TABLE OF CONTENTS

List of Tables

List of Appendices

13. HAZARD TO LIFE

13.1 Introduction

13.1.1.1 This section of the EIA presents the analysis and findings of the Hazard to Life Assessment undertaken for the Project.

13.1.1.2 In accordance with Section 3.4.14 of the EIA Study Brief (ESB-360/2023), a hazard to life assessment should be conducted to evaluate the risks from dangerous goods (DG) due to the existing and/or planned hazardous facilities, including but not limited to the planned desalination plant at TKO 137, town gas pipeline, synthetic natural gas production plant, LPG filling stations, explosive off-loading pier, and potential biogas production and storage at the proposed effluent polishing plant, during both construction and operation phases of the Project.

13.1.1.3 In addition, a review of the risks from the use, transport and overnight storage of explosives (if any) during construction and operation of the Project should be conducted, and assess if risk to life is a key issue with respect to Risk Guidelines given in Annex 4 of the TM. QRA for the use, transport and overnight storage of explosives for the Project shall be conducted if, and only if, risk to life is a key issue with respect to Risk Guidelines following the requirements in Section 12.1 of the TM.

13.1.1.4 The locations of hazardous facilities that were assessed with respect to the Project Site are shown in **Plate 13-1**. Furthermore, it is confirmed that all the proposed facilities in TKO 132 have been reviewed and no risks from dangerous goods due to existing and/ or planned hazardous facilities in TKO 132 are identified.

