and Tong Chun Street	Intermediate	Intermediate	Low	Low	Slight / Moderate	Slight / Moderate	CM1, CM2, CM6 to CM9, CM11, OM2 to OM7	Slight	Slight	Insubstantial

VSR Type & ID.	Key Visually Sensitive Receiver (VSR)	Magnitude of Impact (Negligible, Small, Intermediate, Large)		Receptor Sensitivity (Low, Medium, High)		Impact Significance Threshold Before Mitigation (Insubstantial, Slight, Moderate, Substantial)		Recommended Mitigation Measures	Residual Impact Significance Threshold After Mitigation (Insubstantial, Slight, Moderate, Substantial)		
									Construction	Operation	
		Construction	Operation	Construction	Operation	Construction	Operation			DAY 1	YEAR 10
OU1	Visitor of Junk Bay Chinese Permanent Cemetery	Intermediate	Intermediate	Low	Low	Slight / Moderate	Slight / Moderate	CM1, CM2, CM6 to CM8, CM11, OM2 to OM7	Slight	Slight	Slight
Planned VSRs											
GIC6	Planned GIC development of TKO area 67, Area 72 and Area 74	-	Intermediate	-	Medium	-	Moderate	OM2 to OM7	-	Slight	Slight
GIC7	Planned Fire Services Training School cum Driving School, and the proposed private hospital in Area 78	-	Intermediate	-	Medium	-	Moderate	OM2 to OM7	-	Slight	Slight
GIC8	Planned high-rise residential uses along Shek Kok Road in Area 85	Intermediate	Intermediate	Medium	Medium	Moderate	Moderate	OM2 to OM7	Slight	Slight	Slight
O1	Planned visitors at the proposed "Central Avenue" in Town Centre South near the promenade in open space of TKO Area 68 and the promenade user in the former TKO Stage I Landfill site.	-	Large	-	High	-	Substantial	OM2 to OM7	-	Moderate	Moderate
O2	Planned visitors along the waterfront near the Eastern Channel in open space of TKO Area 68	-	Intermediate	-	High	-	Moderate/ Substantial	OM2 to OM7	-	Moderate	Moderate

VSR Type & ID.	Key Visually Sensitive Receiver (VSR)	Magnitude of Impact (Negligible, Small, Intermediate, Large)		Receptor Sensitivity (Low, Medium, High)		Impact Significance Threshold Before Mitigation (Insubstantial, Slight, Moderate, Substantial)		Recommended Mitigation Measures	Residual Impact Significance Threshold After Mitigation (Insubstantial, Slight, Moderate, Substantial)		
									Construction	Operation	
		Construction	Operation	Construction	Operation	Construction	Operation			DAY 1	YEAR 10
O3	Planned visitors at the proposed Open Space in Area 74	-	Small	-	Low	-	Slight	OM2 to OM7	-	Slight	Slight
R7	Planned Residential area of TKO Area 65, 66 and 68	Intermediate	Large	High	High	Moderate/ Substantial	Substantial	OM2 to OM7	Moderate	Moderate	Moderate
T3	Planned Travellers of Cross Bay Link and Tseung Kwan O – Lam Tin Tunnel	-	Large	-	Low	-	Moderate	OM2 to OM7	-	Insubstantial	Insubstantial
OU2	Planned visitor and residents in commercial development with Public Transport Interchange	Intermediate	Intermediate	Medium	Medium	Moderate	Moderate	OM2 to OM7	Moderate	Slight	Slight
REC1	Planned recreational users in TKO Stage I Landfill	-	Large	-	Medium	-	Moderate / Substantial	OM2 to OM7	-	Slight	Slight
I 1	Planned Tseung Kwan O Industrial Estate Extension	-	Large	-	Low	-	Moderate	OM2 to OM7	-	Slight	Insubstantial
				-					-		

* C = commercial, CA = conservation area or countryside conservation area, CDA = comprehensive development area, C/R = commercial / residential, GIC = government/institution/community, I = industrial, O = open space, OU = other specific use, R = residential, T = transport related.

13.9 Residual Impacts

13.9.1 Residual Impacts

13.9.1.1 The major existing / planned concurrent projects are listed below (refer to chapter 1 for detail description):-

Table 9.1 Programme of Concurrent projects with CBL

Project	Start	End	Remarks
Tseung Kwan O – Lam Tin Tunnel	2016	2020	To be constructed concurrently with marine works of CBL
Area 86 Development		2020	A promenade along the Area 86 Development is proposed by MTRC as shown on drawing no. 209506/EIA/LV/1101. The cycle track is preliminarily designed to 4.5m wide. Construction of the promenade is scheduled to complete in 2019
Tseung Kwan O further development – Infrastructure works at Town Centre South and Tiu Keng Leng, Tseung Kwan O	Late 2009	Early 2012	PWP item 715CL This project comprises construction of roads, removal of preloading material, realignment of box culvert, raising of existing seawall level and ancillary works including footpaths, cycle tracks, drainage works, water works and landscaping works etc.
Infrastructure Works for TKO Stage 1 Landfill Site (Phase 1)	2009	2012	PWP item 743CL This project is to provide necessary infrastructure works for supporting the recreational development at TKO Stage I Landfill site, including improvement of the linkage between the Landfill site and adjacent areas. Major works of this project comprises construction of: ▪ an approximately 2km long footpath and an approximately 1.6km long cycle track at the landfill toe and in Town Centre South. ▪ an approximately 140m long bridge, namely Northern Bridge, for pedestrians and cyclists across the eastern channel, with approximately 335m long approach roads and

Project	Start	End	Remarks
			a lift ▪ an approximately 1km long grasscrete paved access along the landfill toe, landscaping works and walking trails and associated slope, drainage and ancillary works.
Cycle Tracks and Associated Facilities along Waterfront at Town Centre South, Tseung Kwan O	End 2010	2012	PWP item 270RS The project comprises mainly the construction of about 1.6km cycle tracks connecting from TKO Area 65 to Tiu Keng Leng along waterfront at Town Centre South including adjoining footpaths and cycle parking areas with hard and soft landscaping works

13.9.2 Prediction of Significance of Landscape Impacts

13.9.2.1 The potential significance of the landscape impacts during the construction and operation phases, before and after mitigation, is provided in Table 7.4. This assessment follows the proposed methodology and assumes that the appropriate design measures incorporated in the development layout and the mitigation measures identified in Tables 7.1 and 7.2 would be implemented and that the full effect of the soft landscape mitigation measures would be realized after 10 years. Cumulative impact during construction phase and operation phase of CBL and all concurrent projects within the assessment area on landscape resources and landscape character areas are described below.

13.9.3 Residual Landscape Impact in Construction Phase

13.9.3.1 Based on the tree survey report on CBL, approximately 308 no. of trees will be affected, of which approximately 58 no. are proposed to be transplanted, and approximately 250 no. trees are proposed to be felled (including 190 no. *Leucaena leucocephala* and 60 no. common trees). Due to construction of the CBL, it is unavoidably considered to remove the affected trees.

13.9.3.2 Trees surveyed within the proposed works boundary are primarily common species. There are no LCSD Champion Trees, Registered Old and Valuable Trees nor trees that meet the criteria for Important

Trees (ITs) as listed in ETWBTC(W) 3/2006. There are no tree species listed under Forests and Countryside Ordinance (Cap. 96); and Protection of Endangered Species of Animals and Plants Ordinance(Cap. 586).

13.9.3.3 In accordance with ETWB TC(W) No. 3/2006, the proposed compensatory planting proposal should be of a ratio not less than 1:1 in terms of quality and quantity within the site. For the proposed trees to be felled, heavy standard trees with trunk diameter from 75mm to 150mm (as specified in the Clause 3.15 of General Specification of Civil Engineering Works 2006) will be adopted for compensatory planting. It is expected approx. 67 heavy standard sized trees shall be planted as compensatory tree planting within the site boundary of the proposed works.

13.9.3.4 Cumulative impact on existing trees is summarized in Table 9.2, and final tree removal report is under Appendix 13.1.

Table 9.2 Cumulative Impact on Existing Trees

Landscape Resources	Source of Impact	Residual Impact on Trees in Construction Phase
LR03	Vegetation along Wan O Road (including promenade, Road D9, Wan O Road)	approximately 308 no. of trees will be affected, of which approximately 58 no. are proposed to be transplanted, and approximately 250 no. trees are proposed to be felled (including 190 no. Leucaena leucocephala and 60 no. common trees)

13.9.3.5 There will be permanently loss of 800 sq.m. seawater body, which accounts for 0.05% of the sea water body in the study area, in Junk Bay due to the construction of CBL 10 no. approach piers and 2 no. main bridge piers. The landscape impacts on Seawater body (LR01) can only be slightly mitigated by minimizing area and construction period. Due to the abundance of sea water, therefore, it is considered that the landscape impacts on LR01 are slight with the implementation of mitigation measures.

13.9.3.6 There will be no impact on existing open space, stream course, SSSI, Green Belt area in Chiu Keng Wan Shan and Clear Water Bay Country Park due to the construction of CBL.

13.9.3.7 The residual impact on other LRs and LCAs will be mostly insubstantial, except on LR03, LCA01 and LCA02 will be slight.

13.9.3.8 The overall residual impact on all LR and LCA are considered as acceptable with implementation of mitigation measures.

13.9.4 Residual Landscape Impact in Operation Phase

13.9.4.1 Residual impact on landscape resources and landscape character areas are shown in Table 7.4 and mapped in Drawing no. 209506/EIA/LV/1611 and 1621.

13.9.4.2 In compensation for the lost of vegetation and affected trees, approx 67 new trees will be planted as Compensatory planting. Detailed tree preservation, transplanting and felling including compensatory planting proposals shall be submitted to relevant government departments for approval in accordance with ETWB 3/2006 in Detail Design Stage.

13.9.4.3 LCA01 – There will be some impact on Junk Bay Coastal Landscape due to the operation of CBL and the lost of visual identity and character of Junk Bay. It is considered that the residual impact on this LCA is slight.

13.9.4.4 LCA02 - There will be slight impact on Reclamation / Ongoing Major Development Landscape due to the operation of CBL. However, with the proposed mitigation measures including the aesthetic design of the built structures and soft landscape treatment works, it is considered that the residual impact on this LCA is insubstantial.

13.9.4.5 LCA03 – Tseung Kwan O Industrial Urban Landscape will be subject to insubstantial impact as this LCA is relatively far away from the CBL.

13.9.4.6 LCA04 – Chiu Keng Wan Coastal Upland and Hillside Landscape will be subject to insubstantial impact as this LCA is relatively far away from the CBL. However, this LCA will definitely be affected by the interface project : TKO-LTT.

13.9.4.7 LCA05 – Tseung Kwan O Landfill Landscape (Stage II and Stage III) will be subject to insubstantial impact as this LCA is relatively far away from the CBL and will not be affected.

13.9.4.8 LCA06 – Tseung Kwan O Miscellaneous Urban Fringe Landscape will be subject to insubstantial impact as this LCA is relatively far away from the CBL and will not be affected.

13.9.4.9 LCA07 – High Junk Peak Coastal Upland and Hillside Landscape will be subject to insubstantial impact as this LCA is relatively far away from the CBL and will not be affected.

13.9.4.10 LCA08 – Residential Urban Fringe Landscape will be subject to insubstantial impact as this LCA is relatively far away from the CBL and will not be affected.

13.9.4.11 LR01 – there is expected to be some minor impact upon the sea waterbody in Junk Bay. The sea water body will be lost due to the construction of the piers for CBL bridge. It is considered that the residual impact is expected to be slight.

13.9.4.12 LR2 – there is expected to be negligible impact upon the Landscaped Area and Plantation within High-rise residential development in CDA 86 (LOHAS Park). It is considered that the residual impact is expected to be insubstantial.

13.9.4.13 LR3 – approximately 308 no. of trees will be affected, of which approximately 58 no. are proposed to be transplanted, and approximately 250 no. trees are proposed to be felled (including 190 no. Leucaena leucocephala and 60 no. common trees). Proposed compensatory planting is proposed to comepsate for the loss. It is considered that the residual impact is expected to be insubstantial.

13.9.4.14 LR4 – there is expected to be negligible impact upon the Plantation within Vacant land (LR4). It is considered that the residual impact is expected to be insubstantial.

13.9.4.15 LR5 – there is expected to be negligible impact upon Plantation within Industrial Building (LR5). It is considered that the residual impact is expected to be insubstantial.

13.9.4.16 LR6 – there is expected to be negligible impact upon Woodland at Foothill and Hillside. It is considered that the residual impact is expected to be insubstantial.

13.9.4.17 LR7 – there is expected to be negligible impact upon Grassland and Scrubland at Hillside in Chiu Keng Wan. It is considered that the residual impact is expected to be insubstantial.

13.9.4.18 LR8 – there is expected to be negligible impact upon Vegetation of clustered newly planted trees and shrubs scattered on Tseung Kwan O Stage II and III Landfill Area. It is considered that the residual impact is expected to be insubstantial.

13.9.4.19 LR9 – there is expected to be negligible impact upon Nature Rocky and Sand Shoreline in Chiu Keng Wan. It is considered that the residual impact is expected to be insubstantial.

13.9.4.20 LR10 – there is expected to be negligible impact upon Plantation at Wasteland / Construction Area in Chiu Keng Wan. It is considered that the residual impact is expected to be insubstantial.

13.9.4.21 LR11 – there is expected to be negligible impact upon Vegetation along the Coastline Adjacent to Lohas Park Road. It is considered that the residual impact is expected to be insubstantial.

13.9.4.22 LR12 – there is expected to be negligible impact upon Roadside Planting in Lohas Park Road. It is considered that the residual impact is expected to be insubstantial.

13.9.4.23 LR13 – there is expected to be negligible impact upon Seawall in Tseung Kwan O Industrial Estate. It is considered that the residual impact is expected to be insubstantial.

13.9.4.24 Therefore, the overall cumulative residual impacts on existing trees are considered acceptable with mitigation measures.

13.9.5 Residual Visual Impact in Construction Phase

13.9.5.1 Given the distance and location of the VSRs at strategic and district levels are generally far away from the development, the adverse residual impacts are expected to be slight or insubstantial with the implementation of appropriate mitigation measures.

13.9.5.2 Hikers along High Junk Peak (Tiu Yue Yung) in Clear Water Bay Country Park (S2), Visitors/Hikers at Mount Parker (S5), Visitors/Hikers at Pottinger Peak (S6), Visitors/Hikers at Mount

Collinson (S7) and Visitors/Hikers at Black Hill (S8) will have intermittent and direct views to the construction works of CBL. The distance and topography means that the views will be rare. They will also look down onto the Junk Bay that has already been significantly developed with high-rise residential blocks. There is expected to be small magnitude of change after mitigation with residual impact significance being slight.

13.9.5.3 At local level, VSRs abutting the project boundary of CBL will be subject to moderate residual visual impacts during the construction phase. With the implementation of appropriate mitigation measures like incorporation of decorative hoarding, the residual visual impacts will be lowered to slight level. For residents in Tseung Kwan O CDA (CDA1) and Residents of Ocean Shores (Phase I to Phase III), the residual impacts are still considered to be moderate given their high sensitivity, close proximity to the source of impacts and the Road D9 noise barrier effect on their perception of the visual quality.

