For discussion **PWSC(2004-05)45**
on 15 December 2004

ITEM FOR PUBLIC WORKS SUBCOMMITTEE OF FINANCE COMMITTEE

HEAD 705 – CIVIL ENGINEERING
Environmental Protection – Refuse Disposal
166DR – Restoration of Tseung Kwan O Landfills – post-completion environmental monitoring work

Members are invited to recommend to the Finance Committee the upgrading of **166DR** to Category A at an estimated cost of $96.8 million in money-of-the-day prices for the continuation of the environmental monitoring work at the Tseung Kwan O Landfills for a further period of seven years.

PROBLEM

We have carried out an environmental review of the closed Tseung Kwan O Landfills (TKOL). The review has concluded that environmental monitoring work at the sites is still necessary.

PROPOSAL

2. The Director of Environmental Protection, with the support of the Secretary for the Environment, Transport and Works, proposes to upgrade **166DR** to Category A at an estimated cost of $96.8 million in money-of-the-day (MOD) prices for the continuation of the environmental monitoring work at the TKOL for a further period of seven years from February 2006 to January 2013.

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PROJECT SCOPE AND NATURE

3. The scope of the environmental monitoring work proposed for continuation comprises –

(a) operation and maintenance of the landfill gas (LFG) management systems to control gas emission and to prevent off-site gas migration;

(b) operation and maintenance of the leachate management system to control surface and groundwater infiltration into the landfills and to extract, collect, treat and dispose of the landfill leachate;

(c) environmental monitoring and auditing; and

(d) maintenance of landscape and site infrastructure.

The site plan of the TKOL is at Enclosure 1.

JUSTIFICATION

4. Landfills, whether operating or closed, produce LFG and leachate[1] as products of refuse decomposition. LFG is malodorous and potentially asphyxiating, flammable and explosive. Leachate is highly polluting and, if not properly controlled, may seriously contaminate water bodies due to its infiltration or direct discharge.

5. Municipal solid waste, when disposed of at landfills, does not exhibit homogeneous geotechnical properties, as it is subject to a continuing biological degradation process. This results in differential settlement of the landfill surface which may lead to slope instability problems. We therefore need to monitor and improve slope stability at landfills. For some landfills, we also need to stabilise the natural slopes adjacent to the top platform of landfills to prevent possible boulder falls or soil debris flows.

6. TKOL include Tseung Kwan O Stage I Landfill (TKOL-I) and Tseung Kwan O Stage II/III Landfill (TKOL-II/III). TKOL-I and TKOL-II/III are located on the eastern shoreline of Tseung Kwan O Bay, and adjacent to residential developments of the Tseung Kwan O new town and the industrial developments at the southeast of the new town. TKOL-II/III is about 1 km south east of the

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[1] "Leachate" is the water which has permeated through the waste mass.

TKOL-I. The landfills were closed in 1995 and 1994 respectively. They did not have proper LFG and leachate management systems at the time. To minimise the adverse environmental impacts of TKOL and to put the land to productive use, we sought funding approval from the Finance Committee (FC) in 1995 vide PWSC(95-96)15 for the design and construction of the restoration facilities and a period of seven years' post-completion environmental monitoring work to maintain the facilities and monitor the LFG migration and leachate pollution under PWP Item **156DR**. LFG produced in TKOL is utilised on-site for operation of the leachate management system and other on-site requirements.

7. In approving funding for **156DR** in 1995, FC agreed that we should carry out an environmental review five years from the commencement of the environmental monitoring work to determine if the landfill sites have been completely restored and if further monitoring is needed. If further monitoring work is required, funding approval from FC would have to be sought again.

8. The construction of the restoration facilities for the TKOL was completed in January 1999 and the seven-year post-completion environmental monitoring work[2] commenced thereafter. The restoration facilities comprise LFG and leachate management systems, a low permeability final cover and surface water drainage system to reduce infiltration of water into the waste mass so as to minimise leachate generation and other ancillary works.

9. In late 2002, the Environmental Protection Department (EPD) commissioned an environmental review of the TKOL as required by the FC. The review completed in December 2003 and revealed that while the amount of LFG had substantially decreased[3] since 1999, the pollution level of leachate collected for treatment had only slightly decreased[4]. Both the LFG and leachate were still

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2 Funding sought for the first seven years' post-completion environmental monitoring work lasts up to January 2006.