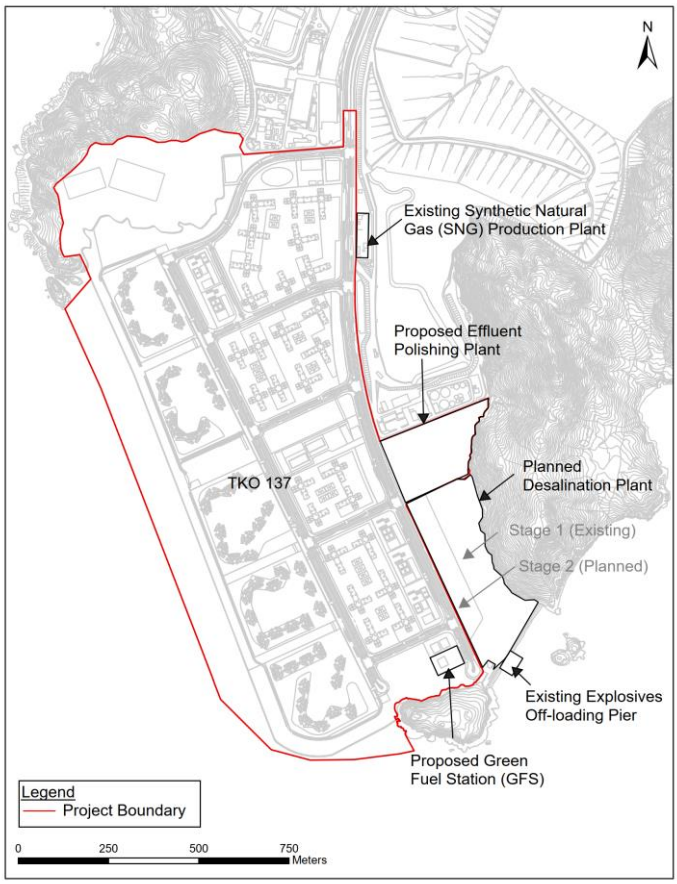

Plate 13-1 Locations of Hazardous Facilities and Project Layout

13.2 Environmental Legislation, Standards and Guidelines

13.2.1.1 As set out in Annex 4 of the EIAO-TM, the criterion for hazard to life specifies the Individual and Societal Risk Guidelines. The Hong Kong Government Risk Guidelines (HKRG) per the EIAO TM Annex 4 states that the individual risk is the predicted increase in the chance of fatality per year to an individual due to a potential hazard. The individual risk guidelines require that the maximum level of off-site individual risk should not exceed 1 in 100,000 per year i.e. 1×10^{-5} per year. Societal risk expresses the risks to the whole population. It is expressed in terms of lines plotting the cumulative frequency (F) of N or more deaths in the population from incidents at the installation. Two F-N risk lines are used in the HKRG that demark "Acceptable" or "Unacceptable" societal risks. To avoid major disasters, there is a vertical cut-off line at the 1,000 fatality level extending down to a frequency of 1 in a billion years. The intermediate region indicates the acceptability of societal risk is borderline and should be reduced to a level which is "as low as reasonably practicable" (ALARP). It seeks to ensure that all practicable and cost-effective measures that can reduce risk are considered. The HKRG is presented graphically in **Plate 13-2**.

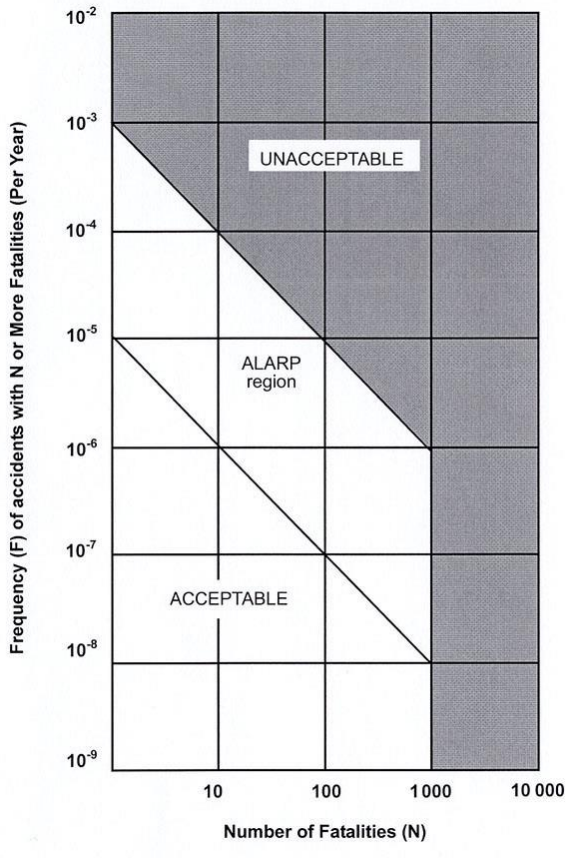

Plate 13-2 Societal Risk Guidelines

13.3 Study Objectives and Methodology

13.3.1.1 The Hazard to Life Assessment requirements for the hazardous facilities and explosives as detailed in Appendix L of the EIA Study Brief are shown below:

(a) Identify hazardous scenarios and then determine a set of relevant scenarios to be included in a Quantitative Risk Assessment (QRA);

i. For hazardous facilities: Hazard scenarios associated with the manufacture, on-site transport, storage and use of dangerous goods in the hazardous facilities;

ii. For Explosives: Hazardous scenarios associated with the use, transport and overnight storage of the explosives.

(b) Execute a QRA of the set of hazardous scenarios determined in (a), expressing population risks in both individual and societal terms;

(c) Compare individual and societal risks with the criteria for evaluating hazard to life as stipulated in Annex 4 of the TM; and

(d) Identify and assess practicable and cost-effective risk mitigation measures to demonstrate the compliance with the Risk Guidelines.

13.3.1.2 This assessment consists of the following six main tasks:

(a) **Data / Information Collection and Update**: collect relevant data / information that is essential for the hazard assessment;

(b) **Hazard Identification**: identify credible set of hazardous scenarios associated with the operation of the hazardous facilities / explosives;

(c) **Frequency Estimation**: estimate the frequencies of the identified hazardous scenarios by using Fault Tree and Event Tree Analysis;

(d) **Consequence Analysis**: analyse the consequences of the identified hazardous scenarios by using the well-established and widely accepted model, e.g. SAFETI, ESTC;

(e) **Risk Assessment and Evaluation**: evaluate the risks associated with the identified hazardous scenarios. The evaluated risks will be compared with HKRG to determine their acceptability. Where necessary, risk mitigation measures will be identified and assessed to comply with the ALARP principle used in the HKRG; and

(f) **Identification of Mitigation Measures**: review the recommended risk mitigation measures from previous studies, practicable and cost-effective risk mitigation measures will be identified and assessed as necessary. The risk outcomes of the mitigated case will then be reassessed to determine the level of risk reduction.