13.9.5.4 Other local VSRs further away will only have partial or glimpse views to CBL. Therefore, the residual impacts will be slight after implementation of mitigation measures.

For Planned VSRs, Planned Residential area of TKO Area 65, 66 and 68 (R7) and Planned visitor and residents in commercial development with Public Transport Interchange (OU2), the residual impacts are considered to be moderate during its close and direct views towards the structure of the CBL.

13.9.6 Residual Visual Impact in Operation Phase

13.9.6.1 Residual impact on VSRs are shown in Table 8.1 and mapped in Drawing no. 209506/EIA/LV/1631 and 1633.

13.9.6.2 For VSRs at district levels, the direct sea view from Island Resort Residential Area and Visitors in Siu Sai Wan Promenade and Sports Ground (D2), and Heng Fa Chuen Residential Area (D1) and Logistics Centre and Preliminary Treatments Works and Cargo Handling Basin (D4) will be changed from open seaview to partial blockage by CBL. Given the long distance, the residual visual impact is considered as slight with the implementation of the appropriate mitigation measures. Workers in the TKO Industrial Estate (D3) will have intermittent and distant views of the CBL, hence the residual visual impact during operation phase is insubstantial.

13.9.6.3 For VSRs at strategic levels, the view from Lei Yue Mun Holiday Village and Lei Yue Mun Park, and Hong Kong Museum of Coastal Defence (S1), Lei Yue Mun and Tathong Channel (S3) and Wilson Trail (near Devil's Peak of Lei Yue Mun) (S4) will be changed from open seaview to partial blockage by the CBL. However, as S1, S3 and S4 will have alternative view and sightseeing, it is considered that the residual visual impacts during operation phase are slight.

13.9.6.4 Viewpoint along the High Junk Peak (Tiu Yue Yung) in Clear Water Bay Country Park (S2) and along Black Hill (S8) is approximately 1500m and 2000m respectively from the CBL. The existing Junk Bay will be slightly blocked by the CBL, while the open seaview across the Tathong Channel will not be affected, hence the residual visual impact during operation phase is insubstantial.

13.9.6.5 Visitors/Hikers at Mount Parker (S5), at Pottinger Peak (S6), and at Mount Collinson (S7) are approximately 4500m from the CBL. Visitors will look down onto the Junk Bay that has already been significantly developed with residential blocks, hence the residual visual impact during operation phase is insubstantial.

13.9.6.6 At local level, for VSRs in close proximity to CBL, including residents or workers in Tsueng Kwan O Comprehensive Development Area 86 (CDA1), Residents of Bauhinia Garden (R1), Residents of Ocean Shores (Phase I to Phase III) (R2), Residents of Metro Town (R3), Residents of Park Central (R4), Residents of The Grandiose and Tseung Kwan O Plaza (R5), Residents of Oscar By the Sea (R6) , the residual impacts are expected to be from moderate to slight. There will inevitably be permanent loss of open seaview in Junk Bay and obstruction of existing bay view, even with the implementation of mitigation measures.

13.9.6.7 For the commercial development with PTI along Po Yap Road (OU 2), recreational users in TKO Stage I Landfill (REC 1), proposed "Central Avenue" in Town Centre South near the promenade in open space of TKO Area 68 and the promenade user in the former TKO Stage I Landfill site (O1), along the waterfront near the Eastern Channel in open space of TKO Area 68 (O2), and proposed Open Space in Area 74 (O3), the residual impacts are expected to be slight after the implementation of mitigation measures. There will inevitably be permanent loss of open panoramic seaview, obstruction of existing views and reduction of depth of view, even with the implementation of mitigation measures. In particular, the visual impact of the pier structure cannot be softened because soft landscape treatment cannot be installed over there. Its visual impact can only be slightly minimized by aesthetic design such as the use of visually unobtrusive colours and avoidance of excessive height and bulk of structures.

13.9.6.8 Photomontages showing visual impact on representative VSRs due to the development and the view point plans are shown in Drawing no. 209506/EIA/LV/1700 to 209506/EIA/LV/1709. Their residual impacts are assessed and summarized as below:-

13.9.6.9 Viewpoint from Residents of Park Central (R4) is approximately 1100m from the CBL (Drawing no. 209506/EIA/LV/1701). The existing open seaview will be partially blocked by the proposed CBL, TKO-LTT. With the implementation of mitigation measures, including aesthetic treatment to the engineering structures, the residual visual impact is considered as slight.

13.9.6.10 Viewpoint along Wilson Trail (S4) (near Devil’s Peak of Lei Yue Mun) is approximately 1000m from the CBL (Drawing no. 209506/EIA/LV/1702). The existing open seaview will be partially blocked by the proposed CBL, TKO-LTT. Since the VSR will only have alternative view and only occasional view towards the Junk Bay, the residual visual impact is considered as slight.

13.9.6.11 Viewpoint from Planned Travellers of CBL and TKO-LTT (T3) is shown in Drawing no. 209506/EIA/LV/1703. With the implementation of shrub planting and aesthetic treatment, the residual visual impact is considered as insubstantial.

13.9.6.12 Viewpoint from Tsueng Kwan O Comprehensive Development Area 86 (CDA1) is approximately 100m from CBL (Drawing no. 209506/EIA/LV/1704), and the viewpoint from Planned VSRs in the TKO Area 65, 66, 68 (R 7) is directly facing towards the proposed CBL. The existing Junk Bay seascape will be obstructed by the CBL, Road D9 approach viaduct and associated noise mitigation measures. The proposed mitigation measures and aesthetic design will be incorporated to all developments, and associated facilities; however, due to the close proximity to the CBL, the residual visual impact is considered as moderate.

13.9.6.13 Viewpoint along High Junk Peak (Tiu Yue Yung) in Clear Water Bay Country Park (S2) is approximately 2000m from the CBL (Drawing no. 209506/EIA/LV/1705). The existing open seaview will be partially blocked by the proposed CBL, TKO-LTT. Since the VSR will only have alternative view and only occasional view towards the Junk Bay, the residual visual impact is considered as insubstantial.

13.9.6.14 Viewpoint from Residents of Heng Fa Chuen Residential Area (D1) and Island Resort Residential Area and visitor in Siu Sai Wan Promenade and Sports Ground (D2) are approximately 3000m from the CBL (Drawing no. 209506/EIA/LV/1706 & 1707 series). The existing open seaview will be partially blocked by the proposed CBL, TKO-LTT. With the implementation of mitigation measures, including aesthetic treatment to the engineering structures, the residual visual impact is considered as slight.

13.9.6.15 Workers in the Creative Secondary School (GIC5) will have intermittent views to the CBL, which will mostly screened by the residential development of Oscar By the Sea on its western side, therefore, the residual impact are considered as slight.

13.9.6.16 Workers in the Tseung Kwan O Methodist Primary School and Evangel College (GIC2), P.O.H. 80th Anniversary Tang Ying Hei College, C.&M. A. Sung Kei Secondary School, Yan Chai Hospital Wong Wah San Secondary School and Yan Oi Tong Tin Ka Ping Primary School (GIC3), Hong Kong Design Institute Campus (GIC4), and Planned GIC development of TKO area 67, Area 72 and Area 74 (GIC6) will have intermittent views to the CBL which will be mostly screened by the residential development in Area 65, 66 and 68, thus, the residual development are considered as slight.

Travellers of Wan Po Road (T1) and travellers of TKO station and PT1 in the junction of Tong Tak Street and Tong Chun Street (T2) will have intermittent views to the CBL. Views from the TKO station will more likely be dominated by residential development in Area 65, 66 and 68, while views from the Wan Po Road will be dominated by the high-density residential development in Area 86. Therefore, the residual visual impact is considered as insubstantial; workers in the Tseung Kwan O Sewage Treatment Works, Bus depot in TKO Area 85 and Tseung Kwan O Stage II and III Landfill area (GIC1), Planned high-rise residential uses along Shek Kok Road in Area 85 (GIC8), Planned Fire Services Training School cum Driving School, and the proposed private hospital and Area 78 (GIC7), and workers at Hong Kong Movie City (GIC9) will have intermittent views to the CBL. Views will be blocked by the high-density residential development in Area 86 and therefore, the residual impact are considered as insubstantial.

Workers in the TKO Industrial Estate Extension will have intermittent and direct view of the CBL. Therefore, the residual impact is considered as insubstantial.

Workers in the planned high-rise residential uses along Shek Kok Road in Area 85 (GIC8), and workers at Hong Kong Movie City (GIC9) will have intermittent views to the CBL. Views will be locked by the high-density residential development in Area 86 and therefore, the residual impact are considered as insubstantial.

Visitor and residents in commercial development in PT1 (OU2) will have intermittent views to the CBL. However, views towards CBL will be blocked and are likely be dominated by the residential development on its southern side. Therefore, the residual visual impact is considered as slight.

Visitors of Junk Bay Chinese Permanent Cemetery (OU1) will have direct and close view to CBL and Junk Bay. However, majority of visitors walk in this area during Ching Ming Festival and Chung Yeung Festival only. Therefore the residual visual impact is considered as slight.

13.10 Conclusion

13.10.1.1 The proposed development and associated works follow in principle the planning intentions from the approved Tseung Kwan O – Outline Zoning Plan (S/TKO/20). However, the scale of CBL together with concurrent projects, namely, TKO-LTT will inevitably result in some landscape and visual impacts.

13.10.1.2 Based on the tree survey report on CBL, approximately 308 no. of trees will be affected (LR3), of which approximately 58 no. are proposed to be transplanted, and approximately 250 no. trees are proposed to be felled (including 190 no. Leucaena leucocephala and 60 no. common trees). Due to construction of the CBL, it is unavoidably considered to remove the affected trees. Affected trees with high to medium amenity value and medium survival rate are proposed to be transplanted. Trees surveyed within the proposed works boundary are primarily common species. There are no LCSD Champion Trees, Registered Old and Valuable Trees and Protected Species under Cap 586 Protection of Endangered Species of Animals and Plants Ordinance. It is expected approx. 67 heavy standard sized trees shall be planted as compensatory tree planting. The overall residual impact on trees is considered as acceptable with mitigation measures.

13.10.1.3 There is expected to be some minor impact upon the sea waterbody in Junk Bay (LR1). The sea water body will be permanent lost due to the construction of the piers for CBL bridge. Residual impacts after 10 years of operation are expected to be slight.

13.10.1.4 There is expected to be negligible impact upon the Landscaped Area and Plantation within High-rise residential development in CDA 86 (LOHAS Park) (LR2). It is considered that the residual impact is expected to be insubstantial.

13.10.1.5 There is expected to be negligible impact upon the Plantation within Vacant land (LR4), It is considered that the residual impact is expected to be insubstantial after year 10.

13.10.1.6 There is expected to be negligible impact upon Plantation within Industrial Building (LR5). Residual impact after Year 10 is expected to be insubstantial.

13.10.1.7 There is expected to be negligible impact upon Woodland at Foothill and Hillside (LR6). Residual impact after Year 10 is expected to be insubstantial.

13.10.1.8 There is expected to be negligible impact upon Grassland and Scrubland at Hillside in Chiu Keng Wan (LR7). Residual impact after Year 10 is expected to be insubstantial.

13.10.1.9 There is expected to be negligible impact upon Vegetation of clustered newly planted trees and shrubs scattered on Tseung Kwan O Stage II and III Landfill Area (LR8). Residual impact after Year 10 is expected to be insubstantial.

13.10.1.10 There is expected to be negligible impact upon Nature Rocky and Sand Shoreline in Chiu Keng Wan (LR9) and Plantation at Wasteland / Construction Area in Chiu Keng Wan (LR10). Residual impact after Year 10 is expected to be insubstantial.

13.10.1.11 There is expected to be negligible impact upon Vegetation along the Coastline Adjacent to Lohas Park Road (LR11). Residual impact after Year 10 is expected to be insubstantial.

13.10.1.12 There is expected to be negligible impact upon Roadside Planting in Lohas Park Road (LR12). Residual impact after Year 10 is expected to be insubstantial.

13.10.1.13 There is expected to be negligible impact upon Seawall in Tseung Kwan O Industrial Estate (LR13). Residual impact after Year 10 is expected to be insubstantial.

13.10.1.14 With the proposed mitigation measures including the compensatory planting and aesthetic treatments, the Junk Bay Coastal Landscape (LCA 1) will still suffer from slight landscape impact during construction and operation due to the artificial engineering structure which is incompatible with the natural Junk Bay character.

13.10.1.15 LCA2 - There will be slight impact on Reclamation / ongoing major development landscape due to the operation of CBL. However, with the proposed mitigation measures including the aesthetic design of the built structures and soft landscape treatment works, it is considered that the residual impact on this LCA is insubstantial.

13.10.1.16 LCA3 – Tseung Kwan O Industrial Urban Landscape will be subject to insubstantial impact as this LCA is relatively far away from the CBL.

13.10.1.17 LCA4 – Chiu Keng Wan Coastal Upland and Hillside Landscape will be subject to insubstantial impact as this LCA is relatively far away from the CBL. However, this LCA will definitely be affected by the interface project : TKO-LTT.

13.10.1.18 LCA5 – Tseung Kwan O Landfill Landscape (Stage II and III) will be subject to insubstantial impact as this LCA is relatively far away from the CBL and will not be affected.

13.10.1.19 LCA6 – Tseung Kwan O Miscellaneous Urban Fringe Landscapewill be subject to insubstantial impact as this LCA is relatively far away from the CBL and will not be affected.

13.10.1.20 LCA7 – High Junk Peak Coastal Upland and Hillside Landscape will be subject to insubstantial impact as this LCA is relatively far away from the CBL and will not be affected.

13.10.1.21 LCA8 – Residential Urban Fringe Landscape will be subject to insubstantial impact as this LCA is relatively far away from the CBL and will not be affected.

13.10.1.22 Lei Yue Mun and Tathong Channel are a unique public asset and natural visual resources as viewed from Shau Kei Wan, Heng Fa Chuen and Siu Sai Wan, providing an open seascape along the Junk Bay. The proposed CBL, particularly the pier structure will induce partial blockage of views and permanent loss of open seascape view. Residents in TKO Area 86 (CDA1) will have direct, short range views to the new road which is immediately adjacent to or very close to several receivers. The cumulative visual impacts can only be slightly mitigated by minimizing area, avoidance of excessive height and bulk of buildings and structures and construction period. Therefore, the VSRs (CDA1) located in close proximity to CBL will still suffer from moderate residual visual impact of the CBL and TKO LTT.

13.10.1.23 The Planned proposed “Central Avenue” user in Town Centre South near the promenade in open space of TKO Area 68 and the promenade user in the former TKO Stage I Landfill site (O1), the Planned waterfront near the Eastern Channel in open space of TKO Area 68 (O2), and Planned Residential area of TKO Area 65, 66 and 68 (R7) will have direct and close range views to the CBL and TKO-LTT. The cumulative visual impacts can only be mitigated by using visually unobtrusive building material and refinement of engineering design. Screening planting/amenity planting in the open space itself is expected to have minor screening effect to these views because the CBL are elevated. Therefore, the VSRs (O1, O2 and R7) will still suffer from moderate residual visual impact of the CBL and TKO-LTT.