3 For example, the LFG generation rates of the TKOL-I and TKOL-II/III have reduced from 3 530 cubic metres per hour (m^3/hr) and 3 610 m^3/hr in 1999 to 1 310 m^3/hr and 2 890 m^3/hr in 2003 respectively. The methane content in the LFG remains fairly constant at 44%-48% between 1999 and 2003. Such LFG quantity and methane content levels still require monitoring as the landfills could only be considered as fully restored from the perspective of LFG safety when the methane content is reduced to 1% or below.

4 The total nitrogen concentration in leachate has reduced from 1 150 milligrams per litre (mg/l) in 1999 to around 1 030 mg/l in 2003. It still exceeds the acceptable discharge standard on total nitrogen, 200 mg/l, stipulated in the Technical Memorandum of the Water Pollution Control Ordinance for discharge to Government sewers.

of significant quantities and required continuous control and treatment. Landfill settlement was expected to continue and regular maintenance work would be required to maintain the surface drainage, slopes and internal access roads. The review confirmed that monitoring work at the TKOL should continue to ensure that the sites would pose no threat to the safety of the public and to provide a safe environment for future afteruse.

FINANCIAL IMPLICATIONS

10. We estimate the cost of the proposed post-completion environmental monitoring work for the seven years to be $96.8 million in MOD prices (see paragraph 11 below), made up as follows –

		$ million	
(a)	Operation and maintenance of LFG management systems	32.1	
(b)	Operation and maintenance of leachate management systems	28.5	
(c)	Environmental monitoring and audit	8.6	
(d)	Maintenance of landscape	9.2	
(e)	Maintenance of site infrastructure	12.0	
(f)	Contingencies	4.6	
	Sub-total	95.0	(in September 2004 prices)
(g)	Provision for price adjustment	1.8	
	Total	96.8	(in MOD prices)

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11. Subject to approval, we will phase the expenditure as follows –

Year	$ million (Sept 2004)	Price adjustment factor	$ million (MOD)
2006 – 2007	14.6	0.98753	14.4
2007 – 2008	14.6	0.99123	14.5
2008 – 2009	14.6	0.99990	14.6
2009 – 2010	12.8	1.01515	13.0
2010 – 2011	12.8	1.03241	13.2
2011 – 2012	12.8	1.04996	13.4
2012 – 2013	12.8	1.06781	13.7
	95.0		96.8

12. We have derived the MOD estimates on the basis of the Government's latest forecast of trend rate of change in prices of public sector building and construction output for the period 2006 to 2013. The cost of the post-completion environmental monitoring work will be subject to price adjustment as the contract period will exceed 21 months.

13. We estimate that the annual recurrent expenditure will be about $1.96 million.

14. The environmental monitoring work for closed landfills may last more than two decades (could be up to 30 years). We propose to carry out an environmental review five years after commencing the proposed 7-year period to determine if the monitoring work should continue. We will continue with the existing 30-year "design-build-and-operate" contract to ensure that continuous liability is borne by the contractor. As specified in the contract, we have the right to terminate the contract or amend the coverage of the contract provided that we give the contractor sufficient advance notice.

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15. The first seven years' environmental monitoring work at the TKOL costs about $105 million (in MOD prices). Such work involved LFG and leachate management, site maintenance work as well as about 13 000 annual measurements of LFG, 2 000 annual measurements on leachate quality, and 4 700 annual measurements on groundwater and surface/marine water quality. The monitoring programme is provided at Enclosure 2.

PUBLIC CONSULTATION

16. We consulted the Sai Kung District Council (SKDC) in June 2004 on the progress of the restoration/ monitoring work and the potential afteruse of the TKOL. The SKDC expressed no objection to the continuation of the post-completion environmental monitoring work at the TKOL. On 25 October 2004, we consulted the Legislative Council Panel on Environmental Affairs on the proposal to continue the environmental monitoring work at TKOL for a further period of seven years. Members supported the proposal, and requested more information on landfill costs, progress of restoration of landfills and a plan on usage of restored landfill sites. Such information has been provided in a separate information paper.

ENVIRONMENTAL IMPLICATIONS

17. We completed in 1994 an Initial Environmental Impact Assessment study, covering both the restoration and post-completion environmental monitoring work, as part of the feasibility study for the restoration works of the TKOL. The study indicated that the restoration and monitoring work would ensure proper control of the emission and off-site migration of LFG and leachate. This would ameliorate the environmental impacts of the landfills and enable the landfill sites to be put to beneficial use.

18. During the contract period, we will withhold payment to the contractor if there is any non-compliance with the required environmental standards.