13.3.1.3 According to the latest design, it is confirmed that the use, transport and overnight storage of explosives is not required for the Project, therefore, risk assessment associated with explosives related issue is not required.

13.3.1.4 In consultation with the Hong Kong and China Gas Company Limited, medium pressure town gas pipeline will be enough for both TKO 132 and 137 development, no high pressure town gas pipeline is anticipated and thus risk assessment associated with town gas pipeline is considered to be not necessary.

13.3.1.5 With reference to Section 5 of Appendix L of the EIA Study Brief, the methodology adopted in the risk assessment associated with planned desalination plant at TKO 137 is consistent with previous studies having similar issues (e.g. EIA study of the Desalination Plant at Tseung Kwan O (EIA Register No. AEIAR-192/2015) and Detailed Design Plan for Chlorine and Carbon Dioxide Storage of Desalination Plant).

13.4 Risk Assessment Associated with Planned Desalination Plant at TKO 137

13.4.1.1 The risk results for the planned desalination plant associated with chlorine, sulphur dioxide and liquid carbon dioxide hazards are detailed in **Appendix 13.1**. The maximum individual risk (IR) is found to be 1×10^{-7} per year, which is confined within the boundary of the desalination plant. Given the off-site individual risk does not exceed 1×10^{-5} per year, the level of individual risk posed by the operation of the facility to the surrounding population is considered acceptable and in compliance with the HKRG. In addition, the societal risks fall within the “Acceptable” region in both assessment years, while the potential loss of life (PLL)

for the facility were found to be about 2.5×10^{-6} and 2.0×10^{-6} per year for year 2035 and 2041 respectively.

13.5 Risk Assessment Associated with Existing Synthetic Natural Gas (SNG) Production Plant

13.5.1.1 The risk results for the existing SNG production plant are detailed in **Appendix 13.2**. The 1×10^{-5} per year contour is confined within the boundary of the SNG production plant. Given that there is no off-site risk with frequency greater than 1×10^{-5} per year, the level of individual risk posed by the operation of the facility to the surrounding population is considered acceptable and in compliance with the HKRG. In addition, the societal risks fall within the "Acceptable" region in both assessment years, while the potential loss of life (PLL) for the facility were found to be about 2.6×10^{-8} per year and 2.3×10^{-8} per year for year 2030 and 2041 respectively.

13.6 Risk Assessment Associated with Explosive Off-loading Pier

13.6.1 Background

13.6.1.1 The explosives off-loading pier (pier) is located on the southeast corner of TKO 137, it is currently operated by Mines Division of Civil Engineering and Development Department (CEDD). The Pier is used for the explosives delivery operation from the Government Explosives Depot at Kau Shat Wan, Lantau, to projects throughout the HKSAR. The pier will be relocated before the first population intake at the northern part of TKO 137 in 2030, and there will be no manufacture, storage or use of dangerous goods in the explosives off-loading pier accordingly.

13.6.1.2 According to the latest available information from CEDD, the pier may be retained supplying explosives to support the developments within the area under other projects, till end of 2029. The pier will be decommissioned and relocated thereafter.

13.6.2 Evaluation of Risk Implications Associated with Operation of Explosives Off-loading Pier

13.6.2.1 The development of the Project is divided into several phases. Details of the site phasing plan please refer to **Appendix 2.3** of Section 2. The construction activities of the Project will be commenced in phases, starting from Phase A at the northern portion of the development site in Q4 2025, to Phase J at the southern portion of the development site in Q4 2031.