The proposed Open Space in Area 74 (O3), and Planned recreational users in TKO Stage I Landfill (REC1), the residual impact would be slight due to screening/amenity planting along the waterfront promenade will be fully established and is expected to have screening effect on the CBL and TKO-LTT. Residents of Ocean Shores (R2) will have direct, close views to the new CBL and TKO-LTT which is immediately adjacent or very close to the VSRs. Mitigation in the form of screening planting, refinement of structure and architectural design of road structures will help in reducing these visual impacts. However, the VSRs will still be subject to the partial blockage of views and permanent loss of open seaview. Therefore, the VSRs (R2) will still suffer from moderate residual visual impact of CBL and TKO-LTT.

13.10.1.24 The landscape and visual impact assessment has been conducted according to the criteria and guidelines for evaluating and assessing impacts as stated in Annex 10 and 18 of the TM-EIAO, it is considered that the identified residual impacts, taking account of both importance and degree of compliance, will be acceptable with mitigation measures.

14 Landfill Gas Hazard

14.1 Legislation and Standards

14.1.1 Relevant legislation and guidelines applicable to the landfill gas (LFG) hazards include:

- Section 1.1(f) in Annex 7 of the EIA Technical Memorandum (TM);
- Section 3.3 in Annex 19 of the EIA TM;
- Landfill Gas Hazard Assessment Guidance Note (1997) (EPD/TR8/97); and
- Landfill Gas Hazard Assessment for Development Adjacent to Landfills (ProPECC PN 3/96).

14.1.2 These legislation and guidelines recommend that, in general, a qualitative assessment of the risk posed by LFG will be required for a development within the 250m Consultation Zone of a landfill site to ensure appropriate precautionary measures would be designed and implemented to safeguard the development. For particular sensitive developments and/or where the development is particularly close to the landfill site, it may be necessary to undertake a quantitative risk assessment (QRA). The requirement for a QRA is usually identified during the qualitative assessment.

14.1.3 Two landfills, namely Tseung Kwan O Stage I Landfill (TKOL-I) and Tseung Kwan O Stage II/III Landfill (TKOL-II/III), are located in the proximity of the eastern end of the proposed CBL development. The CBL Wan Po Road junction, which aligns with Wan O Road and links up Wan Po Road, encroaches into the 250m Consultation Zone of TKOL-II/III. A plan showing the relative locations of the landfill and the proposed development is shown on **Drawing No. 209506/EIA/LFG/001**. A qualitative risk assessment of LFG hazard on the potential sensitive receivers is carried out for the safety of the development, mainly focusing on the TKOL-II/III.

14.1.4 As the proposed CBL is at least 500m away from TKOL-I, a landfill gas hazard assessment is not required under the Study Brief.

14.2 Scope of the Assessment

14.2.1 In accordance with the procedures recommended in *Landfill Gas Hazard Assessment Guidance Note* and the requirement listed in the Study Brief, the following tasks have been undertaken to allow a full consideration of the potential risk of LFG from the TKOL-II/III:

- Review of background information (including landfill gas monitoring data) and studies related to the TKOL-II/III;
- Identification of the nature and extent of the sources, including the likely concentrations and/or amounts of hazardous emissions which might have the potential impacts on the Project and impacts from the Project to the potential receivers;
- Identification of possible pathways through the ground, underground cavities, utilities or groundwater, and the nature of these pathways through which hazardous emissions must traverse if they were to reach the Project;
- Identification of the potential receivers associated with the Project which are sensitive to the impacts of the hazardous emissions;
- Qualitative assessment on the degree of risk which the hazardous emissions may impose on the receivers for each of the source-pathway-receiver combinations; and
- Design of suitable level of precautionary measures and contingency plan for the Project and the potential receivers, if needed.

14.3 Description of Existing Environment

Desktop Study

14.3.1 Previous studies have been undertaken at, or involving, the TKOL-II/III. The information and documents which have been used as background materials for the preparation of this assessment include the following:

- Restoration of Tseung Kwan O Landfills monthly reports, Tseung Kwan O Landfill Restoration Contract, Swire SITA Waste Services Ltd. (provided by EPD)
- Landfill gas monitoring data for the TKOL-II/III and background information regarding the restoration works and landfill gas control measures provided by EPD;

- Agreement No. CE 87/2001 (CE). Further Development of Tseung Kwan O Feasibility Study: Environmental Impact Assessment Report, Maunsell Consultants Asia Ltd, July 2005;
- Agreement No. CE 10/2005 (EP) South East New Territories (SENT) Landfill Extension – Feasibility Study: Environmental Impact Assessment Report, ERM-Hong Kong, Limited, December 2007;
- Geology Map, Hong Kong Geological Survey, GEO / Planning Division.

Background Information

History of Tseung Kwan O Stage II/III Landfill

14.3.2 Based on the information provided by the approved EIA report of Agreement No. CE 87/2001 (CE) – Further Development of Tseung Kwan O Feasibility Study, a review of the existing conditions at and around the TKOL-II/III is given in this section.

14.3.3 TKOL-II/III is located at TKO Development Area 105 on the eastern shoreline of Junk Bay. It is a valley landfill sited in a coastal location approximately 1km south-east of TKOL-I. The site covers an area of about 42 hectares. To the east of the site lies the Clear Water Bay Country Park; to the west lies reclaimed land which contains the comprehensive development area (e.g. Lohas Park and MTR Depot) and the TKO Industrial Estate.

14.3.4 Engineering preparation works were carried out prior to the start of landfilling in 1988. A permanent seawall on a dredged foundation was constructed to the seaward boundary. There is a 15m wide margin of completely decomposed volcanic (CDV) material behind the seawall, and between this and the waste deposit there is a 3m wide trench constructed in coarse aggregate with a continuous length of perforated pipe. The trench forms a leachate interception and collection zone, together with a vent trench for LFG. Collected leachate flows to TKO Sewage Treatment Works at the northwest of the landfill site.

14.3.5 Inert materials were used to raise the formation of the landfill base above sea level. The site was not totally lined, although discrete areas of low permeability membrane were laid, which drain leachate into the leachate collection system. TKOL-II/III actual operation to receive waste began in 1988 and ended in 1994. Deposited waste at this site included municipal, construction, industrial and chemical waste. It is estimated that the landfill has received 17 million tonnes of waste with a density of approximately 1.3tonnes/m^3. The site was temporarily restored by the end of 1995 with an interim cap of 1m of inert cover, hydroseeded, with surface and sub-surface drains installed. Proper LFG and leachate management systems were not established at that time.

Restoration Works and Aftercare

14.3.6 The restoration works of TKOL-II/III commenced in July 1997 and completed in January 1999. The restoration works generally included installation of an engineered capping layer, a landfill gas collection system with flaring and electricity generation, a leachate collection and treatment system, surface and sub-surface drainage systems, and works to improve geotechnical stability and landscaping of the site. A site plan on completion of final cap and the cross sections of TKOL-II/III is illustrated in **Appendix 14.1**.

14.3.7 The engineered capping layer (with low permeability) and surface water drainage system are installed to reduce infiltration of rain water into the waste mass thereby reducing the amount of leachate to be treated. Typical details of a restoration capping system are shown in Detail 2 and Detail 5 of **Appendix 14.1**. The components of the landfill restoration capping system include the following (from top to bottom):

- *General Cover Layer*: A 850 mm thick soil layer comprising CDV material or completely decomposed granite (CDG); an additional 650 mm CDV is also provided in the location where trees or shrubs are provided;
- *Filtration Geotextile-Geonet Composites*: A subsoil drainage layer comprising a synthetic drainage medium, surrounded by suitable geotextile filters.
- *Geomembrane and Cushion Geotextile*: An impermeable layer (anchored in CDV at the perimeter) comprising a 1mm thick linear low density polyethylene (LLDPE) geomembrane; and
- *Final intermediate Cover*: A well compacted 500 mm thick soil, free from stones or other sharp particles, above the waste.

14.3.8 The landfill gas management system consists of active extraction wells, electricity generation from LFG, flaring system for LFG, passive vent trenches/ pipes, and monitoring of LFG both on and off-site. The gas extraction system is integrated with the leachate management system. LFG is collected from the landfill by active gas extraction. It is transferred to the on-site gas utilization plants for electricity generation and used for heating in the leachate treatment process. Surplus LFG is flared at the gas flaring plant at the southeast of the landfill for complete destruction. The system aims to control LFG from migrating off-site in sub-surface layer.

14.3.9 Leachate management system comprises a leachate collection system and a leachate treatment works. Leachate generated at TKOL-II/III is intercepted by the leachate collection system, which then transfers the collected leachate to the on site leachate treatment works. Leachate is treated at the treatment plant to meet the discharge standards prior to discharge at the public sewer.

14.3.10 The aftercare period commenced from February 1999 onwards. Environmental monitoring work for the landfill may continue for more than two decades or up to 30 years. The methane content in the landfill gas remained fairly constant at 44%-48% between 1999 and 2003[1]. Such landfill gas quantity and methane content levels still require monitoring as the landfills could only be considered as fully restored from the perspective of landfill gas safety when the methane content is reduced to 1% or below. The site has been an open space / green zone as its tentative afteruse. The Hong Kong Air Cadet Corps has also been using the top platform at TKOL-II/III as a model aeroplane training field on weekends and public holidays.

Geology/ Hydrogeology at Tseung Kwan O Stage II/III Landfill and Proposed Development

14.3.11 According to Hong Kong Geological Survey Map (**Appendix 14.2**), the geological formation at the west of the landfill is mainly superficial deposits of fill (natural earth and waste) of Holocene Age, on top of which is the extension of reclaimed land towards Junk Bay; at the north and south of the landfill is mainly undivided tuffaceous mud stone, siltstone and breccias of Upper Jurassic Age; at the east of

[1] Environment, Transport and Works Bureau, October 2004. Legislative Council Panel on Environmental Affairs: PWP Item 5166DR – Restoration of Tseung Kwan O Landfills – post-completion environmental monitoring work

the landfill is mainly trachydacite lava of Upper Jurassic Age; and at the central is mainly alluvium (clay/silt, sand, and gravel) of Holocene Age.

14.3.12 There are a few numbers of drillholes in rock strata and boreholes in waste for groundwater and leachate monitoring. These have indicated a relatively consistent hydraulic gradient of groundwater/leachate through the wastes to sea level.

14.4 Potential Hazards and Properties of Landfill Gas

14.4.1 *Methane* is odourless and colourless, and typically associated with numerous highly odoriferous compounds in LFG which will give some warning of its presence. However, the absence of odour should not be taken to mean that there is no methane – this can only be confirmed by using appropriately calibrated methane detectors. Methane is a flammable gas and will burn when mixed with air between approximately 5% and 15% by volume, the Lower Explosive Limit (LEL) and Upper Explosive Limit (UEL) respectively. A mixture of methane and air with a composition between the LEL and UEL ignited in a confined space could lead to an explosion. Methane is also an asphyxiant.

14.4.2 Carbon Dioxide, which is another major component of landfill gas, could induce asphyxia and adverse health effects. The long-term eight hour Occupational Exposure Limit (OEL) is 0.5% by volume. Similar to methane, it is also odourless and colourless and can only be detected using appropriately calibrated detectors.

14.4.3 Gas Buoyancy: Methane is lighter than air whereas carbon dioxide is heavier than air. Typical mixtures of LFG are likely to have a density close to or equal to that of air. However, site conditions may result in a ratio of methane to carbon dioxide which may make the gas mixture lighter than air or heavier than air. As a result, LFG may be concentrated in the bottoms of trenches or excavations, or may rise up and accumulate beneath structures and foundations.

14.5 Assessment Methodology

Assessment Criteria

14.5.1 In accordance with the Guidance Note, the risk due to LFG may be evaluated based upon the following three criteria:

- Source – the rate and concentration of LFG generated by the landfill;
- Pathway – the nature and length of potential pathways through which LFG can migrate and leachate flow, such as geological strata, utility services; and
- Target (Receiver sensitivity) – the level of vulnerability of various elements of the development to LFG.

14.5.2 Each of these criteria is further described below.

Source

The classification of the Source (i.e. the landfill) is determined as follows:

Major: Recently filled landfill site at which there is little or no control to prevent migration of gas or at which the efficacy of the gas control measures has not been assessed; or

Any landfill site at which monitoring has demonstrated that there is significant migration of gas beyond the site boundary.

Medium: Landfill site at which some form of gas control has been installed (e.g. lined site or one where vents or barriers have been retrospectively installed) but where there are only limited monitoring data to demonstrate its efficacy to prevent migration of gas; or

Landfill site where comprehensive monitoring has demonstrated that there is no migration of gas beyond the landfill boundary but where the control of gas relies solely on an active gas extraction system or any other single control system which is vulnerable to failure.

Minor: Landfill sites at which gas controls have been installed and proven to be effective by comprehensive monitoring which has demonstrated that there is no migration of gas beyond the landfill boundary (or any specific control measures) and at which control of gas does not rely solely on an active gas extraction system or any other single control measure which is vulnerable to failure; or

Old landfill sites where the maximum concentration of methane within the waste, as measured at several locations across the landfill and on at least four occasions over a period of at least 6 months, is less than 5% (v/v).

14.5.3 The 'significance' of migration should be assessed by reference to the concentration, frequency and location at which gas is detected. For guidance, it should be assumed that any concentration of methane or carbon dioxide greater than 5% v/v above background levels in any monitoring well outside the landfill's boundary indicates significant migration. Lower concentrations may still be 'significant' if they are observed in more than one monitoring well, on several occasions or in monitoring wells located some distance from the site boundary. In general, concentrations of greater than 1% v/v methane or 1.5% v/v carbon dioxide (above background levels in each case) indicate less than adequate control of the gas at source.

Pathway

14.5.4 Generally, three types of pathway are considered for the transmission of LFG. They are:

- *Man-made* pathways e.g. utility connections, stormwater channels, etc.;
- *Natural* pathways such as rock jointing planes, fissures and other naturally occurring phenomena which may promote or give rise to the transmission of gas over distances; and
- A *combination* of the previous categories. An example of the latter may be, for instance, where a specific geological feature promotes gas transmission but which stops short of directly linking the landfill and target. A man made connection, however my also co-exist near the edge of the geological feature, which in combination with the former, may act to link the two sites. In this instance, careful assessment of the likelihood of the mechanism acting to link the two pathways needs to be undertaken before assigning an appropriate pathway classification.

14.5.5 The broad classification of the Pathway is as follows:

Very short / direct:	Path length of less than 50m for unsaturated permeable strata and fissured rock or less than 100m for man-made conduits.
Moderately short / direct:	Path length of 50 to 100m for unsaturated permeable soil or fissured rock or 100 to 250m for man-made conduits.
Long / indirect:	Path length of 100 to 250m for unsaturated permeable soil and fissured rock.

14.5.6 In classifying the pathway, however, adjustment to the above general guidelines will often be required to take account of other factors which will affect the extent of gas migration including the following:

- permeability of the soil;
- spacing, tightness and direction of the fissures/joints;
- topography;
- depth and thickness of the medium through which the gas may migrate (which may be affected by groundwater level);
- the nature of the strata over the potential pathway;
- the number of different media involved; and
- depth to groundwater table and groundwater flow patterns.