19. We have given due consideration to minimise the generation of construction and demolition (C&D) materials, and to reuse and recycle the C&D materials wherever practicable. C&D materials mainly arise from maintenance of drainage, access roads, capping layer, landscape, treatment plant and other site infrastructure. We will encourage the contractor to use non-timber formwork and

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recyclable materials for temporary works. We will control the disposal of C&D materials to landfills or other appropriate reception facilities through a trip ticket system recording the disposal, reuse and recycling of C&D materials. We estimate that the project will generate about 1 000 cubic metres (m^3) of C&D materials, of which we would reuse about 600 m^3 (60%) on site, recycle or reuse 300 m^3 (30%) as fill materials in public filling areas[5] and dispose of 100 m^3 (10%), the non-inert portion, at landfills. The notional cost of accommodating C&D waste at landfill sites is estimated to be $12,500 for this project (based on a notional unit cost[6] of $125/$m^3$).

LAND ACQUISITION

20. The project does not require any land acquisition.

BACKGROUND INFORMATION

21. There are 16 landfills in Hong Kong of which three are operating[7] and serving the public for final waste disposal. The remaining 13 landfills[8] were closed between 1975 and 1996. A plan showing the location of the 16 landfills is at Enclosure 3.

22. Landfills produce LFG and leachate which would, if unmonitored and uncontrolled, seriously pollute the environment. In view of the problems envisaged, the "White Paper: Pollution in Hong Kong – A Time to Act" issued in June 1989 set out the policy objective of formulating a programme for

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5 A public filling area is a designated part of a development project that accepts public fill for reclamation purposes. Disposal of public fill in a public filling area requires a licence issued by the Director of Civil Engineering and Development.

6 This estimate has taken into the account the cost of developing, operating and restoring the landfills after they are filled and the aftercare required. It does not include the land opportunity cost for existing landfill sites (which is estimated at $90/$m^3$), nor the cost to provide new landfills (which are likely to be more expensive) when the existing ones are filled. The notional cost estimate is for reference only and does not form part of this project estimate.

7 The three operating strategic landfills are Southeast New Territories (SENT) Landfill, Northeast New Territories (NENT) Landfill and West New Territories (WENT) Landfill.

8 The 13 closed landfills are Shuen Wan Landfill, Urban Landfills (Sai Tso Wan, Ma Yau Tong West, Ma Yau Tong Central, Jordan Valley and Ngau Chi Wan Landfills), Northwest New Territories Landfills (Ma Tso Lung, Siu Lang Shui and Ngau Tam Mei Landfills), Gin Drinkers Bay Landfill, Tseung Kwan O Stage I Landfill, Tseung Kwan O Stage II/III Landfill and Pillar Point Valley Landfill.

