9c. HEALTH IMPACT (CO-EXIST SCENARIO)

9c.1 Introduction

9c.1.1.1 This section presents the assessment of the potential health risk impacts associated with the operation phase of the IWMF located in both Tsang Tsui Ash Lagoon (TTAL) site and an artificial island near SKC concurrently (i.e. co-exist scenario). A key environmental issue would be the cumulative health impacts during operation phase in the vicinity of the IWMFs at both sites.

9c.2 Prediction and Evaluation of Environmental Impacts

9c.2.1 Operation Phase

Non-Carcinogenic Hazard

9c.2.1.1 The methodology for the assessment of the potential for compounds of potential concern (COPC) to cause adverse non-carcinogenic health effects is the same as in **Sections 9a** and **9b**.

Classical COPCs of the HKAQO

9c.2.1.2 The highest cumulative annual average SO_2 concentrations predicted at the hot spot areas (as identified in **Sections 3a & 3b**) based on territory-wide scale model results (PATH model) would range from 6 to 17 $\mu g/m^3$. The average contribution by the IWMF would range from 0.34 to 3.82%. Nevertheless, there is still considerable scientific uncertainty as to whether SO_2 is the pollutant responsible for the observed adverse air effects or, rather a surrogate for particulate matters[1]. While it is not possible to totally rule out its adverse health effects, the potential additional health effects are likely to be small.

9c.2.1.3 For the RSP, the highest cumulative annual average RSP concentrations predicted at the hot spot areas based on territory-wide scale model results (PATH model) would range from 39 to 48 $\mu g/m^3$. The average contributions by the IWMF would be below 0.08%. As such, the associated adverse health effects of RSP due to the IWMF are likely to be very small and are unlikely to be quantifiable[2].

9c.2.1.4 For NO_2, the highest cumulative annual average NO_2 concentrations predicted at the hot spot areas based on territory-wide scale model results (PATH model) would range from 13 to 40 $\mu g/m^3$. The average contribution by the IWMF would range from 0.05 to 1.77%. The associated additional risk for adverse health effects of NO_2 due to the IWMF are likely to be very small. As such, it is very unlikely that the NO_2 emitted by the IWMF will cause significant long-term adverse health effects.

9c.2.1.5 The detailed percentage contributions of SO_2, NO_2 and RSP by the IWMF are presented in **Appendix 9.3**.

Other COPCs

9c.2.1.6 The cumulative non-carcinogenic health impact due to chronic inhalation, includes the impact arising from the IWMF plus the background contribution are presented in **Appendix 9.4**. Cumulative chronic health impact of the IWMF at all receptors are assessed and compared with the exposure limits/reference levels. It is concluded that

[1] *WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide, Global update 2005, Summary of risk assessment*, World Health Organization
[2] *Fourth External Review Draft of Air Quality Criteria for Particulate Matter (June, 2003), Appendix 9A*, USEPA

the effect are insignificant when compared to the proposed exposure limits/reference levels. No adverse chronic inhalation health effects are expected and no risks due to long-term exposure are expected.

9c.2.1.7 For individual chemicals, hazard quotients have been added across exposure pathways to determine the total non-carcinogenic hazard index (HI) for each receptor potentially exposed to facility-related COPC in the environment. This calculated hazard index (HI) is then compared with the USEPA risk management guidance (USEPA, 1998) suggested initial screening benchmark for exposures of HI = 0.25.

9c.2.1.8 With reference to the risk assessment results on non-carcinogenic hazard presented in **Appendix 9.5**, it can be concluded that the Hazard Index at all receptors falls under 0.25. The highest hazard quotient occurs at receptor TC4 with a value of 0.02. Therefore, the exposure of the receptors for the co-exist scenario to the non-carcinogenic COPCs is not expected to cause significant adverse health effects.

Cancer Risk

9c.2.1.9 The methodology for calculating potential incremental lifetime cancer risks is the same as in **Sections 9a** and **9b**. The cancer risk from each carcinogenic COPC and from each exposure pathway have been added together to estimate the total cancer risk for each receptor. This calculated total cancer risk is then compared with the target risk level of $1x10^{-5}$ stated in the USEPA risk management guidance[3] (USEPA, 1998). In accordance with the USEPA risk management guidance, if a calculated risk falls within the target values, the authority may, without further investigation, conclude that the proposed project does not present an unacceptable risk.

9c.2.1.10 The predicted total carcinogenic risk at the representative receptors are summarized in **Appendix 9.5**. The calculated risk at all receptors falls within the target risk level of $1x10^{-5}$. The highest total cancer risk occurs at receptor TC4 with a value of 3.49×10^{-6}. Therefore, it is expected that the Project would not present an unacceptable risk.