13.6.2.2 Under the EIA study of the Desalination Plant at Tseung Kwan O (EIA Register No. AEIAR-192/2015), a QRA was carried out to investigate the feasibility of coexistence of the pier and the proposed desalination plant. The Environment Review Report (ERR) carried out in 2017 for the Desalination Plant shows the individual risk contour plot associated with the pier down to 1E-06 per year, it also stated that the hazard distance of 1% fatality probability for the explosives unloading operation is 161m. According to Figure 11.18 of the ERR, the individual risk contour 1E-06 per year will not encroach into the boundary of this Project.

13.6.2.3 Further, the development sites of the Project closest to the pier will be developed in Phase J, in which any construction activities will be commenced no earlier than December 2031 and the earliest population intake of this phase is 2035. There will be no construction activities within the 1% fatality probability for the explosives unloading operation (i.e. 161m from the pier) before the decommissioning and relocation of the pier, operation of the pier will have no risk implication on the Project during both construction and operation phases.

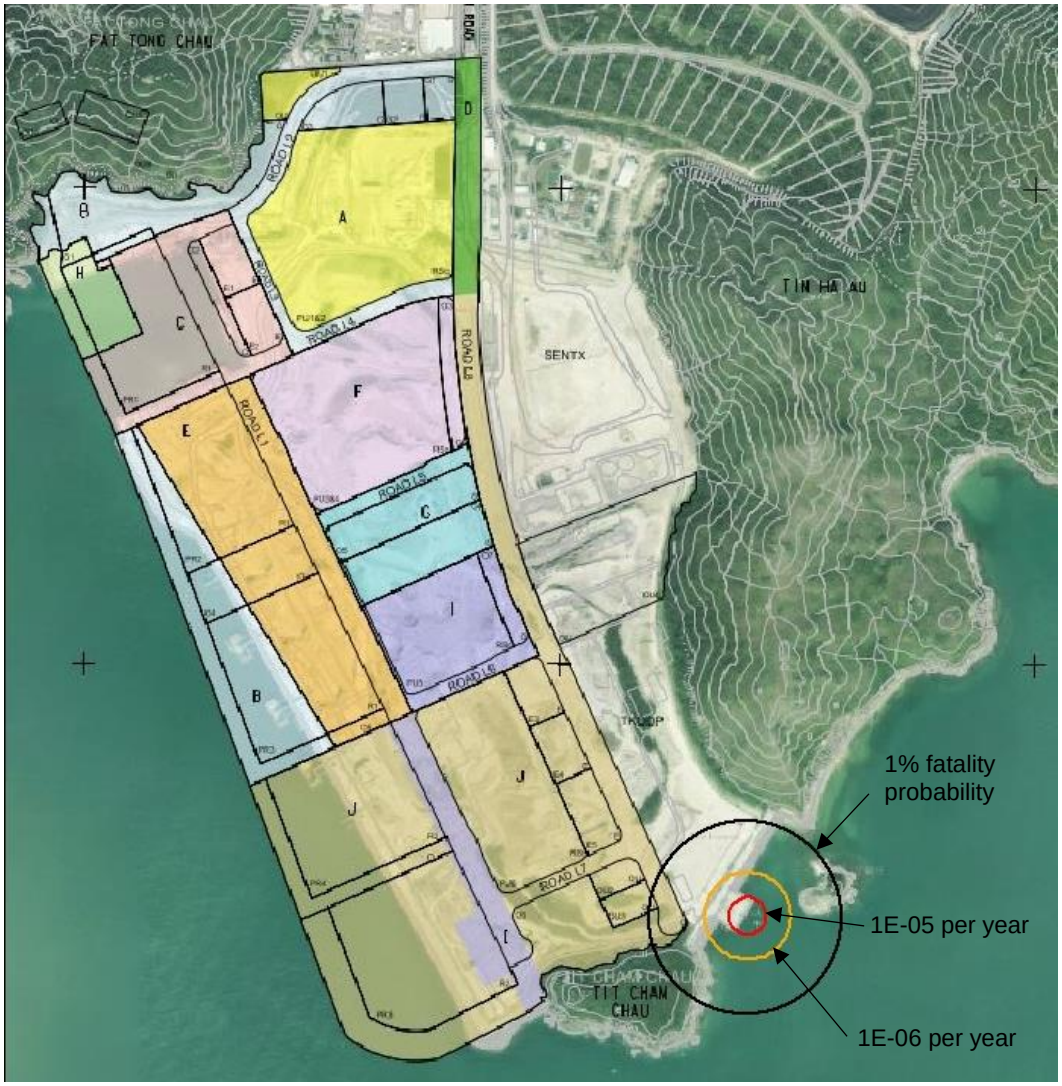

Plate 13-3 Individual Risk Contours of the Pier

13.6.3 Evaluation of Risk Implications Associated with Off-site Transport of Explosives from Explosives Off-loading Pier

13.6.3.1 According to CEDD, the approximate weight of the explosives to be transported is 800kg, to support the developments within the area under other projects till end of 2029. The consequences of accidental explosion during transporting explosives from the pier is assessed by the *Explosives Storage and Transport Committee (ESTC)* model developed by the UK Health and Safety Committee (HSC)[1] to determine the probability of fatality due to blast and overpressure waves. The hazard zone of 1% fatality probability associated with transportation of 800kg explosives is 87m for indoor population and 31m for outdoor population. A buffer distance of 90m along the transport route of explosives will be kept for all site offices of the Project. For the outdoor construction activities, the contractors will keep close liaison with CEDD on the schedule and routing of explosives delivery, all construction activities within a 35m buffer distance along the transport route of explosives will be suspended during the explosives delivery and all construction workers will also be evacuated from the zone.

[1] HSC, 2000. Selection and Use of Explosion Effects and Consequence Models for Explosives, Advisory Committee on Dangerous Substances.