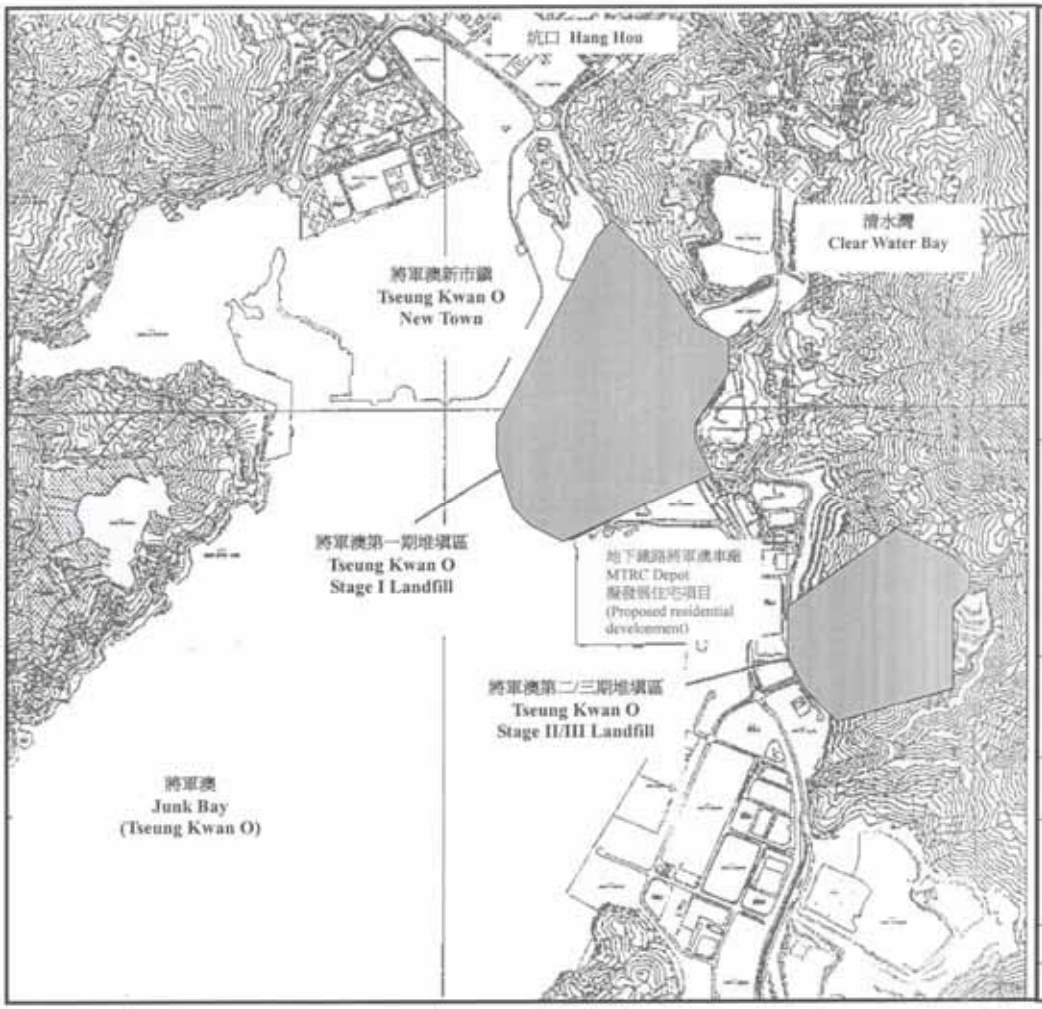
the comprehensive restoration of closed landfill sites. The landfill restoration programme initiative and target were promulgated in the 1995 Policy Address. The restoration includes mitigating measures to control the leachate and LFG problems, which aims to minimise the potential impacts on the environment and to enable the restored landfills to be safe for future beneficial use. The costs for the restoration and the estimated costs for post-completion environmental monitoring work of all the closed landfills are provided at Enclosure 4.

23. We included **45DR** "Restoration of landfill sites" in Category B in August 1990. In May 1995, we upgraded part of **45DR** entitled "Restoration of Tseung Kwan O landfills –works" to Category A as **156DR** at an estimated cost of $972 million for the design and construction of the restoration facilities and the first seven years' post-completion work.

24. The proposed works will not involve any tree removal and/or planting proposals.

25. We estimate that the proposed project will continue to provide 20 existing jobs (11 professional/technical staff and nine labourers), totalling 1 680 man-months.

Environment, Transport and Works Bureau
December 2004



圖例:
LEGEND:

堆填區
LANDFILL

工務計劃項目編號 5166 DR –
將軍澳堆填區修復計劃 –
驗收後的環境監測工程

PWP Item No. 5166 DR –
Restoration of Tseung Kwan O Landfills –
post-completion environmental
monitoring work