Target

14.5.7 Different levels of vulnerability or sensitivity of potential Targets for LFG have been classified as follows:

High sensitivity:	Buildings and structures with ground level or below ground rooms / voids or into which services enter directly from the ground and to which members of the general public have unrestricted access or which contain sources for ignition. This would include any developments where there is a possibility of additional structures being erected directly on the ground on an *ad hoc* basis and thereby without due regard to the potential risks.
Medium Sensitivity:	Other buildings, structures or service voids where there is access only by

	authorized, well trained personnel, such as the staff of utility companies, who have been briefed on the potential hazards relating to LFG and the specific safety procedures to be followed.
	Deep excavations.
Low Sensitivity:	Buildings and structures which are less prone to gas ingress by virtue of their design (such as those with a raised floor slab).
	Shallow excavations.
	Developments which involve essentially outdoor activities but where evolution of gas could pose potential problems.

14.5.8 The above examples of different categories within each criteria are to be used as a general guide only and specific aspects of a development may render it more or less sensitive than indicated. Account needs to be taken of any particular circumstances when assigning a target to one of the three indicated categories.

Assessment Methodology

14.5.9 Following the determination of the categories of source, pathway and target in which the combination of landfill, pathway and development fall, a qualitative assessment of the overall risk is undertaken with reference to **Table 14.1**, which is extracted from *EPD's Guidance Note*. The potential implications associated with the various qualitative risk categories are summarized in **Table 14.2**. It should be noted that the different levels of risk determine the likely extent of the protection measures required to ensure the safety of a development.

Table 14.1 Classification of Risk Category

Source	Pathway	Target Sensitivity	Risk Category
Major	Very short/direct	High	Very high
		Medium	High
		Low	Medium
	Moderately short/direct	High	High
		Medium	Medium
		Low	Low
	Long/Indirect	High	High
		Medium	Medium

Source	Pathway	Target Sensitivity	Risk Category
		Low	Low
Medium	Very short/direct	High	High
		Medium	Medium
		Low	Low
	Moderately short/direct	High	High
		Medium	Medium
		Low	Low
	Long/Indirect	High	Medium
		Medium	Low
		Low	Very low
Minor	Very short/direct	High	High
		Medium	Medium
		Low	Low
	Moderately short/direct	High	Medium
		Medium	Low
		Low	Very low
	Long/Indirect	High	Medium
		Medium	Low
		Low	Very low

Table 14.2 Summary of General Categorizations of Risk

Category	Level of Risk	Implication
A	Very high (undesirable)	The type of development being proposed is very undesirable and a less sensitive form of development should be considered. At the very least, extensive engineering measures, alarm systems and emergency action plans are likely to be required.
B	High	Significant engineering measures will be required to protect the planned development.
C	Medium	Engineering measures will be required to protect the proposed development.
D	Low	Some precautionary measures will be required to ensure that the planned development is safe.
E	Very low (insignificant)	The risk is so low that no precautionary measures are required.

14.6 Qualitative Risk Assessment

The Source

14.6.1 Reference has been made to the EIA Report of Agreement No. CE 87/2001 (CE) Further Development of Tseung Kwan O Feasibility Study to evaluate the potential risk at the TKOL-II/III. Available gas monitoring results of the TKOL-II/III from February 1998 to May 2009 provided by EPD are tabulated in **Appendix 14.3**.

14.6.2 LFG generation is dependent upon a number of factors including temperature, pH, substrate availability, moisture content and oxygen level. The LFG generation rate peaked in 1993, producing a collectable volume of nearly 200 $Mm^3\ yr^{-1}$. By the time of 2007, the quantity of gas collected has reduced to 11 $Mm^3\ yr^{-1}$ (1271 $m^3\ hr^{-1}$; EPD's website[2]). TKOL-II/III is one of the closed landfill that is able to generate LFG with more than 35% methane content (utilization value) and with high enough production rate. The LFG collected by active extraction system is utilized to provide thermal energy to treat leachate and generate electricity to operate the on-site thermal destructor, leachate treatment works and site office.

Restoration Stage

14.6.3 A post-restoration monitoring programme commenced in July 1997 under the restoration contract for TKOL-II/III. LFG management system was installed to control gas emission and prevent off-site gas migration. LFG (mainly methane and carbon dioxide) and oxygen were monitored at some monitoring wells deployed within and at the perimeter boreholes around the boundary of the landfill. **Drawing No. 209506/EIA/LFG/002** shows the locations of the off-site monitoring wells and their identification codes are given as follows:

- Down gradient monitoring wells: 2DG1, 2DG2, 2DG3, 2DG4, 2DG5, 2DG6, 2DG7
- Up gradient monitoring wells: 2UG1, 2UG2, 2UG3, 2UG4, 2UG5, 2UG6, 2UG7, 2UG8, 2UG9

14.6.4 Summary of the available gas monitoring data from the 15 out of 16 off-site drillholes provided by EPD during the restoration stage (March 1998 to January 1999) are tabulated in **Table 14.3**.

Table 14.3 Landfill Gas Monitoring Results at Tseung Kwan O Stage II/III Landfill (March 1998 – January 1999)[1]

Location	Methane (%)		Carbon Dioxide (%)		Oxygen (%)	
	Range	Average	Range	Average	Range	Average
2DG1	0.0-0.0	0.0	0.3-7.1	3.5	10.2-19.3	15.5

[2] EPD's website. Waste: Problems and Solutions. Landfill Gas to Energy at Closed Landfills [http://www.epd.gov.hk/epd/english/environmentinhk/waste/prob_solutions/msw_lgu.html]

Location	Methane (%)		Carbon Dioxide (%)		Oxygen (%)	
	Range	Average	Range	Average	Range	Average
2DG2	0.0-0.0	0.0	9.6-12.8	11.7	1.7-7.4	4.1
2DG3	0.0-12.0	7.2	0.1-8.5	5.5	0.1-10	2.0
2DG4	0.0-0.4	0.0	0.0-10.0	5.2	5.5-18.9	5.2
2DG5	0.0-0.6	0.1	0.0-0.8	0.1	16.9-20.5	19.5
2DG6	0.0-0.8	0.1	0.0-0.2	0.1	18.9-20.4	19.8
2DG7	0.0-0.0	0.0	0.0-3.2	1.2	14.3-20.4	18.2
2UG1	0.0-0.0	0.0	0.0-0.0	0.0	20.0-20.3	20.2
2UG2	-	-	-	-	-	-
2UG3	0.0-0.0	0.0	0.0-0.1	0.1	19.8-20.4	20.3
2UG4	0.0-0.0	0.0	0.0-0.2	0.1	19.2-20.4	20.0
2UG5	0.0-0.0	0.0	0.0-0.1	0.0	20.1-20.4	20.3
2UG6	0.0-0.0	0.0	0.0-0.1	0.0	20.1-20.4	20.3
2UG7	0.0-0.1	0.0	0.0-0.1	0.1	20.1-20.4	20.3
2UG8	0.0-0.0	0.0	0.0-0.3	0.1	19.8-20.4	20.2
2UG9	0.0-2.1	0.5	0.0-2.9	0.7	18.1-20.4	19.4

Note: All information is provided by EPD.

(1) The background level of methane is taken to be 0.0% v/v and the background level of carbon dioxide is below the instrument detection limit of 0.1% v/v.

(2) Standard compliance level of methane is taken to be 1% v/v and that of carbon dioxide is 1.5% v/v above natural background level. As stated in EPD’s Guidance Note, it should be assumed that concentrations of greater than 1% v/v methane or 1.5% v/v carbon dioxide (above background levels in each case) indicate less than adequate control of the gas at source. In addition, any concentration of methane or carbon dioxide greater than 5% v/v above background levels in any monitoring well outside the landfill's boundary indicates significant migration.

14.6.5 Low concentrations of methane have been observed at all off-site monitoring drillholes, except from 2DG3 and 2UG9, where significant methane concentrations (>1% v/v) have been detected. 2DG3 is located immediately adjacent to the existing leachate treatment plant at the south-western landfill boundary while 2UG9 is located at the northern boundary. The maximum methane concentrations of 2DG3 and 2UG9 are 12.0% v/v and 2.1% v/v, recorded on 10-Sept-98 and 12-Jan-99 respectively. It is worth noting that, according to the information provided by EPD, an illegal petrol filling station was sited near 2DG3 before 2001, which resulted in the contamination of this monitoring well by gasoline and diesel. Therefore, constant high levels of methane, as well as carbon dioxide, were recorded at 2DG3.

14.6.6 Carbon dioxide concentrations above 5% v/v were observed at 2DG1, 2DG2, 2DG3 and 2DG4. Maximum gas concentrations from 2DG1, 2DG2, 2DG3 and 2DG4 were 7.1, 12.8, 8.5 and 10.0% v/v, which were detected on 31-Aug-98, 10-Sep-98, 11-Nov-98 and 14-Dec-98 respectively. The average carbon dioxide concentrations at other monitoring wells were well below 5% v/v.

Aftercare Period

14.6.7 The aftercare period commenced in February 1999. A summary of the 10-year monitoring data is given in **Table 14.4**.

Table 14.4 Landfill Gas Monitoring Results at Tseung Kwan O Stage II/III Landfill (February 1999 – May 2009)[1]

Location	Methane (%)		Carbon Dioxide (%)		Oxygen (%)	
	Range	Average	Range	Average	Range	Average
2DG1	0.0-0.5	0.0	0.0-7.2	1.8	4.8-21.2	17.5
2DG2	0.0-0.3	0.0	0.0-13.8	5.7	1.9-20.8	12.7
2DG3	0.0-12.4	0.8	0.0-14.9	4.0	0.0-20.9	4.2
2DG4	0.0-0.0	0.0	0.0-7.3	2.6	11.0-21.4	17.4
2DG5	0.0-0.1	0.0	0.0-3.7	0.4	16.9-21.7	19.7
2DG6	0.0-0.8	0.0	0.0-3.1	0.6	0.7-26.6	18.9
2DG7	0.0-2.0	0.0	0.0-3.6	1.0	13.4-22.4	18.7
2UG1	0.0-0.1	0.0	0.0-7.2	0.6	14.6-21.4	19.2
2UG2	0.0-0.2	0.0	0.0-2.1	0.4	10.5-22.3	19.6
2UG3	0.0-0.2	0.0	0.0-1.6	0.4	15.8-21.9	19.7
2UG4	0.0-0.2	0.0	0.0-2.2	0.4	0.9-21.1	19.3
2UG5	0.0-0.2	0.0	0.0-3.2	0.3	13.6-22.6	19.7
2UG6	0.0-0.1	0.0	0.0-1.7	0.3	15.7-22.7	19.6
2UG7	0.0-0.2	0.0	0.0-0.7	0.2	16.5-22.5	20.0
2UG8	0.0-0.1	0.0	0.0-2.4	0.4	15.4-22.4	19.7
2UG9	0.0-3.5	0.1	0.0-3.6	0.6	10.2-21.6	19.3

Note:

(1) All information is provided by EPD.

(2) The background level of methane is taken to be 0.0% v/v and the background level of carbon dioxide is below the instrument detection limit of 0.1% v/v.

(3) Standard compliance level of methane is taken to be 1% v/v and that of carbon dioxide is 1.5% v/v above natural background level. As stated in EPD's Guidance Note, it should be assumed that concentrations of greater than 1% v/v methane or 1.5% v/v carbon dioxide (above background levels in each case) indicate less than adequate control of the gas at source. In addition, any concentration of methane or carbon dioxide greater than 5% v/v above background levels in any monitoring well outside the landfill's boundary indicates significant migration.

14.6.8 As shown in the above table, an average zero level of methane has been detected at most of the monitoring wells installed along the boundary of the landfill. However, 2DG3, 2DG7 and 2UG9 have been recorded with elevation of methane levels of above 1% v/v. All these exceedances occurred before 2002 and the recent recorded methane level is significantly low. As mentioned above, an illegal petrol filling station was sited near 2DG3 before 2001, which resulted in the contamination of this monitoring well by gasoline and diesel. The contractor spent a year to decontaminate the site after the petrol station was shut down. Therefore, constant high levels of methane, as well as carbon dioxide, were recorded at 2DG3 before 2002 and the methane levels reduce to below 1% v/v thereafter, indicating that there is no sub-surface off-site migration of methane in recent years. It has also been concluded that the methane content detected at 2DG3 was not caused by gas migration from the landfill.

14.6.9 The carbon dioxide levels varied from 0.0% to 14.9% (with unknown background level) at the 16 monitoring wells, averagely well below 5% v/v except for 2DG2. Elevated carbon dioxide concentration (>5% v/v) was recorded in 2DG1, 2DG2, 2DG3, 2DG4 and 2UG1, with maximum concentrations of 7.2, 13.8, 14.9, 7.3 and 7.2 detected on 6-Dec-05, 18-Jan-06, 24-Jan-02, 6-Oct-06 and 22-Apr-99 respectively. According to the *Guidance Note*, a carbon dioxide concentration greater than 5% v/v above background levels in any monitoring well outside the landfill's boundary indicates significance migration. Hence, the potential of off-site migration of LFG cannot be eliminated.

Classification of Source

14.6.10 In view of the insignificant evidence of off-site methane migration (though potential gas migration may still occur at some locations, particularly 2DG1, 2DG2, 2DG3 and 2DG4 due to occasional >5% v/v carbon dioxide concentrations measured), and that the landfill site has multiple LFG control measures (such as vents and barriers; **Section 14.3**), the LFG source of TKOL-II/III would be classified as **Medium**.

The Pathways

Natural Pathways

14.6.11 For the natural pathways, the presence of natural cavities is directly related to the prevailing local geology. The geological formation beneath TKOL-II/III and beneath the proposed CBL mainly comprises natural earth and waste. A cross section between TKOL-II/III and the Project site is illustrated in **Appendix 14.4**. There are no fault lines or cracks existing in the Landfill and the Project site and the area in between. The landfill and the future CBL site should however be cautiously considered as conducive to LFG migration. Taking into consideration of the precautionary assumption of the strata's permeability and the path length between the landfill and the proposed CBL site, which is about 100-250m, it is considered that the natural pathway should be categorised as **Long/Indirect**.

Man-made Pathways

14.6.12 Based on the available utility layout plan (**Appendix 14.5**) such as that of stormwater drainage and sewerage, communications services cable and CLP power cables, it is known that underground utilities exist within the landfill Consultation Zone. Possible transmission of LFG to the proposed CBL junction may occur through these linkages. The path length is between 100-250m. However, there should be no direct connection between the existing utilities or services and the landfill with the proposed works area. As such, man-made pathways are considered to be **Moderately Short/Direct**.

The Targets

14.6.13 The layout of the CBL work boundary is illustrated in **Drawing No. 209506/EIA/LFG/001**. The construction works which fall within the 250m Consultation Zone include modification or improvement of the existing Wan O Road and Wan Po Road around CBL / Wan Po Road junction.

14.6.14 In general, potential targets associated with a proposed development include:

- Excavations for utilities installation during construction phase,
- Road works and drainage works during construction phase, and
- Manholes, inspection chambers or voids of services/utilities during operational phase.

14.6.15 It is expected that excavations for utilities (<2m depth) would be involved during the construction phase of the proposed project. Site worker in areas of confined space and trenches are prone to higher risk of exposure to LFG. Therefore, the level of risk for excavations is categorised as **Medium**.

14.6.16 Based on the preliminary design, some manholes, inspection chambers and voids of services/utilities will be present within the Project site during operational phase. Since access to these confined spaces will be restricted to authorised personnel who have been briefed on the potential LFG hazards and specific safety procedures, the risk level for these targets is also categorised as **Medium**.