13.7 Risk Assessment Associated with Proposed Green Fuel Station (GFS)

13.7.1.1 A Green Fuel Station (GFS) with provision of LPG filling facilities is proposed at the southern portion of the development, close to the existing pier. The risk results for the proposed GFS are detailed in **Appendix 13.4**. The maximum individual risk of less than 1×10^{-5} per year was observed. Given that there is no off-site risk with frequency greater than 1×10^{-5} per year, the level of individual risk posed by the operation of the GFS to the surrounding population is considered acceptable and in compliance with the HKRG. In addition, the societal risks fall within the "Acceptable" region in both assessment years, while the potential loss of life (PLL) for the facility were found to be about 8.6×10^{-6} and 8.2×10^{-6} per year for year 2035 and 2041 respectively.

13.8 Risk Assessment Associated with Proposed Effluent Polishing Plant

13.8.1.1 The risk results for the proposed effluent polishing plant are detailed in **Appendix 13.3**. A salient finding from the individual risk result is that the maximum individual risk is less than 1×10^{-5} per year and highly localized around the biogas equipment and largely confined within the site area. The 1×10^{-6} per year individual risk contour only exceeds slightly outside the proposed EPP. Furthermore, even the lowest risk contour of 1×10^{-9} per year does not reach any residential area nearby. As such, it is concluded that the proposed development and associated activities do not impose any significant risk to the nearby population and conform with HKRG.

13.9 Secondary Impact and Cumulative Risk Assessment

13.9.1.1 This section addresses secondary impact and cumulative impacts of the Project related to the planned desalination plant, existing SNG Production Plant, proposed effluent polishing plant and proposed GFS.

Secondary Impact

13.9.1.2 Secondary impact refers to indirect or induced hazardous event in which another hazardous source is initialized by a hazardous event of an initiating hazardous source. In general, toxic effect does not cause knock-on impact to other hazardous sources. The maximum hazard distance from the planned EPP is about 77m and is confined within the EPP boundary and thus, will not affect the Desalination Plant. Meanwhile, the separation distance between road tanker in the planned GFS and chemical building in DP is about 85 m, which is greater than the fireball radius of about 60 m due to catastrophic failure of a 9-tonnes LPG road tanker and thus, knock on effect due to the planned GFS is also not anticipated. A review of the secondary impact to other hazardous sources is summarised in **Table 13.1**.