圖形名稱 Drawing Title
修復工程工地範圍
SITE LOCATION PLAN

圖形編號 Drawing No.
TKO_SITE LOCATION.DWG

ENVIRONMENTAL PROTECTION
DEPARTMENT
環境保護署

日期 Date : 08-2004

不按比例 NTS

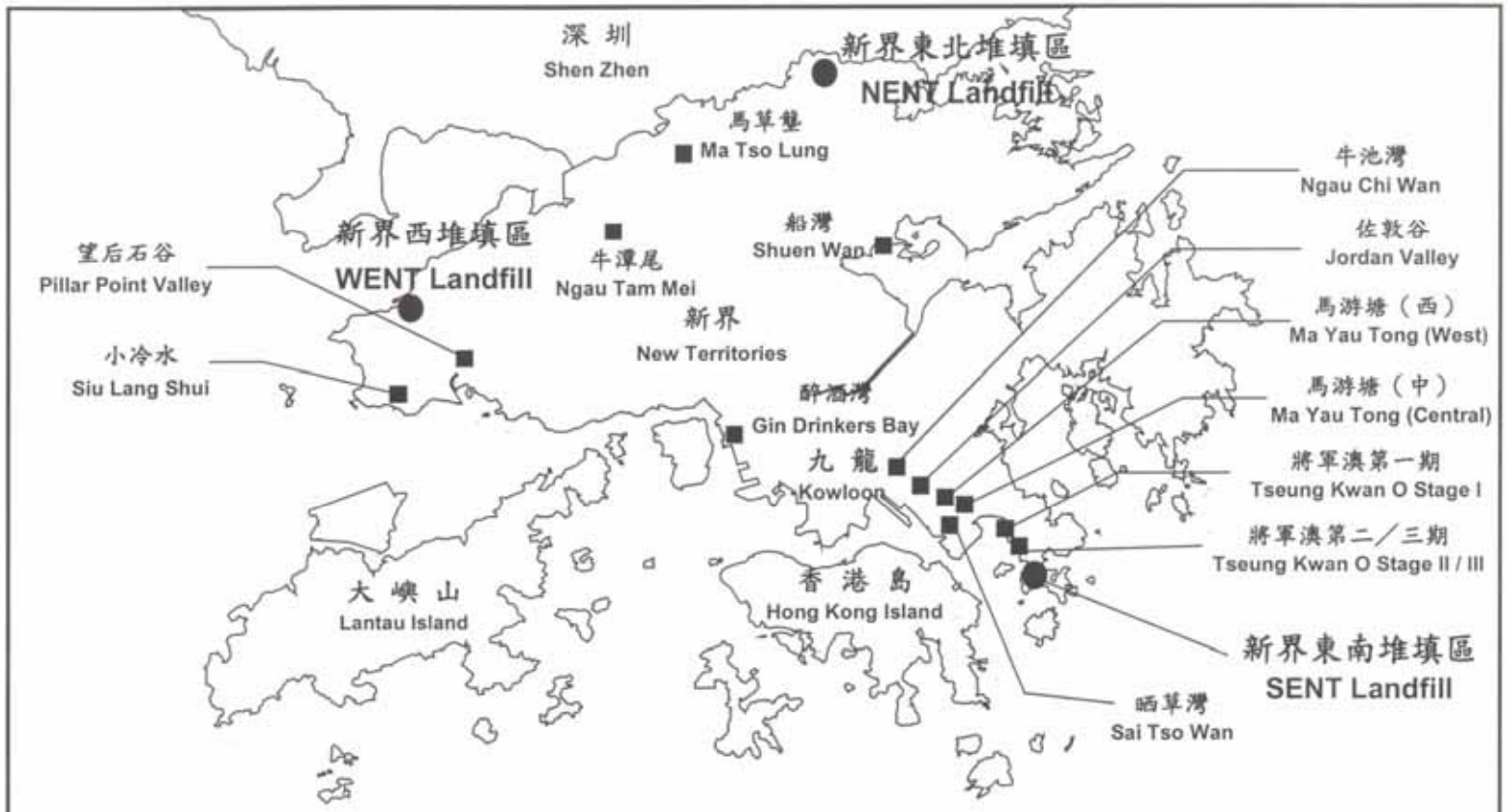
Enclosure 1 附件 1

Enclosure 2 to PWSC(2004-05)45

The monitoring programme for the Tseung Kwan O landfills

Category	Monitoring Details	Measurement	Purpose
Landfill Gas	Measure surface landfill gas emission	Methane	To ensure no safety risks to the personnel on site
	Detect landfill gas at perimeter monitoring boreholes, passive vents and utility manholes	Methane , Carbon Dioxide , Oxygen , Temperature	To monitor off site gas migration and safeguard the neighbourhood
	Analyse landfill gas collected from boreholes and extraction wells	Oxygen, Nitrogen, Carbon Monoxide , Carbon Dioxide , Hydrogen , Methane , Ethane , Propane , n-Butane	To monitor changes in the landfill gas quality over the years
	Detect landfill gas in buildings and confined space on site and off site	Methane , Carbon Dioxide , Oxygen	To ensure no safety risk to occupiers of these structures
	Measure landfill gas at the extraction system	Methane , Carbon Dioxide , Oxygen ,Temperature , Differential Pressure, Static Pressure , Flow	To monitor the landfill gas composition to ensure optimal operation of the landfill gas management system
	Analyse emissions of gas flaring facilities at TKOL-I and TKOL-II/III	Hydrogen Sulphide, Hydrogen Chloride, Hydrogen Fluoride, Hydrogen Bromide, Sulphur Dioxide, Nitrogen Dioxide, Carbon Monoxide, Total Non-methane Hydrocarbons	To monitor the performance of the landfill gas treatment plants
	Analyse volatile organic compound (VOC)	Trichloroethylene, Vinyl Chloride, Methylene Chloride, Chloroform, 1,2-Dichlorethane, 1,1,1-Trichloride, Carbon Tetrachloride, Tetrachloroethylene, 1,2-Dibromoethane, Toluene, Methane, Benzene	To ensure the VOC contents comply with international standards
Groundwater	Measure groundwater level and quality	Well Depth , Groundwater Level , Temperature, pH, Electrical Conductivity , Dissolved Oxygen , Alkalinity, COD , Chloride, Ammoniacal Nitrogen , Total Kjeldahl Nitrogen , Total Oxidized Nitrogen, Total Nitrogen, Sulphate, Sulphite, Phosphorous, Total Organic Carbon, Sodium, Potassium, Calcium, Magnesium, Iron, Manganese , Cadmium, Copper, Nickel, Lead, Zinc, Mercury, Chromium, Sliver	To monitor groundwater quality