Source – Pathway – Target Analysis

14.6.17 On the basis of the source, pathways and targets identified above, a source – pathway – target analysis has been undertaken and is presented in **Table 14.5** according to EPD's assessment framework. The combination of a medium source term and moderately short to long distances between the landfill site and the proposed site results in an overall risks of "**Low to Medium**" depending on the sensitivity of the particular targets.

Table 14.5 Qualitative Assessment of LFG Hazard to the Proposed Junction of CBL

Source	Pathway	Target	Hazard
TKOL-II/III is one of the closed landfill that generates LFG with more than 35% methane content (utilization value) and with high enough production rate. The LFG collected by active extraction system is utilized to provide thermal energy to treat leachate and generate electricity to operate the on-site leachate treatment plant. A post-restoration monitoring programme commenced in July 1997 under the restoration contract for TKOL-II/III. LFG management system has been installed to control gas emission and prevent off-site gas migration. LFG (mainly methane and carbon dioxide) and oxygen are monitored at some monitoring wells deployed within and at the perimeter boreholes around the boundary of the landfill. Average zero level of methane has been detected at each of the monitoring well installed along the boundary of the landfill during recent years,	<u>Natural Pathways</u> The geological formation beneath TKOL-II/III and beneath the proposed CBL mainly comprises natural earth and waste. There are no fault lines or cracks existing in the Landfill and the Project site and the area in between. The landfill and the future CBL site should however be cautiously considered as conducive to LFG migration. Taking into consideration of the precautionary assumption of the strata's permeability and the path length between the landfill and the proposed CBL site, which is about 100-250m, it is considered that the natural pathway should be categorised as ***Long/Indirect***.	<u>Construction Phase</u> It is expected that excavations for utilities would be involved during the construction phase of the proposed project. Site workers in areas of confined space and trenches are especially prone to higher risk of exposure to LFG. Therefore, the level of risk for excavations is categorised as having ***Medium Sensitivity***. <u>Operational Phase</u> Although detailed design information is not available at this stage, some manholes, inspection chambers or voids of services/utilities would be present within the project site during operational phase. Since access to these confined spaces will be restricted to authorised personnel who have been briefed on the potential LFG hazards and specific safety procedures, the risk level for these targets is also categorised as having ***Medium Sensitivity***.	Low Low

Source	**Pathway**	**Target**	**Hazard**
indicating that there is no sub-surface off-site migration of methane. The carbon dioxide levels varied from 0.0% to 14.9% (with background level <0.1% v/v) at 16 of the monitoring wells. Elevated carbon dioxide concentration (>5% v/v) was recorded in 2DG1, 2DG2, 2DG3, 2DG4 and 2UG1 only. According to the Guidance Note, a carbon dioxide concentration greater than 5% v/v above background levels in any monitoring well indicates significance migration. Hence, the potential of off-site migration of LFG cannot be eliminated. In view of the insignificant evidence of off-site methane migration and that the landfill site has multiple LFG control measures (such as vents and barriers; **Section 14.3**), the LFG source of TKOL-II/III would be classified as ***Medium***.	<u>Man-made Pathways</u> Based on the available utility layout plan such as that of stormwater drainage and sewerage, communications services cable and CLP power cables, it is known that underground utilities exist within the landfill Consultation Zone. Possible transmission of LFG to the proposed CBL junction may occur through these linkages. The path length is between 100-250m. However, there should be no direct connection between the existing utilities or services and the landfill with the proposed works area. As such, man-made pathways are considered to be ***Moderately short/Direct***.	<u>Construction Phase</u> It is expected that excavations for utilities would be involved during the construction phase of the proposed project. Site workers in areas of confined space and trenches are especially prone to higher risk of exposure to LFG. Therefore, the level of risk for excavations is categorised as having ***Medium Sensitivity***. <u>Operational Phase</u> Although detailed design information is not available at this stage, some manholes, inspection chambers or voids of services/utilities would be present within the project site during operational phase. Since access to these confined spaces will be restricted to authorised personnel who have been briefed on the potential LFG hazards and specific safety procedures, the risk level for these targets is also categorised as having ***Medium Sensitivity***.	 Medium Medium

Site Categorisation

14.6.18 According to the *Guidance Note*, for the purposes of categorizing the site, the category will be based upon the highest level of risk nominated for any of the potential impacts identified. For example, a site with three low risks, and one medium risk will fall into Category C, and a site with three low risks, three medium risks and one high risk will fall into Category B. **Table 14.2** summarizes the general implications for developments which fall into the different overall risk categories. If four or more different impacts arise in a particular risk category, however, then the overall risk classification may be considered to be one category higher. For example, a site with two low risks and five medium risks will fall into Category B.

14.6.19 **Table 14.5** depicts that the overall hazard level for the proposed CBL associated with TKOL-II/III should be falling into the risk category of *Medium* level (Category C). Engineering measures are required to protect a proposed area of medium or higher level of risk. Recommendations for protection measures are provided for the proposed project (during construction phase and operational phase) in the following section.

14.7 Precautionary and Protective Measures

14.7.1 The qualitative hazard assessment undertaken in **Section 14.6** has concluded that the potential for landfill gas to affect the development during the construction and operational phases is ‘low’ to ‘medium’ depending upon the location and nature of the target being considered.

14.7.2 This section provides general advice and recommendations for the avoidance of environmental impacts related to LFG during the construction and operational phases. Where applicable, specific measures for handling the hazards identified during the construction and operational phases should be addressed to further reduce the likelihood of incidents and increase the level of safety to the workers and the public. These measures should be reviewed taking into account of the findings of the detailed Qualitative LFG Hazards Assessment (QLFGHA) to be undertaken by the project proponent (Refer to **Section 14.7.12**).

14.7.3 In general, the measures being taken for the restoration of the landfill site and the control of LFG should not be relied upon to ensure the safety of adjoining developments. However, it must also be acknowledged that the works being undertaken would have the effect of lowering the potential for an incident to occur off-site when compared to the historical situation.

Precautionary Measures

14.7.4 All contractors participating in the works should be aware that methane and carbon dioxide are always likely to be present in the soil and rock voids and all works should be undertaken on the basis of an "assumed presence of LFG".

14.7.5 Risks in the construction works mainly result from construction workers' contact with LFG. Whilst the risks are not expected to be significant, owing to the use of powered mechanical equipment to undertake excavation works, there may still be instances where human exposure may be inevitable when personnel may have to enter confined spaces. Precautionary measures to be adopted by the contractors (for both site formation and infrastructure development) for the period of construction of infrastructure within the 250m Consultation Zone are outlined in Paragraphs 8.3 to 8.49 of EPD's Landfill Gas Hazard Assessment Guidance Note. The following guidance has been extracted from this Guidance Note to ensure a robust and comprehensive set of measures to protect workers are provided.

- During all works, safety procedures should be implemented to minimize the risks of fires and explosions, asphyxiation of workers (especially in confined space) and toxicity effects resulting from contact with contaminated soils and groundwater.
- Safety officers who are specifically trained with regard to LFG and leachate related hazards and the appropriate actions to take in adverse circumstances should be present on all worksites throughout the works.
- All personnel who work on site and all visitors to the site should be made aware of the possibility of ignition of gas in the vicinity of the works, the possible presence of contaminated water and the need to avoid physical contact with it.
- Those staff who work in, or have responsibility for "at risk" areas, including all excavation workers, supervisors and engineers working within the consultation zone, should receive appropriate training on working in areas susceptible to LFG hazards.

- Enhanced personal hygiene practices including washing thoroughly after working and eating only in “clean” areas should be adopted where contact may have been made with any groundwater which is thought to be contaminated with leachate.
- Ground level construction plant should be fitted with vertical exhausts at least 0.6m above ground level and with spark arrestors.
- During piping assembly or conduiting construction, all valves/seals should be closed immediately after installation. As construction progresses, all valves/seals should be closed as installed to prevent the migration of gases through the pipeline/conduit. All piping / conduiting should be capped at the end of each working day.
- Mobile offices, equipment stores, mess rooms etc. should be located on an area which has been proven to be gas free (by survey with portable gas detectors) and ongoing monitoring should be carried out to ensure that these areas remain gas free. Alternatively, such buildings should be raised clear of the ground. If buildings are raised clear of the ground, a minimum, clear separation distance (as measured from the highest point on the ground surface to the underside of the lowest floor joist) should be 500mm. However, in this case, it is highly recommended that all the site offices, equipment stores and mess rooms should be located outside the 250m Consultation Zone.
- Smoking and naked flames should be prohibited within confined spaces. “No Smoking” and “No Naked Flame” notices in Chinese and English should be posted prominently around the construction site. Safety notices should be posted warning of the potential hazards.
- Welding, flame-cutting or other hot works may only be carried out in confined spaces when controlled by a “permit to work” procedure, properly authorized by the Safety Office. The permit to work procedure should set down clearly the requirements for continuous monitoring of methane, carbon dioxide and oxygen throughout the period during which the hot works are in progress. The procedure should also require the presence of an appropriately qualified person who shall be responsible for reviewing the gas measurements as they are made, and who shall have executive responsibility for suspending the work in the event of unacceptable or hazardous conditions. Only those workers who are appropriately trained and fully aware of the potentially hazardous

conditions which may arise should be permitted to carry out hot works in confined areas.

- During the construction works, adequate fire extinguishers and breathing apparatus sets should be made available on site and appropriate training given in their use.

Monitoring

14.7.6 Monitoring should be undertaken when construction works are carried out in confined space within the 250m Consultation Zone. The monitoring requirements and procedures specified in Paragraphs 8.23 to 8.28 of EPD’s Guidance Note are highlighted as follows:

- The monitoring equipment used should be capable of measuring methane, carbon dioxide and oxygen concentrations. The equipment should be intrinsically safe and calibrated according to the manufacturers instructions.
- When portable monitoring equipment is to be used, the frequency and areas to be monitored should be set down prior to commencement of the works either by the Safety Officer or by an appropriately qualified person.
- All measurements should be made with the monitoring tube located not more than 10mm from the surface.
- A standard form, detailing the location, time of monitoring and equipment used together with the gas concentrations measured, should be used when undertaking manual monitoring to ensure that all relevant data are recorded.
- If methane (flammable gas) or carbon dioxide concentrations are in excess of the trigger levels or that of oxygen is below the level specified in the Emergency Management in the following section, then evacuation should be initiated.

Actions in the Event of Abnormal Gas being Detected

14.7.7 Depending on the results of the measurements, actions required will vary and should be set down by the Safety Officer or another appropriately qualified person. As a minimum these should encompass those actions specified in **Table 14.6**

Table 14.6 Actions in the Event of LFG Being Detected in Excavations

Parameter	Monitoring Results	Actions
O^2	<19% v/v	Increase underground ventilation to restore O_2 to >19% v/v
	<18% v/v	Stop works; evacuate all personnel, prohibit entry; and increase ventilation to restore O_2 level to >19%
CH_4	>10% LEL	Prohibit hot works; increase ventilation to restore CH_4 to <10% LEL
	>20% LEL	Stop works; evacuate all personnel; increase ventilation further to restore CH_4 to <10% LEL
CO_2	>0.5% v/v	Increase ventilation to restore CO_2 to <0.5% v/v
	>1.5% v/v	Stop works; evacuate all personnel; increase ventilation further to restore CO_2 to <0.5%

Emergency Management

14.7.8 In order to ensure that evacuation procedures are implemented in the event of the trigger levels specified in **Table 14.6** above being exceeded, it is recommended that a person, such as the Safety Officer, is nominated, with deputies, to be responsible for dealing with any emergency which may occur due to LFG.

14.7.9 In an emergency situation the nominated person, or his deputies, shall have the necessary authority and shall ensure that the confined space is evacuated and the necessary works implemented for reducing the concentrations of gas. The following organizations should also be contacted as appropriate:

- Hong Kong Police Force;
- Fire Services Department;
- Environmental Protection Department.

General Recommended Precautionary and Protection Measures – Design Phase

14.7.10 At the preliminary assessment stage, it is not practicable to determine detailed protection, but a provisional classification of the site into one of five categories will allow the Professional Person a means of understanding the generic types of protection which would be appropriate. The potential implications associated with the various qualitative risk categories are summarized in **Table 14.2**.

14.7.11 According to the source-path-target analysis in **Section 14.6**, the risk category at the proposed CBL development ranged from low to medium. Therefore, "some precautionary measures" to "engineering measures required" should be applied by the project proponent to protect the proposed development. To avoid engineering measures, underground rooms or void should be avoided in the CBL development as far as practicable.

14.7.12 The need and practicality of incorporating measures for higher risk category should be reviewed in the detailed QLFGHA during the detailed design stage.

14.7.13 The CBL project proponent should make the utility companies aware of the location and features of the site within the 250m Consultation Zone during the respective detailed design stage as part of the QLFGHA. The utilities companies should have a responsibility to train and ensure their staff to take appropriate precautions at all times when entering enclosed spaces or plant rooms.

General Recommended Precautionary and Protection Measures – Operational Phase

14.7.14 Precautionary measures below are recommended for implementation during operational phase.

14.7.15 As this project only includes road works or drainage works with no involvement of any building structure, the main precautionary measures during the operational phase will be mainly applied to the inspection or maintenance of the utilities services at the area within the 250m Consultation Zone.

14.7.16 An assumed presence of landfill gas should be adopted at all times by maintenance workers. All maintenance workers inspecting any manhole should be fully trained in the issue of LFG hazard. Any manhole which is large enough to permit to access to personnel should be subject to entry safety procedure. Such work in confined spaces is controlled by the Factories and Industrial Undertakings (Confined Spaces) Regulations of the Factories and Industrial Undertakings

Ordinance. Following the Code of Practice on Safety and Health at Work in Confined Spaces (Labour Department, Hong Kong) ensures compliance with the above regulations. A strictly regulated "work permit procedure" should be implemented and the relevant safety procedures must be rigidly followed. Adequate communication with maintenance staff should be maintained with respect to LFG.

14.7.17 The utility companies should undertake a LFG surveillance exercise at the utility manholes/inspection chambers. The surveillance exercise shall be:

- Undertaken using an intrinsically safe portable instrument, appropriately calibrated and capable of measuring the following gases in the ranges indicated:

Methane	0-100% Lower Explosive Limit (LEL) and 0-100% v/v
Carbon Dioxide	0-100%
Oxygen	0-21%

- Undertaken for the duration of the site occupancy, or until such time that EPD agree that surveillance is no longer required;
- Depending on the results of the measurements, actions required will vary and should be set down by appropriately qualified person. As a minimum, these shall encompass those actions specified in **Table 14.1**.

Monitoring Requirement

14.7.18 The existing monitoring wells will continue to be monitored by EPD's Landfill Restoration Contractors as part of the restoration contract for TKOL-II/III.

14.7.19 To protect the site workers and future owners within the 250m Consultation Zone, it is recommended that monitoring of any LFG which may be migrated to the site should be undertaken during the construction of CBL infrastructure when the works involve confined spaces. The monitoring requirement has been discussed in **Section 14.7.6**. The requirements of operational monitoring by future site developers should be determined in the detailed QLFGHA during the detailed design stage when the risk potential and mitigation measures, if required, are confirmed.