Table 13.1 Summary of Secondary Impacts

Source \ Target	Chlorine	Hydrogen	Sodium Hypochlorite	Sodium Bisulphite	32% wt HCl	Liquid Carbon Dioxide	Other DGs	SNG Power Generation	Proposed Green Fuel Station	Proposed Effluent Polishing Plant
Chlorine		No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact
Hydrogen	May result in indoor chlorine release but no offsite impact [Note 4]		Separate compartment and provided bund containment in case of spillage	Separate compartment and provided bund containment in case of spillage	Separate compartment and provided bund containment in case of spillage	20 m separation; no impact [Note 3]	310 m separation; no impact [Note 3]	50 m separation; no impact [Note 3]	No impact	No impact
Sodium Hypochlorite	No impact	No impact		No impact	No impact	No impact	No impact	No impact	No impact	No impact
Sodium Bisulphite	No impact	No impact	No impact		No impact	No impact	No impact	No impact	No impact	No impact
32% wt HCl	No impact	No impact	No impact	No impact		No impact	No impact	No impact	No impact	No impact
Liquid Carbon Dioxide	No impact	No impact	No impact	No impact	No impact		No impact	No impact	No impact	No impact
Other DGs	No impact	No impact	No impact	No impact	No impact	No impact		No impact	No impact	No impact
SNG Power Generation	50 m separation; no impact [Note 3]	50 m separation; no impact [Note 3]	50 m separation; no impact [Note 3]	50 m separation; no impact [Note 3]	50 m separation; no impact [Note 3]	80 m separation; no impact [Note 3]	370 m separation; no impact [Note 3]		No impact	No impact
Proposed Green Fuel Station	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact		No impact
Proposed Effluent Polishing Plant	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact	

Note 1: The separation distance is greater than the required separation distance 178m for the explosives unloading pier.
Note 2: No hazard to life issue by considering chemicals' concentrations in the atmosphere due to accidental spillage and the escape factor of the surrounding population.
Note 3: The separation distance is greater than the maximum hazard distance 47 m for SNG Power Generation and 11m for hydrogen (OSCG).
Note 4: Chlorine gas pipeline close to the explosion source may be damaged. Chlorine generation will be disrupted in the explosion.

Cumulative Risk Assessment

13.9.2.1 These are presented as combined Individual Risk Contours and F-N curve following the same approach as the approved EIA for the In-situ Reprovisioning of Sha Tin Water Treatment Works project[2].

13.9.2.2 The Individual Risk contours presented in **Plate 13-4** show that cumulative risks are lower than 10^{-5} per year for off-site areas of the abovementioned hazardous facilities. The F-N curves for both construction and operational phases of the Project are shown in **Plate 13-5**. The cumulative societal risks from these facilities fall within the "Acceptable" region for both phases of the Projects.