Category	Monitoring Details	Measurement	Purpose
Marine water	Analyse marine water and sediment	Appearance, Temperature, pH, Electrical Conductivity, Dissolved Oxygen, Salinity, Turbidity , COD, BOD, Ammoniacal Nitrogen, Nitrite-Nitrogen, Nitrate-Nitrogen, Total Nitrogen, Total Phosphorous, Reactive Phosphorous, Total Suspended Solids, Total Organic Carbon, Sulphate, Sulphite, PCB, PAH, Cadmium, Copper, Nickel, Lead, Zinc, Mercury, Chromium, Arsenic, Selenium	To monitor quality of the receiving waters.
Leachate	Measure level of leachate at monitoring wells	Well Depth, Leachate Level , Temperature , pH , Electrical Conductivity	To avoid excessive water pressure built up at the man-made slope which might affect the overall slope stability
	Measure leachate quality at leachate management system	Temperature, pH, Electrical Conductivity, Alkalinity, COD, BOD, Chloride, Ammoniacal Nitrogen, Total Kjeldahl Nitrogen, Total Oxidized Nitrogen, Total Nitrogen, Sulphate, Total Organic Carbon, Sodium, Potassium, Calcium, Magnesium , Iron , Manganese, Cadmium, Copper, Nickel, Lead, Zinc	To check the strength of leachate in relation to landfill aging
Surface Water	Analyse surface water quality	Appearance, Temperature, pH, Electrical Conductivity, Dissolved Oxygen, Alkalinity, COD, BOD, Chloride, Ammoniacal nitrogen, Total Kjeldahl Nitrogen, Total Oxidized Nitrogen, Total Nitrogen, Sulphate, Total Suspended Solids, Total Organic Carbon, Sodium, Potassium, Calcium, Magnesium, Iron, Manganese, Cadmium, Copper, Nickel, Lead, Zinc	To ensure no discharge of contaminated surface water off site
Nuisance	Dust	Total Suspended Particulates (TSP), Respirable Suspended Particulates (RSP)	To protect the general public, neighbouring residents as well as visitors from nuisance problems
	Noise	Noise Level	
	Odour	Odour	



堆填區位置圖

Location Plan of Landfills

The costs for the restoration and estimated costs for post-completion environmental monitoring work of the closed landfills

Closed landfill (approximate site area in hectares (ha))	**Actual cost for construction of restoration facilities ($ million) (in MOD prices)**	**Estimated cost for 30 years post-completion environmental monitoring works[(1)] ($ million) (in MOD prices)**
Shuen Wan Landfill (50 ha)	160	113
Ngau Chi Wan Landfill (8 ha) Sai Tso Wan Landfill (9 ha) Ma Yau Tong West Landfill (5 ha) Ma Yau Tong Central Landfill (11 ha) Jordan Valley Landfill (11 ha)	249	307
Tseung Kwan O Landfill I (68 ha) Tseung Kwan O Landfill II/III (42 ha)	369	411
Ngau Tam Mei Landfill (2 ha) Ma Tso Lung Landfill (2 ha) Siu Lang Shui Landfill (12 ha) Gin Drinkers Bay Landfill (29 ha)	332	431
Pillar Point Valley Landfill (38 ha)[(2)]	221	328
Total	1,331	1,590

(1) Estimates based on 30 years post-completion environmental monitoring work. Estimated costs for different landfills vary mainly due to the size of the landfills, the required restoration facilities and treatment, the number of sites under each restoration contract and geographical locations.

(2) The cost shown here is the contract price. The construction of restoration facilities is expected to complete in mid 2006 and the post-completion environmental monitoring work will commence thereafter.