22. STRATEGIC ENVIRONMENTAL MONITORING AND AUDIT

22.1 Introduction

22.1.1 It should be noted at the outset that Strategic Environmental Monitoring and Audit (SEM&A) is not a higher-level version of the project Environmental Monitoring and Audit (EM&A), which assesses actual changes the physical environment as a result of the construction (and operation) of a project.

22.1.2 SEM&A should, perhaps, be referred to as Strategic Project Monitoring and Audit, since it identifies strategic-level actions to facilitate the development of a preferred option for a project in a sustainable manner.

22.1.3 This SEA has included a predominantly qualitative assessment of the potential impacts associated with the construction and operation of twelve marine based new sites, one new land based site and two extensions to existing landfills. To facilitate a strategic perspective on the overall evaluation of potential impacts, a methodology has been developed that accommodates the qualitative nature of the assessment and facilitates a consistent and transparent approach to the impact assessment.

22.1.4 It has been concluded that it is technically feasible to develop either a new marine based landfill site and / or an extension to an existing landfill site. The sites considered suitable for further investigation, (on environmental grounds) include:

• M.5	South Cheung Chau Island Landfill (SCCIL)	New Sites
• M.6	Lamma Breakwater Island Landfill (LBIL)	
• M.8	Eastern Waters Island Landfill (EWIL)	
• M.9	Tai Long Wan Offshore Island Landfill (TLWOIL)	
• M.10	South East Offshore Island Landfill (SEOIL)	
• L.1	Pillar Point Valley North Landfill (PPVNL)	
• E.1	NENT Landfill Extension (NLES)	Extensions at Existing Landfills
• E.2&3	WENT Landfill Extensions (WLES)	

22.1.5 Following this Study, the preferred site(s) will be subject to further investigation followed by preparation of preliminary designs upon which a quantitative Environmental Impact Assessment will be carried out in accordance with the EIA Ordinance.

22.1.6 By addressing key environmental issues during the early stages of a project, there remains sufficient flexibility in the design process to maximise opportunities for impact avoidance, such that the need for impact mitigation is reduced as far as is practicable and applied only where absolutely necessary. Key environmental issues associated with each of the individual sites considered acceptable are discussed in the relevant Sections of Part B of this SEA. This Section identifies the key areas that should be addressed and investigated further, during the subsequent stages, in the development of the overall project. The purpose of this section is to:

- Highlight key design issues that should be addressed as the project develops; and
- Identify strategic-level actions to facilitate the development of a preferred option in a sustainable manner.

22.2 Design Issues to be taken into Account During the Development of a New Landfill Site / Extension to an Existing Landfill Site

22.2.1 The SEA has identified that the potential environmental impacts caused by the preferred development options fall into two distinct groups, depending on whether the options are land or marine based. These issues will need to be examined in detail during the EIA stage to confirm that the baseline environmental conditions and assumptions made in this SEA have not altered and that the findings of the SEA remain valid.

22.2.2 Generic approaches to mitigation of impacts are presented in Part A of this SEA, and likely requirements for each site have been identified in Part B. At the next stage of the project, further refinement of the design can ultimately reduce the overall need for mitigation. The following sections set out recommended design issues for further consideration during the project development; these are summarised in *Table 22.1.*

Marine Water Quality Issues

22.2.3 As discussed in Chapter 21, marine based sites have the benefit of being able to accommodate the projected surplus of inert C&D material. However, at a local level, the primary environmental issue associated with marine based development is that it has the potential to impact directly upon marine water quality and indirectly upon marine ecological and fisheries resources.

22.2.4 Opportunities to minimise such impacts are a key consideration that should be focused upon throughout the development of the design. To refine the findings of the territory-wide water modelling carried out under this Study, it is recommended that a local hydrodynamic and water quality model be developed for the selected site. This will accommodate changes in the future baseline situation, (such as changes in water quality inputs from other sources) and facilitate development of the optimal environmentally friendly design. This may be achieved in a number of ways, including, repositioning of the artificial island within the site search envelope, refinement of the island shape, and the re-consideration of the layout of landfill infrastructure and afteruse facilities, including discharge points.