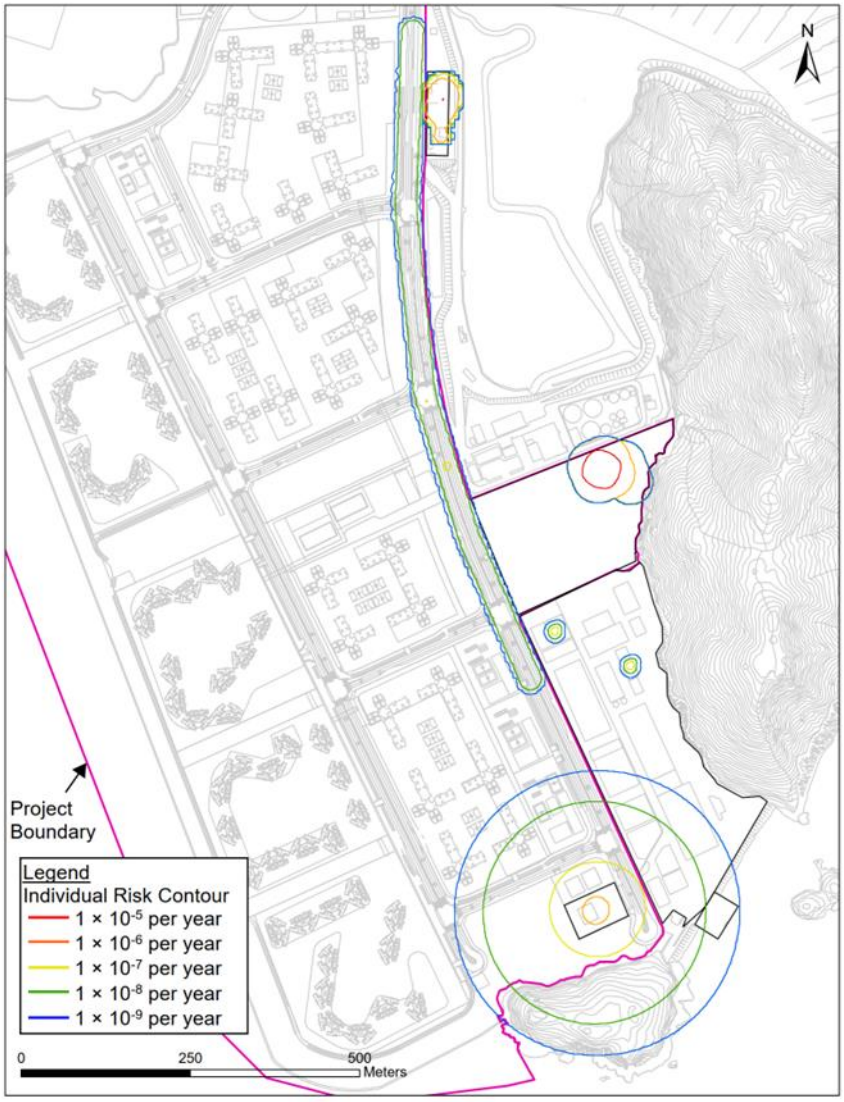

Plate 13-4 Cumulative Individual Risk Contours

[2] Water Supplies Department (2015). Agreement No. CE13/2009 (WS) In-situ Reprovisioning of Sha Tin Water Treatment Works – South Works. Environmental Impact Assessment Report.