14.8 Conclusion

- This chapter provides a qualitative risk assessment for LFG hazards associated with the proposed CBL development. The TKOL-II/III is considered as a "**Medium**" source of gas migration due to occasional high carbon dioxide levels of more than 5% v/v above natural background level detected in the gas monitoring wells though LFG control measures such as an active gas extraction system have been installed. The source-pathway-target analysis indicates that the overall risks to the receivers within the 250m Consultation Zone during both construction and operational phases would be categorised as "**Low** to **Medium**". Appropriate precautionary measures have been recommended to reduce such risk to comply with the requirements of the TM-EIAO. It is expected that with the proposed measures in place, the potential risk of LFG migration to the respective targets will be minimal and has complied with Section 1.1(f) in Annex 7 and Section 3.3 in Annex 19 of the TM-EIAO. Moreover, a detailed assessment will be carried during the detailed design of the project.

15 Environmental Monitoring and Audit

15.1 Introduction

15.1.1 The findings and recommendations of the EIA report will constitute a formal commitment by the Project Proponent to achieve the levels of environmental protection. It also states the Project Proponent's environmental performance criteria. In order to ensure the performance commitments are incorporated throughout various implementation phases (e.g. detailed design, tendering, construction and operation of the project), a number of contractual, managerial and administrative mechanisms will be implemented, including:

- Setting up of a project organization and hierarchy,
- Development of Environmental Monitoring and Audit (EM&A) programme,
- Outline of Environmental Mitigation Implementation Schedule,
- Formulation of Environmental Management Plan which includes Waste Management Plan, and
- Approval of Contractor's Work Method Statement.

15.2 Project Organization

15.2.1 A project organisation consisting of the Independent Environmental Checker (IEC), Contractor's Environmental Team (ET), Engineer's Representative (ER), and Contractor shall be formed to take the responsibilities of the environmental protection for this project's EM&A Manual & Implementation Schedule.

15.2.2 The IEC will be appointed by the Project Proponent to conduct independent auditing on the overall EM&A programme including the implementation of all environmental mitigation, submissions relating to EM&A, and any other submission required under the Environmental Permit (EP). The organisation, responsibilities of respective parties and lines of communication with respect to environmental protection works are given in the EM&A Manual.

15.3 EM&A Manual & Implementation Schedule

15.3.1 The EM&A is an important aspect in the EIA process that specifies the time frame and responsibilities for the implementation of the environmental mitigation measures identified. Requirements on environmental monitoring (including baseline and impact monitoring) will be given.

15.3.2 A project specific EM&A Manual has been prepared based on the latest design information available and EPD’s generic EM&A Manual. The project specific EM&A Manual specifies the following:

- Organisation, hierarchy and responsibilities of the Contractor, the Engineer or ER, ET, and IEC with respect to the EM&A requirements during construction;
- Information on project organisation and programming of construction activities for the project;
- Requirements with respect to the construction schedule and the necessary EM&A programme to track the varying environmental impact;
- Full details of the methodologies to be adopted, including all field, laboratory and analytical procedures, and details on quality assurance;
- Procedure for undertaking on-site environmental audits;
- Definition of Action and Limit levels;
- Establishment of event and action plans;
- Requirements of reviewing pollution sources and working procedures required in the event of non-compliance of the environmental criteria and complaints;
- Requirements for review of EIA predictions, implementation of mitigation measures, and the effectiveness of the environmental protect and pollution control measures adopted; and
- Presentation requirements for EM&A data and appropriate reporting procedures.

15.4 EM&A Programme

15.4.1 The aim of implementing the EM&A programme is to ensure compliance with the EIA study recommendations, to assess the effectiveness of the recommended mitigation measures and to identify any further need for additional mitigation measures or remedial action.

15.4.2 Detailed requirements of the EM&A programme are described in the EM&A Manual. Measurements and activities that shall be conducted in accordance with the requirements in the EM&A Manual are summarised in the follow:

- Baseline monitoring,
- Impact monitoring,
- Remedial actions in accordance with the Event and Action Plan within the time frame in cases where specified criteria in the EM&A Manual are exceeded,
- Logging and keeping records of the details of monitoring results, and
- Preparing and submitting monthly EM&A Reports.

15.5 Environmental Management Plan

15.5.1 A systematic EMP shall be set up by the Contractor to ensure effective implementation of the mitigation measures, monitoring and remedial requirements presented in the EIA, EM&A and EMIS. The ER and the IEC will audit the implementation status against the EMP and advise the necessary remedial actions required. These remedial actions shall be enforced by the ER through contractual means.

15.5.2 The EMP will require the Contractor (together with its sub-contractors) to define in detail how to implement the recommended mitigation measures in order to achieve the environmental performance defined in Hong Kong's environmental legislation and the EIA documentation.

15.5.3 The review of on-site environmental performance shall be undertaken by the ER and the IEC through a systematic checklist and audit once the construction commences. The environmental performance review programme comprises a regular assessment on the effectiveness of the EMP. Reference should be made to ETWBTC 19/2005

"Environmental Management on Construction Sites" or its latest versions, and any other relevant Technical Circulars.

15.6 Construction Method Statement

15.6.1 In case the Contractor would like to adopt alternative construction methods or implementation schedules, it is required to submit details of methodology and equipment to the ER for approval before the work commences. Any changes in construction method shall be reflected in a revised EMP or the Contractor will be required to demonstrate the manner in which the existing EMP should accommodate the proposed changes. The Contractor may need to apply for a Further Environmental Permit (FEP) from EPD before commencement of any construction activities.

16 Summary of Environmental Outcomes

16.1 Population and Environmental Sensitive Areas Protected

16.1.1.1 As described in Section 1.5, CEDD commissioned the TKO Study in 2002 to formulate a comprehensive plan for further development of TKO and improvement of its overall design with a view to building TKO into a new town that can boast of its convenience, vibrancy, distinctive urban design and quality living environment. As an integral part of the TKO Study, the long-term transport need of TKO had been examined.

16.1.1.2 The TKO Study identified that the existing TKO Tunnel would have insufficient capacity to cater for projected traffic flow to be generated from further population intake and industrial developments in TKO. It recommended that a new external road network comprising the CBL and TKO-LT Tunnel should be provided to meet the anticipated traffic flow. The TKO Study was substantially completed in 2005 with endorsement of its recommendations.

16.1.1.3 The consequence of not proceeding with the Project would have been a constraining factor upon the planning and development of Area 87 and Area 137 due to traffic congestion along Wan Po Road and at the existing TKO tunnel. The Area 87 and Area 137 projects have since proceeded in the knowledge that CBL and TKO-LT Tunnel would meet the anticipated traffic demand.

16.1.1.4 With the CBL and Route 6, including TKO-LT Tunnel, the journey time between TKO Area 86 and Kowloon would be significantly reduced. Currently, from the junction of Wan Po Road and Wan O Road, the journey to Gascoigne Road, Yau Ma Tei, is approximately 35 minutes. After completion of these projects, it is estimated the journey time will be reduced by 20 minutes. Without CBL and TKO-LT Tunnel, long queue lengths at the existing TKO Tunnel will only be further exacerbated by the traffic generated by further development of TKO.

16.2 Approaches Adopted to Avoid Environmental Impacts

16.2.1 The EIA Study for Further Development of Tseung Kwan O Feasibility Study concluded that a route option without CBL would be environmentally undesirable and was not suitable for further consideration. In the absence of CBL and TKO-LT Tunnel, there would be increased traffic through TKO Town Centre, overloading its road network and causing heavy congestion. Higher traffic flows through TKO Town Centre will result in greater levels of air and noise impacts. Therefore, with the development of CBL and TKO-LT Tunnel, environmental impacts due to increased traffic and congestion through TKO Town Centre have been avoided.

16.3 Approaches Adopted to Minimize Environmental Impacts

16.3.1 Approaches adopted to minimize environmental impacts have been one of the key considerations throughout the entire project development and design. The following sections provide a summary of key approaches adopted.

- Route alignment and design option evaluation to develop a feature bridge design for CBL and become a landmark for TKO;
- Deployment of large span piers to minimize construction works and work front;
- Addition of 'green features' such as footpath and cycle track to connect to existing and planned cycle tracks; and
- Deployment of construction methods such as off-site precast segmental construction, off-site fabrication and non-dredge method.

Route alignment and design option evaluation to develop a feature bridge design for CBL and become a landmark for TKO

16.3.1.1 According to "Further Development of Tseung Kwan O Feasibility Study – Final Topical Study Report: Cross Bay Link" (2005), the four route alignment options are appraised broadly in terms of traffic performance, compatibility with land use planning intentions, and potential environmental impacts. As result, Scheme A (Bridge Arrangement) would be preferred as its compatible with the land use planning for TKO, met the necessary functional requirements for this road link and would also perform best in terms of technical criteria including environmental performance.

16.3.1.2 From an evaluation of a long list of bridge design options, six were identified to be technically feasible for the project and shortlisted by the Final Design Options Review Report (2010). Consultation with the government departments and the Sai Kung District Council in November 2009 confirmed the six design options to be taken forward for public consultation. As result, Design Option 5, the Eternity Arch, gained the most support and was therefore subsequently taken forward as the preferred option for CBL. Details refer to **Section 3.3**.

Large span pier design to minimize works front and construction works

16.3.1.3 The span of the piers for CBL ranges from 75m to 200m. This span is larger than the normal 50m span for bridge structures. With the larger span, a smaller number of piers are required, and thus the works front number and construction works is reduced. Associated impacts on marine water quality and marine habitat loss are therefore minimised. Details refer to **Sections 8** and **10**, respectively.

Addition of 'green features' such as footpath and cycle track to connect to existing and planned cycle tracks

16.3.1.4 Several recreational facilities were also proposed in the TKO Study to further enhance the living environment of the TKO residents. These include a riverine park along the Eastern Channel, a waterfront promenade in town centre south, an area for water sports and recreational facilities at the TKO Stage I Landfill site, and the construction of more cycle tracks in the new developments. CBL will provide a new cycle track which will be connected to the existing and other planned cycle tracks to form a complete loop in TKO. In addition to CBL, new footbridge located at the Eastern Channel, Southern Bridge, is being planned to complement the existing Northern Bridge.

Deployment of construction methods such as off-site precast segmental construction, off-site fabrication and non-dredge method

16.3.2 Off-site construction offers many environmental benefits. In general, by moving construction away from the site, potential nuisance to local residents and the impact on the local environment would be reduced. However, the purpose of the off-site fabrication is not to transfer the problems elsewhere. The concrete pre-casting and steel fabrication yards in China are purpose-built facilities, with production line practices implemented. Hence, the impacts would be better managed and controlled. Details refer to **Section 4**.

16.3.2.1 Non dredging works are envisaged for the construction of CBL. Piling and pile cap construction would occur in three different sections for the Main Bridge, Eastern Approach and Western Approach. Cylindrical steel casings (of the pile diameter) would be installed at each pile location within the steel sheet pile cofferdam. Excavation from within the cylindrical steel casing would be undertaken from the seabed level down to the pile founding level. This construction method would avoid the need to dredge sediment because the pile cap would be located above the sea bed. Sediment excavated from within the cylindrical steel pile casings would be placed in barge and disposed in accordance with regulations. Details refer to **Section 4**.

16.4 Approaches Adopted to Mitigate Environmental Impacts

16.4.1 With the development of CBL and TKO-LT Tunnel, environmental impacts due to increased traffic and congestion throughout TKO Town Centre have been avoided, thus, providing economic and social benefits to the surrounding communities. However, due to the inherent environmental impacts due to construction activities, CBL has minimized its environmental impacts where possible. Where the impacts could not be minimized, efforts have been made to mitigate the impacts as far as practicable. The EIA has recommended a package of mitigation measures that would be required. The Environmental Mitigation Implementation Schedule in the EM&A Manual has clearly stated the details of such mitigation measures, the timeframe and the implementation agents. Some of the key mitigation measures are discussed in the following sections.

16.4.2 Measures adopted to Mitigate Air Quality Impacts

16.4.2.1 In order to reduce dust emission from the Project and achieve compliance with the TSP criteria at ASRs during construction phase, mitigation measures in form of regular watering under a good site practice should be adopted. In addition to the watering and required intensity, the Contractor will also be obliged to follow the procedures and requirements given in the Air Pollution Control (Construction Dust) Regulation.

16.4.2.2 In accordance with the Air Pollution Control (Construction Dust) Regulation, the following dust suppression measures should also be incorporated by the Contractor to control the potential for dust nuisance throughout the construction phase:

- Any excavated or stockpile of dusty material should be covered entirely by impervious sheeting or sprayed with water to maintain the entire surface wet and then removed or backfilled or reinstated where practicable within 24 hours of the excavation or unloading;
- Any dusty materials remaining after a stockpile is removed should be wetted with water and cleared from the surface of roads;
- A stockpile of dusty material should not extend beyond the pedestrian barriers, fencing or traffic cones;
- The load of dusty materials on a vehicle leaving a construction site should be covered entirely by impervious sheeting to ensure that the dusty materials do not leak from the vehicle;
- Where practicable, vehicle washing facilities with high pressure water jet should be provided at every discernible or designated vehicle exit point. The area where vehicle washing takes place and the road section between the washing facilities and the exit point should be paved with concrete, bituminous materials or hardcores;
- When there are open excavation and reinstatement works, hoarding of not less than 2.4m high should be provided as far as practicable along the site boundary with provision for public crossing. Good site practice shall also be adopted by the Contractor to ensure the conditions of the hoardings are properly maintained throughout the construction period;
- The portion of any road leading only to construction site that is within 30m of a vehicle entrance or exit should be kept clear of dusty materials;
- Surfaces where any pneumatic or power-driven drilling, cutting, polishing or other mechanical breaking operation takes place should be sprayed with water or a dust suppression chemical continuously;
- Any area that involves demolition activities should be sprayed with water or a dust suppression chemical immediately prior to, during and immediately after the activities so as to maintain the entire surface wet;

- Where a scaffolding is erected around the perimeter of a building under construction, effective dust screens, sheeting or netting should be provided to enclose the scaffolding from the ground floor level of the building, or a canopy should be provided from the first floor level up to the highest level of the scaffolding;
- Any skip hoist for material transport should be totally enclosed by impervious sheeting; and
- Exposed earth should be properly treated by compaction, turfing, hydroseeding, vegetation planting or sealing with latex, vinyl, bitumen, shortcrete or other suitable surface stabiliser within six months after the last construction activity on the construction site or part of the construction site where the exposed earth lies.

16.4.2.3 For the barging facilities proposed at the site compound, the following good site practice is required:

- All road surfaces within the barging facilities should be paved,
- Vehicles should pass through designated wheel wash facilities, and
- Continuous water spray should be installed at the loading point.

16.4.2.4 The above requirements should be incorporated into the Contract Specification for the civil work. In addition, an audit and monitoring programme during the construction phase should be implemented by the Contractor to ensure that the construction dust impacts are controlled to within the HKAQO.

16.4.2.5 No exceedances of the relevant AQOs are predicted at all representative ASRs during operational phase and cumulative air quality impact or adverse residual air quality impact is not anticipated. Mitigation measures for operational phase are not necessary.

16.4.3 Measures Adopted to Mitigate Noise Impacts

16.4.3.1 For construction phase, the extent of temporary works areas where construction plant would be operated has been reduced to minimize the airborne construction noise impacts as far as practicable. However, unmitigated construction noise would exceed the daytime noise criteria, and therefore, mitigation measures are therefore required. The following mitigation measures have been considered:

- Good site practices to limit noise emissions at the source,
- Use of quiet plant and working methods,

- Use of site hoarding as noise barrier to screen noise at ground level of NSRs,
- Use of shrouds/temporary noise barriers to screen noise from relatively static PMEs,
- Scheduling of construction works outside school examination periods in critical area, and
- Alternative use of plant items within one worksite, wherever practicable.