9c.2.1.11 Since the assessment results meet both the cancer risk and non-carcinogenic hazard index criteria, no further analysis is presumed to be necessary.

Risks due to Short-Term Exposure

9c.2.1.12 In addition to the potential long-term risk to human health presented by COPCs emitted from the facilities, short-term or acute risk has been evaluated for direct inhalation of COPCs. The methodology of determining risk due to short-term exposure is identical to that stated in **Sections 9a** and **9b**.

Classical COPCs of the HKAQO

9c.2.1.13 The average contribution of 1-hr SO_2 concentrations by the IWMF are predicted at the hot spot areas identified in **Sections 3a & 3b** to be in the range of 0.20% to 10.84%. The highest cumulative 1-hr average SO_2 concentration with the operation of the IWMF would be 184μg/m^3 based on territory-wide scale model results (PATH model), which is below the short term exposure level with observable acute health effects in vulnerable groups[4]. Therefore, the associated acute health effect would be negligible.

9c.2.1.14 For CO, the average contribution of 1-hr CO concentrations by the IWMF are predicted at the hot spot areas to be less than 0.12%. The predicted highest cumulative 1-hr average CO concentration is 1712μg/m^3 based on territory-wide scale model results (PATH model)

[3] Region 6 Risk Management Addendum - Draft Human Health Risk Assessment Protocol for hazardous Waste Combustion Facilities.
[4] *Toxicological Profile for Sulfur Dioxide*, US Department of Health and Human Services

and is far below international safe levels[5]. Therefore, adverse health effect of CO contribution from the IWMF is negligible.

9c.2.1.15 For NO_2, the predicted highest cumulative 1-hr average NO_2 concentration is 275µg/m^3 based on territory-wide scale model results (PATH model). The predicted 1-hr average concentration is below the level with clear observable acute health effects in many short term experimental toxicology studies[6]. Nevertheless, the average contribution of 1-hr average NO_2 concentration at the hot spot areas by the IWMF is predicted to be in the range of 0.04% to 5.38%. Therefore, the acute adverse health effects of NO_2 due to the IWMF would be very small and are unlikely to be quantifiable.

Other COPCs

9c.2.1.16 The cumulative non-carcinogenic health impact due to direct inhalation includes the impact arising from the IWMF plus the background contributions are presented in **Appendix 9.6**. Cumulative acute health impact of the IWMF at all receptors are assessed and compared with the exposure limits/reference levels. It is concluded that the effects are insignificant when compared to the proposed exposure limits/reference levels. No adverse acute effects are expected.

Maximum Permitted Concentration of Certain Metals present in Foods

9c.2.1.17 Based on the assessment results presented in **Appendix 9.7**, it can be concluded that food grown in the vicinity of all receptor locations would comply with the maximum permitted concentrations stipulated by the Centre for Food Safety. The concentrations of Antimony, Arsenic, Cadmium, Chromium, Lead and Mercury at all receptor locations fall under the maximum permitted concentrations listed in the first and second schedules in **Tables 9a.3**, **9a.4**, **9b.3** and **9b.4**.

9c.3 Conclusion

9c.3.1.1 The cancer risk arising from exposure to compounds of potential concern (COPCs) associated with the emissions of the IWMF is evaluated in this section. The highest cancer risk arising from the IWMF (co-exist scenario) is predicted to be 3.49 $x10^{-6}$ and it is considered that the Project would not present an unacceptable risk and no further analysis is necessary. The highest predicted total Hazard Index (HI) at all receptors are well below 0.25, which is derived from a conservative approach. Cumulative acute non-carcinogenic health impact of the IWMF imposed to the worst impacted human receptors were assessed and compared with local and overseas guideline levels. It was concluded that the levels of non-carcinogenic chemicals were found to be insignificant when compared to the adopted/derived reference levels. For the classical COPCs of the HKAQO, while it is not possible to rule out adverse health effects from the IWMF with complete certainty, the impact on health from small additional air pollutants is likely to be very small and unlikely to be quantifiable.

9c.3.1.2 A compliance check of the maximum permitted concentration of certain metals present in foods due to the Project as stipulated in "Food Adulteration (Metallic Contamination) Regulations" by the Centre for Food Safety, was conducted. The concentrations of Antimony, Arsenic, Cadmium, Chromium, Lead and Mercury at all receptors fall under the maximum permitted concentrations listed in the first and second schedules of the Regulations.

[5] *Toxicological Profile for Carbon Monoxide*, US Department of Health and Human Services
[6] *WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide, Global update 2005, Summary of risk assessment*, World Health Organization

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