22.2.5 The refined model should be a 3-D hydrodynamic and water quality model (such as Delft-3D) with a sufficiently fine grid at key flow channels and around the island site to reflect in detail the influence of the island configuration. It is suggested that a 25 m grid size in the vicinity of the island should be adequate for detailed modelling. In addition, the refined model should cover all sensitive receivers and water control zones locations where notable impacts have been predicted by the wider model used in this current Study.

22.2.6 Water quality modelling carried out in this Study aimed at addressing the water quality and hydrodynamic impacts. However, the morphological changes such as change in coastline, potential erosion or siltation should also be assessed in the later detailed study stage.

22.2.7 In addition, the water quality modelling has assumed a worst case scenario in which dredging would be necessary for all sites and the modelling assumptions are listed in Appendix I – an extract of the Final Water Quality and Hydrodynamic Assessment Report for future reference. However, the Study does aim to minimise dredging as far as practicable. This approach should remain the principal focus of the design process whilst ensuring the overall integrity of the site. The “no-dredge” option should be pursued in line with a risk assessment of the effects of major storm events on the integrity of exposed seawalls and the landfill liner.

Landscape Design and Landfill Optimisation

22.2.8 The design schemes presented in the SEA are based upon current assumptions regarding waste arisings and are preliminary in nature. As discussed further in Section 22.3, a strategic follow up recommendation is to refine the projections of waste arisings to facilitate the development of detailed designs, which are based upon the specific capacity requirements of landfills extensions and / or new sites. The detailed designs should ensure that the profiles and elevations of landfills optimise the void space available for landfilling whilst balancing the landscape and visual issues.

22.2.9 For artificial island sites, in order to maximise the available void space, the feasibility of utilising inert residues from waste treatment in the construction of the reclamation (upon which the landfill would be constructed) should be investigated further, including an assessment of both the technical and environmental impacts. By diverting these materials away from the landfill itself, this approach would provide greater void space for non-inert solid wastes.

Best Practice Design in Landfill Technologies

22.2.10 Hong Kong has designed and implemented some of the most sophisticated landfill environmental control technologies in the world. The application of the best available technology should continue through subsequent stages of this project. International best practice should be monitored in tandem with local experience, to ensure appropriate design of wastewater and leachate treatment facilities, as well as those for landfill gas management such as extraction, flare, capping and liner technologies. Due to the long-term nature of the project, overall selection of technologies should take in to account "whole life" costing, including consideration of capital costs and recurrent costs.

Greenhouse Gas Issues

22.2.11 In Hong Kong, Municipal Solid Waste (MSW) is the primary source of methane, which is a Greenhouse Gas (GHG). Thermal oxidation of methane to carbon dioxide and water reduces the overall global warming effect of the MSW, as CO_2 has a lower GWP than CH_4 (as discussed in Section 2) The resultant energy can be put to beneficial use, providing power for adjacent, or on-site facilities. It is recommended that opportunities to minimise the long-term contribution of solid waste to Hong Kong's GHG emissions are explored further.

22.2.12 Whilst potential landfill afteruse development is not within the scope if this Study, opportunities to develop afteruse facilities that can utilise the surplus energy should be explored further. This is considered further as a Strategic Follow Up Action in Section 22.3, below.

22.2.13 For the key design considerations shown in *Table 22.1* there are no auditable targets to be achieved. Specific measures for formal monitoring and audit are not considered necessary. Measures and requirements should be included in Study Briefs for future design elements of the overall project and the opportunities evaluated accordingly.

Table 22.1: Design Issues to be Pursued During Development of the Project in order to Minimise Environmental Impacts