16.4.3.2 However, as predicted mitigated noise levels and predicted cumulative noise impacts exceed the noise criterion for Planned Primary School & Secondary School near Wan Po Road during examination period, the contractor should further confirm the construction program of this NSR at the commencement of the CBL construction and reschedule the construction work outside the examination period as far as possible.

16.4.3.3 For the operational phase, partial enclosures along Road D9 and application of low noise surfacing material along CBL and Road D9 have been proposed as noise impacts are contributed by CBL and Road D9.

16.4.4 Measures Adopted to Mitigate Sediment Quality Impacts

16.4.4.1 It is estimated that a total of approximately 4,300m^3 marine deposit is required to be excavated from the pile casings. Amongst the excavated volume, approximately 97% is Category L sediment (Type 1 open sea disposal). Category Mp (Type 1 open sea disposal at dedicated sites), Mf (Type 2 confined marine disposal), and H (Type 2 confined marine disposal) sediments contribute to about 3% of the total volume.

16.4.5 Measures Adopted to Mitigate Water Quality Impacts

16.4.5.1 During construction phase, pile excavation should be undertaken in such a manner as to minimise resuspension of sediments. Standard good practice measures should therefore be implemented including the following requirements:

- All pile excavation works shall be conducted within a cage type silt curtain;

- Floating single silt curtain shall be employed for all marine works;
- Mechanical grabs (with a size of 5m3) shall be designed and maintained to avoid spillage and should seal tightly while being lifted;
- Barges and hoppers shall have tight fitting seals to their bottom openings to prevent leakage of material;
- Any pipe leakages shall be repaired quickly. Plant should not be operated with leaking pipes;
- Loading of barges and hoppers shall be controlled to prevent splashing of dredged material to the surrounding water. Barges or hoppers shall not be filled to a level which will cause overflow of materials or pollution of water during loading or transportation;
- Excess material shall be cleaned from the decks and exposed fittings of barges and hopper dredgers before the vessel is moved;
- Adequate freeboard shall be maintained on barges to reduce the likelihood of decks being washed by wave action;
- All vessels shall be sized such that adequate clearance is maintained between vessels and the sea bed at all states of the tide to ensure that undue turbidity is not generated by turbulence from vessel movement or propeller wash; and
- The works shall not cause foam, oil, grease, litter or other objectionable matter to be present in the water within and adjacent to the works site.

16.4.5.2 In accordance with the Practice Note for Professional Persons on Construction Site Drainage, Environmental Protection Department, 1994 (ProPECC PN 1/94), construction phase mitigation measures, where appropriate, should include the following:

- The design of efficient silt removal facilities should be based on the guidelines in Appendix A1 of ProPECC PN 1/94. The detailed design of the sand/silt traps should be undertaken by the contractor prior to the commencement of construction.
- Open stockpiles of construction materials (for example, aggregates, sand and fill material) of more than 50m3 should be covered with tarpaulin or similar fabric during rainstorms. Measures should be taken to prevent the washing away of construction materials, soil, silt or debris into any marine water bodies.
- All vehicles and plant should be cleaned before leaving a construction site to ensure no earth, mud, debris and the like is deposited by them on roads. An adequately designed and sited wheel washing facilities should be provided at every construction site exit where practicable. Wash-water should have sand and silt settled out and removed at least on a weekly basis to ensure the

continued efficiency of the process. The section of access road leading to, and exiting from, the wheel-wash bay to the public road should be paved with sufficient backfall toward the wheel-wash bay to prevent vehicle tracking of soil and silty water to public roads and drains.

- Construction solid waste, debris and rubbish on site should be collected, handled and disposed of properly to avoid water quality impacts.
- All fuel tanks and storage areas should be provided with locks and sited on sealed areas, within bunds of a capacity equal to 110% of the storage capacity of the largest tank to prevent spilled fuel oils from reaching water sensitive receivers nearby.
- Regular environmental audit on the construction site should be carried out in order to prevent any malpractices. Notices should be posted at conspicuous locations to remind the workers not to discharge any sewage or wastewater into the meander, wetlands and fish ponds.

16.4.5.3 Regarding sewage from workforce, portable chemical toilets and sewage holding tanks should be provided for handling the construction sewage generated by the workforce. A licensed contractor should be employed to provide appropriate and adequate portable toilets and be responsible for appropriate disposal and maintenance. Notices should be posted at conspicuous locations to remind the workers not to discharge any sewage or wastewater into the nearby environment during the construction phase of the Project. Regular environmental audit on the construction site should be conducted in order to provide an effective control of any malpractices and achieve continual improvement of environmental performance on site.

16.4.5.4 During operational phase, proper drainage systems with silt traps and oil interceptors should be installed, maintained and cleaned at regular intervals as a precautionary measure to mitigate potential runoff from road surfaces.

16.4.6 Measures Adopted to Mitigate Impacts on Waste Management

16.4.6.1 The amount of C&D material that would need to be transported off site has been minimized as far as practicable in the design. The Project Proponent will ensure all the mitigation measures mentioned in the C&DMMP will be complied with. Wherever practicable, C&D materials should be segregated from other wastes to avoid contamination and ensure acceptability at public filling areas or reclamation sites. Good site practices have also been recommended for chemical waste, general refuse and disposal of chemical waste will follow the relevant ordinances.

16.4.6.2 Prior to the commencement of the construction works, the contractors should incorporate recommendations into a Waste Management Plan to provide an overall framework for waste management and reduction.

16.4.6.3 It is not anticipated that large quantities of waste would be generated during the operational phase. Only a small amount of general refuse would be generated from the footpath and cycle track along CBL and Road D9. Waste collection bins and recycling bins would be provided.

16.4.7 Measures Adopted to Mitigate Marine Ecology and Fisheries Impacts

16.4.7.1 Besides the adoption of larger span piers to minimize impacts on marine ecology and fisheries resources, good site practices and site runoff control measures would be sufficient to protect water quality. The integrity and effectiveness of all silt curtains should be regularly inspected. Effluent monitoring should be incorporated to make sure that the discharged effluent from construction sites meets the relevant effluent discharge guidelines. For works on land, standard site runoff control measures will be established and strictly enforced to ensure that discharge of contaminated or silt-laden runoff into marine waters is minimised.

16.4.7.2 The water quality programme could also serve the purposes to protect the marine communities inside Junk Bay. No species ecological or fisheries monitoring programme is needed.

16.4.8 Measures Adopted to Mitigate Landscape and Visual Impacts

16.4.8.1 The proposed landscape and visual mitigation measures for the CBL during construction and operation phase are listed below. Generally, all mitigation measures are to be implemented as early as possible and many of these mitigation measures perform multiple functions.

Construction Phase Mitigation Measures

- The construction area and contractor's temporary works areas should be minimised to avoid impacts on adjacent landscape.
- Reduction of construction period to practical minimum.
- Topsoil, where identified, should be stripped and stored for re-use in the construction of the soft landscape works, where the soil material meets acceptable criteria and where practical. The Contract Specification shall include storage and reuse of topsoil as appropriate.
- Existing trees on boundary of the Project Area shall be carefully protected during construction. Detailed Tree Protection Specification shall be provided in the Contract Specification. Under this specification, the Contractor shall be required to submit, for approval, a detailed working method statement for the protection of trees prior to undertaking any works adjacent to all retained trees, including trees in contractor's works areas. (Tree protection measures will be detailed at Tree Removal Application stage).
- Trees unavoidably affected by the works shall be transplanted where practical. Trees should be transplanted straight to their final receptor site and not held in a temporary nursery. A detailed Tree Transplanting Specification shall be provided in the Contract Specification, if applicable. Sufficient time for necessary tree root and crown preparation periods shall be allowed in the project programme.
- Advance screen planting to proposed roads and associated structures.
- Hydroseeding or sheeting of soil stockpiles with visually unobtrusive material (in earth tone).
- Screening of construction works by hoardings/noise barriers around works area in visually unobtrusive colours, to screen Works.
- Control night-time lighting and glare by hooding all lights.
- Ensure no run-off into water body adjacent to the Project Area.
- Avoidance of excessive height and bulk of buildings and structures

Operation Phase Mitigation Measures for Cross Bay Link

- Compensatory tree planting for all felled trees shall be provided to the satisfaction of relevant Government departments. Required numbers and locations of compensatory trees shall be determined and agreed separately with Government during the Tree Felling Application process under ETWBTC 3/2006.

- A continuous belt of screen planting along the roads. Planting of the belt of trees shall be carried out as advance works ahead of other site formation and building works.

- Maximise soft landscape of the site, Where space permits, roadside berms /slope treatment works should be created.

- During detailed design, refine structure layout to create a planting strips along the roads to enhance greenery.

- Use appropriate (visually unobtrusive and non-reflective) building structural materials and colours, and aesthetic design in built structures.

- Streetscape elements (e.g. paving, signage, street furniture, railing etc.) shall be sensitively designed in a manner that responds to the local context, and minimises potential negative landscape and visual impacts. Lighting units should be directional and minimise unnecessary light spill.

- Avoidance of excessive height and bulk of buildings and structures.

16.4.9 Measures Adopted to Mitigate Landfill Gas Impacts

16.4.9.1 General advice and recommendations for avoidance of environmental impacts related to LFG during construction and operational phases have been addressed. Where applicable, specific measures for handling the hazards identified during the construction and operational phases should be addressed to further reduce the likelihood of incidents and increase the level of safety to the workers and the public. These measures should be reviewed taking into account of the findings of the detailed Qualitative LFG Hazards Assessment (QLFGHA) to be undertaken by the project proponent (Refer to **Section 14.7.12**).

16.4.9.2 All contractors participating in the works should be aware that methane and carbon dioxide are always likely to be present in the soil and rock voids and all works should be undertaken on the basis of an "assumed presence of LFG".

16.4.9.3 The precautionary measures outlined in Paragraphs 8.3 to 8.49 and the monitoring requirements and procedures specified in Paragraphs 8.23 to 8.28 of EPD's Landfill Gas Hazard Assessment Guidance Note should be adopted.

16.4.9.4 Depending on the results of measurements, the actions in the event of LFG being detected in excavations as presented in Table 14.6 should be implemented as a minimum. In order to ensure that evacuation procedures are implemented in the event of the trigger levels, it is recommended that a person, such as the Safety Officer, is nominated, with deputies, to be responsible for dealing with any emergency which may occur due to LFG.

16.4.9.5 General recommended precautionary and protection measures during the design stage should be adopted. For example, as the risk category at the proposed CBL development ranged from low to medium, "some precautionary measures" to "engineering measures required" should be applied by the project proponent to protect the proposed development. To avoid engineering measures, underground rooms or void should be avoided in the CBL development as far as practicable.

16.4.9.6 General recommended precautionary and protection measures during the operational phase should also be adopted such as inspection or maintenance of the utilities services at the area within the 250m Consultation Zone, maintenance workers should assume presence of landfill gas at all times and utility companies should undertake a LFG surveillance exercise at the utility manholes/inspection chambers.

16.4.9.7 Existing monitoring of wells will continue to be monitored by EPDs Landfill Restoration Contractors as part of the restoration contract for TKOL-II/III and to protect site workers and future owners within the 250m Consultation Zone, it is recommended that monitoring of any LFG which may be migrated to the site should be undertaken during the construction on CBL infrastructure when the works involve confined spaces.

16.4.10 Environmental Monitoring and Auditing

16.4.10.1 In addition to the mitigation measures as described above (see more details in the Environmental Mitigation Implementation Schedule within the EM&A Manual), a comprehensive environmental monitoring and auditing programme would be implemented to cover various aspects of concern. An independent environmental checker would also be employed to ensure that all the necessary mitigation measures are implemented in a timely and orderly manner.

16.4.11 Overall

16.4.11.1 Mitigation measures and good site practices to minimize the environmental impacts were recommended throughout the impact assessments of air quality, noise, sediment quality, water quality, waste management, marine ecology, fisheries, landscape and visual, and landfill gas. As the Marine Archaeological Investigation did not locate any cultural heritage resources and the diver survey indicated that in many areas the seabed had been disturbed by previous construction work, no further action or mitigation is required for cultural heritage impacts. Recommended mitigation measures were consolidated in the Implementation Schedule which specifies the responsibility, methodology and timing of implementation, such that effective and appropriate implementation of the measures can be assured.

17 Conclusion

17.1 Alternative Options

CBL Alignment Options

17.1.1 The routing of the CBL is proposed as an east-west connection between Wan Po Road and TKO-LT Tunnel across the south of the TKO Town Centre. Four route alignments for the CBL have been identified.

17.1.2 According to "Further Development of Tseung Kwan O Feasibility Study – Final Topical Study Report: Cross Bay Link" (2005), the four route alignment options are appraised broadly in terms of traffic performance, compatibility with land use planning intentions, and potential environmental impacts. Based on the outcome of the assessment, Route Alignment Option 2 is considered suitable. Consequently, the two structural forms of the option – Scheme A (Bridge Arrangement) and Scheme B (Tunnel Arrangement) is further assessed in terms of four aspects including engineering, highway traffic, environmental and cost. In overall terms, Scheme A (Bridge Arrangement) of Route Alignment Option 2 is selected as the preferred CBL scheme.

17.1.3 Following a preliminary evaluation of the long list of bridge options, six design options were identified as technically feasible for the project and were shortlisted in the Final Design Options Review Report (2010). According to the public consultation, Design Option 5, the Eternity Arch, is carried forward as the preferred option for CBL.

Preferred Construction Method

17.1.4 Off-site precast segmental construction and off-site erection will be adopted for the construction of the CBL. The environmental impact was one of the key reasons for adopting these construction methods since moving construction away from the site reduces the nuisance to local residents and the impact on the local environment. However, the purpose of the off-site fabrication is not to transfer the problems elsewhere. The concrete pre-casting and steel fabrication yards in China are purpose-built facilities, with production line practices implemented. Hence, the impacts would be better managed and controlled.

17.2 Construction Descriptions

17.2.1 The CBL is targeted to be commissioned by 2020. Hence, the construction of the CBL will start in late 2016, for completion in 2020, with a construction period of 4 years.

17.2.2 The major construction works would include the following activities:

CBL

- Foundations – Installation of piles by marine piling rigs, erection of cofferdam, building of pile caps, and building of piers;
- Substructure and superstructure – erection of concrete deck segments of the approach, and installation of main bridge and side spans; and
- Construction of the cycle track ramp.

Road D9

- Sea wall modification and strengthening;
- Ground improvement works;
- Piling and erection of noise barrier.

17.3 Air Quality Impact

17.3.1 During construction phase, potential dust impact would be generated from the soil excavation activities, backfilling, site erosion, storage of spoil on site, and transportation of soil during the construction phase. Quantitative fugitive dust assessments have therefore been conducted for the construction of CBL. The assessment result has concluded that watering once per hour on exposed worksites and haul road is recommended to achieve dust removal efficiency of 91.7%. In addition to the watering and required intensity, the Contractor will also be obliged to follow the procedures and requirements given in the Air Pollution Control (Construction Dust) Regulation. With the implementation of recommended mitigation measures, no adverse air quality impact is anticipated during the construction phase.