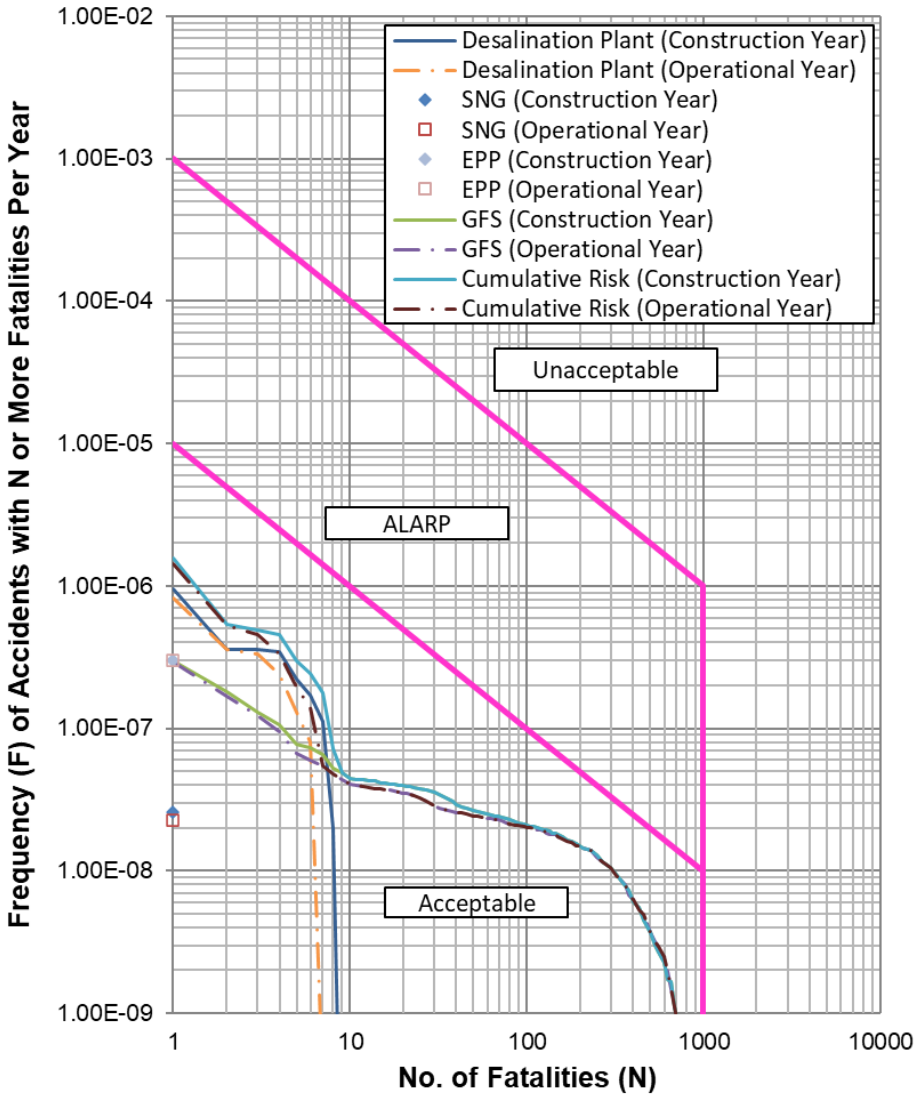

Plate 13-5 Cumulative Societal Risk Curves

13.10 Conclusions and Recommendations

13.10.1.1 Hazard assessments were conducted to assess the risks associated with the planned desalination plant, existing SNG Production Plant, proposed effluent polishing plant, existing explosives off-loading pier and proposed GFS during both construction and operational phases of the Project.

Planned Desalination Plant

13.10.1.2 A hazard assessment was conducted to assess the risks associated with the operation of the planned desalination plant in year 2035 and year 2041 (full population intake).

13.10.1.3 Both the individual and societal risk levels were found to meet relevant requirements stipulated in the HKRG, i.e. the off-site individual risk level is far below 1×10^{-5} per year and the societal risk falls into the “Acceptable” region. Therefore, no mitigation measure is required.

Proposed Green Fuel Station (GFS)

13.10.1.4 A Green Fuel Station (GFS) with provision of LPG filling facilities is proposed as part of the TKO 137 development. The hazard assessment for the risk associated with the operation of the proposed GFS concluded that both the individual and societal risk levels meet relevant requirements stipulated in the HKRG, i.e. the off-site individual risk level is far below 1×10^{-5} per year and the societal risk falls into the "Acceptable" region. Therefore, no mitigation measure is required.

Existing Synthetic Natural Gas (SNG) Production Plant

13.10.1.5 A hazard assessment was conducted to assess the risks associated with the operation of the existing synthetic natural gas (SNG) production plant in year 2030 and year 2041 (full population intake).

13.10.1.6 Both the individual and societal risk levels were found to meet relevant requirements stipulated in the HKRG, i.e. the off-site individual risk level is far below 1×10^{-5} per year and the societal risk falls into the "Acceptable" region. Therefore, no mitigation measure is required.

Existing Explosives Off-loading Pier

13.10.1.7 There will be construction activities within 500m from the pier only after the decommissioning and relocation of the pier, operation of the pier will have no risk implication on the Project during both construction and operation phases.

13.10.1.8 Regarding the potential risk impact associated with the explosives delivery from the pier during construction of the Project, it is recommended that the contractors to keep close liaison with CEDD on the schedule and routing of explosives delivery, and maintain the buffer distances (i.e. 90m for indoor population and 35m for outdoor population) from the delivery route accordingly. With the provision of sufficient buffer distance, negligible risk impact on the construction workers is expected.

Proposed Effluent Polishing Plant

13.10.1.9 The risks results taking into account the population induced by the Project, were found to be in compliance with the risk criteria stipulated in Annex 4 of the EIAO-TM and risk mitigation measures are therefore not required.