Site	Issue	Action	Implementation Stage	Implementation Agent
All Sites	Manage regional contribution of GHG and reduce the requirement for provision of power to future landfill afteruse facilities.	Minimise CH_4 emissions and off-set contributions of GHG from other sources: Maximise utilisation of LFG derived energy on-site, and further explore possible offsite uses of LFG, or consider potential landfill afteruse developments which can utililse LFG derived energy.	Feasibility Study: Preliminary Design	Environmental Consultant & Environmental Protection Department
	Ensure long-term best practice approach to design of waste water treatment facilities & landfill Liner	Monitor international development and implement Best Available Technology for design of wastewater treatment facilities and leachate treatment plant to ensure compliance with discharge standards, taking in to account whole-life costing.	Feasibility Study: Preliminary Design / Detailed Design	Engineering Consultant
	Ensure long-term best practice approach to design of LFG treatment facilities	Monitor international development and implement Best Available Technology for design of LFG treatment management facilities to ensure compliance with air quality objectives taking in to account whole-life costing.	Feasibility Study: Preliminary Design / Detailed Design	Engineering Consultant
	Maximise void space whilst balancing landscape & visual impacts	Develop designs to ensure that profiles and elevations of landfill sites optimize void capacity for landfilling whilst balancing potential adverse landscape and visual impacts.	Feasibility Study: Preliminary Design / Detailed Design	Environmental Consultant and Engineering Consultant
Marine Sites	Further reduction of water quality impacts and secondary impacts on ecology / fisheries	Carry out refined hydrodynamic (HD) and water quality (WQ) modelling using a local model of the selected site and key areas predicted to be impacted by the wider model grid used in this Study.	Feasibility Study: EIA	Environmental Consultant
		Optimise position of site within site search envelope on basis of additional WQ and HD modelling exercise	Feasibility Study: EIA	Environmental Consultant
		Optimise environmental benefits of Island shape and layout of landfill infrastructure facilities on basis of additional WQ and HD modelling exercise incorporating possible afteruse discharge emissions.	Feasibility Study: EIA	Environmental Consultant and Engineering Consultant
	Further reduction of water quality impacts & Minimise volumes of dredged mud requiring management	Confirm viability of no-dredge opportunities in the construction of the artificial island.	Feasibility Study: Preliminary Design / Detailed Design	Engineering Consultant
	Maximize void space of new landfills	Investigate opportunities to utilise inert residues from waste treatment in the construction of the artificial island to divert them from the landfill site itself.	Feasibility Study Preliminary Design	Engineering Consultant

22.3 Strategic Follow Up Actions

22.3.1 In addition to the design issues, which may affect the overall environmental impacts, there are also certain broader issues that could be adopted to maximise strategic environmental benefits and allow improved planning to minimise project level impacts. To achieve this aim, the following sections set out recommendations for consideration by ETWB, these are summarised in *Table 22.2*.

Explore Interface with Complimentary Projects

22.3.2 This Study has identified an opportunity to utilise the projected surplus of inert C&D material (public fill) over the next 30 years for the formation of marine sites prior to construction of the landfill. The preferred arrangements to manage the projected surplus of public fill (as well as uncontaminated dredged mud) are being investigated under a separate study, Agreement No. CE 46/2000: *Study on the Long Term Arrangements to Accommodate* Inert *Construction and Demolition Materials and Uncontaminated Dredged Mud,* (C&D Materials Study) by the Civil Engineering Department. The recommendations of the C&D Materials Study are to utilise the surplus public fill for the construction of an artificial island. The C&D Materials Study also includes an investigation of possible afteruses to be developed on the formed land, one of which includes landfill development.

22.3.3 As the two projects progress, it is recommended that a co-ordinated approach is adopted to maximise the strategic environmental benefits of utilising the C&D material.

Maximise Afteruse Development Opportunities for Strategic Planning of "Bad Neighbour" Environmental Infrastructure

22.3.4 The development of landfill extensions and new sites will ultimately result in the formation of land, which can be developed for public facilities. Due to their relatively close proximity to residential areas, afteruse recreation opportunities on Hong Kong's existing closed landfills have focused upon passive development for the surrounding community. Given the particularly remote location of marine sites considered suitable for landfill development, an opportunity also exists to utilise the formed land to develop necessary infrastructure, (e.g. waste to energy facilities, correctional services facilities, etc.) which, if built on existing land, would likely cause objection by local residents, or (because of their need to be located in remote areas) could result in environmental impacts upon previously undisturbed areas.

22.3.5 At this early stage in project development, afteruse requirements cannot be readily defined, however, the future requirements and any resultant implications for site size and method of construction, should be considered and it is recommended that an interdepartmental group be developed to review the likely afteruse opportunities.