17.3.2 Cumulative air quality impact arising from the vehicular emissions from the open roads, tunnel portals and the chimney emissions from various industries in the TKOIE during the operational phase has been assessed. The assessment results have concluded that all the 1-hour, 24-hour and annual NO_2 and RSP concentrations would comply with the relevant AQOs. Hence, no adverse cumulative air quality is therefore anticipated during the operational phase.

17.3.2.1 Overall, it was concluded that during the both the construction and operational phases of CBL, Annex 12 of the TM-EIAO would be fully complied with.

17.4 Noise Impact

17.4.1 During construction phase, construction noise impacts would arise from major construction works for CBL (i.e. installation of piles by marine piling rigs, erection of cofferdam, building pile caps, erection of noise barrier, etc. Unmitigated construction noise assessment results indicate exceedance of the daytime noise criteria, and therefore, mitigation measures are required. However, with the implementation of proposed mitigation measures (i.e. good site practice, use of quite plant and working methods, use of site hoarding/shrouds/temporary noise barriers, etc.), predicted mitigated noise levels at all Noise Sensitive Receivers will be within the respective noise criteria due to the construction of CBL. The predicted cumulative noise impacts exceed the noise criterion for Planned Primary School & Secondary School near Wan Po Road (R33 & R34) during examination period. The contractor should therefore further confirm the construction program of this NSR at the commencement of the CBL construction work. The CBL construction work at Road D9 will be scheduled to avoid the examination period at the Planned Primary and Secondary School (R33 & R34) if the educational institution at R33 and R34 are constructed before the commencement of CBL construction work.

17.4.2 For operational phase, noise impacts are contributed by traffic at Road D9 and CBL and therefore a 6m height partial enclosure along road D9 and low noise surfacing on CBL and Road D9 have been proposed to mitigate impacts. However, exceedance of the noise criterion is still predicted at planned development residential block R22 of Lohas Park Stage 3. As R22 was previously assessed, mitigation measures have been proposed by the Area 86 development proponent. Further analysis revealed that the noise exceedance is predominantly due to the Road R5 and model predictions indicate that the new roads contribute less than 1dB(A) to the overall noise level and the predicted noise level arising from new roads is less than 70dB(A). No further actions are therefore required by the CBL Project proponent.

17.4.2.1 Overall, in respect of both the construction and operational phases of CBL, Annex 5 of the TM-EIAO would be complied with.

17.5 Sediment Quality

17.5.1 A marine GI with sediment sampling and laboratory testing has been undertaken and analysed in accordance with the requirements in ETWB 34/2002. It is estimated that a total of approximately 4,300m^3 marine deposit is required to be dredged. Amongst the dredged volume, approximately 97% is Category L sediment. Category Mp, Mf, and H sediments contribute approximately 3% of the total volume.

17.5.2 Overall, it was concluded that in respect of the marine sediment to be excavated and disposed at sea during the construction of the CBL, Annex 7 of the TM-EIAO would be complied with.

17.6 Waste Management

17.6.1 Potential waste management implications from the generation of waste during the construction and operational phase of the Project have been evaluated. A range of best practice mitigation measures have been proposed for implementation by the Contractor during the construction period to minimise waste generation and off-site disposal. In addition, monitoring and audit measures are proposed to ensure that robust measures are promoted to minimise impacts and that waste is controlled effectively.

17.6.2 With the implementation of all the proposed mitigation measures, no adverse residual waste management implications were anticipated during both the construction and operational phases. Overall, it was concluded that the waste management implications of CBL would comply with Annex 7 of the TM-EIAO.

17.7 Water Quality Impact

17.7.1 During construction phase, water quality impacts may arise from pile excavation works, construction site runoff and sewage from workforce. For pile excavation works, assessment results indicate that non-compliance with the assessment criteria for WSD's salt water intakes for flushing water (10mg/L), or any Fish Culture Zone in the vicinity, is not anticipated. Although the interface of the marine works for CBL project with T2 is anticipated, the plume from CBL was well confined in Junk Bay area and superpositions of plume with T2 is not anticipated. With the implementation of proposed mitigation measures, adverse water quality impacts during construction phase are not anticipated.

17.7.2 During operational phase, no significant change in the hydrodynamic and water quality regime is anticipated. No mitigation measures such as maintenance dredging are therefore required. Due to potential runoff from road surfaces, proper drainage systems with silt traps and oil interceptors should be installed, maintained and cleaned at regular intervals as a precautionary measure.

17.7.2.1 Overall, it was concluded that water quality impacts would comply with Annex 6 of the TM-EIAO during both the construction and operational phases of CBL.

17.8 Marine Ecological Impact

17.8.1 There are no recognised sites of conservation importance (e.g. SSSIs, Country Parks and Marine Parks) inside Junk Bay, and there are no ecological sensitive areas (e.g. high value coral communities) inside or close to the CBL alignment.

17.8.2 The CBL would cause only limited (< 0.3ha) soft substrate seabed and marine waters loss and potentially affect a section of 450m vertical seawall with low coverage of common soft and hard corals. These habitat loss impacts ranked as insignificant to minor due to the small size and low ecological value of the habitats. And it is anticipated that there will be new seawalls along the waterfront of the future landing point/reclamation, and artificial intertidal and subtidal hard substrate habitat is available for intertidal fauna and coral colonisation after construction.

17.8.3 Only limited marine water quality impacts are anticipated as only 12 pier sites are needed for the project and no reclamation will be performed. Other impacts are also minor or insignificant. The residual impacts, mainly habitat loss, are considered acceptable. No species ecological monitoring programme is needed. Overall, it was concluded that ecological impact due to CBL would comply with Annex 8 of the TM-EIAO.

17.9 Fisheries Impact

17.9.1 There is no fish culture zone or spawning and nursery grounds for fisheries species inside Junk Bay, or inside or close to the CBL alignment.

17.9.2 The CBL would cause only limited (< 1ha) loss of fishing ground of low to moderate production. These habitat loss impacts ranked as insignificant to minor due to the small size and low ecological value of the habitats.

17.9.3 Only limited marine water quality impacts are anticipated as only 12 pier sites are needed for the project and no reclamation will be performed. Other impacts are also minor or insignificant.

17.9.4 The residual impacts, fishing ground loss, are considered acceptable. No specific fisheries monitoring programme is needed. Overall, it was concluded that CBL would comply fully with Annex 9 of the TM-EIAO.

17.10 Cultural Heritage Impact

17.10.1 A comprehensive Marine Archaeological Investigation was completed which followed exactly the methodology set out by the HKSAR Antiquities and Monuments Office. The study did not locate any cultural heritage resources. The diver survey indicated that in many areas the seabed had been disturbed by previous construction work. Consequently, no further action or mitigation is therefore required. Overall, the CBL would comply fully with Annex 10 of the TM-EIAO.

17.11 Landfill Gas Hazard

17.11.1 A preliminary qualitative risk assessment for LFG hazards associated with the proposed CBL development has been conducted. The TKOL-II/III is considered as a "**Medium**" source of gas migration due to occasional high carbon dioxide levels of more than 5% v/v above natural background level detected in the gas monitoring wells though LFG control measures such as in the active gas extraction system installed. The source-pathway-target analysis indicates that the overall risks to the receivers within the 250m Consultation Zone during both construction and operational phases would be categorised as "**Low** to **Medium**". Appropriate precautionary measures and monitoring were reccomended to minimise the potential risk of LFG migration to the respective targets and requirements of Annex 7 of the TM-EIAO.

17.12 Landscape and Visual Impact

17.12.1.1 The proposed development and associated works follow in principle the planning intentions from the draft Tseung Kwan O – Outline Zoning Plan (S/TKO/20). However, the scale of CBL together with concurrent projects, namely, TKO-LTT will inevitably result in some landscape and visual impacts.

17.12.1.2 Based on the tree survey report on CBL, approximately 308 no. of trees will be affected (LR3), of which approximately 58 no. are proposed to be transplanted, and approximately 250 no. trees are proposed to be felled (including 190 no. Leucaena leucocephala and 60 no. common trees). Due to construction of the CBL, it is unavoidably considered to remove the affected trees. Affected trees with high to medium amenity value and medium survival rate are proposed to be transplanted. Trees surveyed within the proposed works boundary are primarily common species. There are no LCSD Champion Trees, Registered Old and Valuable Trees and Protected Species under Cap 586 Protection of Endangered Species of Animals and Plants Ordinance. It is expected approx. 67 heavy standard sized trees shall be planted as compensatory tree planting. The overall residual impact on vegetation along Wan O Road (LR3) is considered as acceptable with mitigation measures.

17.12.1.3 With the proposed mitigation measures including the compensatory planting and aesthetic treatments, the Junk Bay Coastal Landscape (LCA 1) will still suffer from slight landscape impact during construction and operation due to the artificial engineering structure which is incompatible with the natural Junk Bay character.

17.12.1.4 LCA2 - There will be slight impact on Reclamation / ongoing major development landscape due to the operation of CBL. However, with the proposed mitigation measures including the aesthetic design of the built structures and soft landscape treatment works, it is considered that the residual impact on this LCA is insubstantial.

17.12.1.5 LCA3 – Tseung Kwan O Industrial Urban Landscape will be subject to insubstantial impact as this LCA is relatively far away from the CBL.

17.12.1.6 LCA4 – Chiu Keng Wan Coastal Upland and Hillside Landscape will be subject to insubstantial impact as this LCA is relatively far away from the CBL. However, this LCA will definitely be affected by the interface project: TKO-LT Tunnel.

17.12.1.7 LCA5 – Tseung Kwan O Landfill Landscape (Stage II and III) will be subject to insubstantial impact as this LCA is relatively far away from CBL and will not be affected.

17.12.1.8 LCA6 – Tseung Kwan O Miscellaneous Urban Fringe Landscapewill be subject to insubstantial impact as this LCA is relatively far away from CBL and will not be affected.

17.12.1.9 LCA7 – High Junk Peak Coastal Upland and Hillside Landscape will be subject to insubstantial impact as this LCA is relatively far away from CBL and will not be affected.

17.12.1.10 LCA8 – Residential Urban Fringe Landscape will be subject to insubstantial impact as this LCA is relatively far away from CBL and will not be affected.

17.12.1.11 There is expected to be some minor impact upon the sea waterbody in Junk Bay (LR1). The sea water body will be permanent lost due to the construction of the piers for CBL bridge. Residual impacts after 10 years of operation are expected to be slight.

17.12.1.12 There is expected to be negligible impact upon the Landscaped Area and Plantation within High-rise residential development in CDA 86

(LOHAS Park) (LR2). It is considered that the residual impact is expected to be insubstantial.

17.12.1.13 There is expected to be negligible impact upon the Plantation within Vacant land (LR4), It is considered that the residual impact is expected to be insubstantial after year 10.

17.12.1.14 There is expected to be negligible impact upon Plantation within Industrial Building (LR5). Residual impact after Year 10 is expected to be insubstantial.

17.12.1.15 There is expected to be negligible impact upon Woodland at Foothill and Hillside (LR6). Residual impact after Year 10 is expected to be insubstantial.

17.12.1.16 There is expected to be negligible impact upon Grassland and Scrubland at Hillside in Chiu Keng Wan (LR7). Residual impact after Year 10 is expected to be insubstantial.

17.12.1.17 There is expected to be negligible impact upon Vegetation of clustered newly planted trees and shrubs scattered on Tseung Kwan O Stage II and III Landfill Area (LR8). Residual impact after Year 10 is expected to be insubstantial.

17.12.1.18 There is expected to be negligible impact upon Nature Rocky and Sand Shoreline in Chiu Keng Wan (LR9) and Plantation at Wasteland / Construction Area in Chiu Keng Wan (LR10). Residual impact after Year 10 is expected to be insubstantial.

17.12.1.19 There is expected to be negligible impact upon Vegetation along the Coastline Adjacent to Lohas Park Road (LR11). Residual impact after Year 10 is expected to be insubstantial.

17.12.1.20 There is expected to be negligible impact upon Roadside Planting in Lohas Park Road (LR12). Residual impact after Year 10 is expected to be insubstantial.

17.12.1.21 There is expected to be negligible impact upon Seawall in Tseung Kwan O Industrial Estate (LR13). Residual impact after Year 10 is expected to be insubstantial.

17.12.1.22 Lei Yue Mun and Tathong Channel are a unique public asset and natural visual resources as viewed from Shau Kei Wan, providing an open seascape along the Junk Bay. The proposed CBL, particularly the pier structure will induce partial blockage of views and permanent loss of open seascape view. The cumulative visual impacts can only be slightly mitigated by minimizing area, avoidance of excessive height and bulk of buildings and structures and construction period. Therefore, the VSRs (CDA1) located in close proximity to CBL will still suffer from moderate residual visual impact of the CBL

17.12.1.23 While for the proposed Open Space in Area 74 (O3), and Planned recreational users in TKO Stage I Landfill (REC1), the residual impact would be slight due to screening/amenity planting along the waterfront promenade will be fully established and can soften engineering structure built in Junk Bay.

17.12.1.24 The Planned proposed “Central Avenue” user in Town Centre South near the promenade in open space of TKO Area 68 and the promenade user in the former TKO Stage I Landfill site (O1), the Planned waterfront near the Eastern Channel in open space of TKO Area 68 (O2), and Planned Residential area of TKO Area 65, 66 and 68 (R7) will have direct and close range views to the CBL and TKO-LTT. The cumulative visual impacts can only be mitigated by using visually unobtrusive building material and refinement of engineering design. Screening planting/amenity planting in the open space itself is expected to have minor screening effect to these views because CBL are elevated. Therefore, the VSRs (O1, O2 and R7) will still suffer from moderate residual visual impact of CBL and TKO-LT Tunnel.

17.12.1.25 The proposed Open Space in Area 74 (O3), and Planned recreational users in TKO Stage I Landfill (REC1), the residual impact would be slight due to screening/amenity planting along the waterfront promenade will be fully established and is expected to have screening effect on CBL and TKO-LT Tunnel. Residents of Ocean Shores (R2) will have direct, close views to the new CBL and TKO-LT Tunnel which is immediately adjacent or very close to the VSRs. Mitigation in the form of screening planting, refinement of structure and architectural design of road structures will help in reducing these visual impacts. However, the VSRs will still be subject to the partial blockage of views and permanent loss of open seaview. Therefore, the VSRs (R2) will still suffer from moderate residual visual impact of CBL and TKO-LT Tunnel.

17.12.1.26 The landscape and visual impact assessment has been conducted according to the criteria and guidelines for evaluating and assessing impacts as stated in Annex 10 and 18 of the TM-EIAO, it is considered that the identified residual impacts, taking account of both importance and degree of compliance, will be acceptable with mitigation measures.

17.13 Environmental Monitoring and Audit Requirement

17.13.1 It is recommended to implement an Environmental Monitoring and Audit (EM&A) programme throughout the entire construction period to monitor the environmental impacts on the neighbouring sensitive receivers regularly.

17.13.2 An EM&A Manual has been prepared as a standalone document to specify the monitoring requirements, timeframe and responsibilities for the implementation of the environmental mitigation measures identified in the EIA process.

17.13.3 An Environmental Mitigation Implementation Schedule is included in the EM&A Manual to summarises all the measures, the implementation location, timeframe, agency etc.