Review Waste Management Plan & Refine Projections of Municipal Solid Waste Arisings and C&D Materials Arisings

22.3.6 For both this Study and the C&D Materials Study, the anticipated size and construction programme of sites has been determined on the basis of the overall size of available areas (following the constraints mapping site search exercises) and the predicted rate of materials generation over the project horizon. Under both studies, the materials generation models were based on number of materials generation scenarios, which took into account various combinations of assumptions, such as the introduction of landfill charging. The actual volume and timing of the generation of MSW and C&D material can have a profound influence over the environmental impacts of marine landfill site formation, as there is a direct correlation between the rate of filling and the release of fines into the water column.

22.3.7 Whilst CED's Public Fill Committee (PFC) maintains a register of anticipated public fill generation, it is recommended that the landfill expectancy model and overall review of any waste management programme be reviewed regularly. A longer term Strategic Plan is also recommended, which takes in to account the long-term infrastructure needs. The review of the life expectancy model should encompass the effects of issues such as the introduction of landfill charging, introduction of waste to energy facilities, as well as wider measures such as those being introduced under the Waste Reduction Framework Plan. The model could then be used during the development of new landfill sites, to allow more accurate determination of landfill development programme and facilitate future waste management planning beyond the scope of this current Study.

Define Sustainability of Landfills Extensions and Development of New Sites in the Context of Other Waste Management Initiatives.

22.3.8 In the evaluation of potential impacts, this SEA has broadly taken into account issues of sustainability (as described in Section 2.4). However, in order to ensure the proposals adhere to the principles of sustainability and to facilitate transparent and informed decision-making, it is recommended that a formal Sustainability Assessment (SA) is carried out using the Computer Assisted Sustainability Evaluation Tool (CASET). The CASET SA evaluation should include various scenarios relating to the implementation of other proposed waste management strategies, such as the C&D Materials Study, the potential waste to energy facility, and the proposals for management of contaminated dredged muds. This process would be a progression of the "View Sharing Meeting on Future Landfill Development in Hong Kong", held in March 2001 and could be coupled with a public consultation exercise to maximise the overall sustainability of Hong Kong's long-term waste management strategy.

Table 22.2. Strategic Follow Up Actions Recommended for the Development of Selected Landfills Extensions and New Landfill Sites

Issue	Proposed Action	Implementation
Explore Interface with Complimentary Waste Management Projects	As the two projects progress, it is recommended that a co-ordinated approach be investigated to maximise the strategic environmental benefits of utilising the C&D materials.	ETWB to consolidate projects, Consider joint EPD/CED task force for development.
Maximise Afteruse Development Opportunities for Strategic Planning of "Bad Neighbour" Environmental infrastructure	Due to their particularly remote locations, new marine based sites present opportunities to develop afteruses that could present significant environmental and social dis-benefits if developed elsewhere in Hong Kong. Long term planning needs of such facilities should be considered in the planning of afteruse developments.	ETWB to consider establishing joint landfill afteruse development task force (comprising e.g. EPD, PlanD, CSD) to determine long-term afteruse development opportunities.
Review Waste Management Plan & Refine Projections of Municipal Solid Waste Arisings and C&D Materials Arisings	Predictions of materials arising (including public fill for marine sites and municipal solid waste arisings) are based on a variety of assumptions subject to external influences (such as implementation of landfill charging etc). Review the waste management programme, and introduce a longer Term Strategic Plan, encompassing a review of the Hong Kong landfill life expectancy model to facilitate the planning and implementation of landfills extensions and development of new sites as well as longer term waste management strategies.	On the basis of the landfill life expectancy model developed under this Study EPD to continue to monitor and refine projected arisings.
Define Sustainability of Landfills Extensions and Development of New Sites in the Context of Other Waste Management Initiatives.	Carry out a formal SA, using CASET, and a public consultation exercise taking in to account different development scenarios, including the implementation of other waste management measures currently being investigated.	SDU and EPD to conduct CASET evaluation of landfill extensions/new sites final recommendations as well as other waste management initiatives.

22.4 The Next Steps

22.4.1 This Section has identified both environmental design-related issues that should be taken forward in to the next phases of the development of the design, as well as more strategic issues for consideration by Government.

22.4.2 Design issues discussed in Section 22.2 should be implemented through the specific consultant's Briefs for the preliminary design and in the detailed design. Government should consider the strategic EM&A recommendations discussed in Section 22.3 further and an appropriate action plan should be developed following internal consultation and consideration of the most appropriate implementation strategy.