For discussion
on 27 October 2008

Legislative Council Panel on Environmental Affairs

Possible Environmental Impacts associated with the Proposed Extension of South East New Territories Landfill to the Clear Water Bay Country Park

PURPOSE

This paper presents the possible environmental impacts associated with the proposed extension of the South East New Territories (SENT) Landfill (the Extension) to the Clear Water Bay Country Park (CWBCP).

BACKGROUND

2. To address our serious and imminent waste problem in a holistic manner, the Administration published "A Policy Framework for the Management of Municipal Solid Waste (2005-2014)" (Policy Framework) in December 2005, which sets out a comprehensive waste management strategy for the next ten years with clear targets and timetables. The strategy adopts a three-tiered waste management hierarchy with avoidance and minimization as top priorities, followed by reuse, recovery and recycling, with bulk waste reduction and landfill disposal at the bottom of the hierarchy. A number of encompassing initiatives under this hierarchy are being launched for achieving the waste reduction and recycling targets as set out in the Policy Framework. The progress of the key initiatives has been regularly reported to this Panel and the last progress report was submitted to this Panel in February 2008 (Paper No. CB(I) 844/07-08(03)).

3. At present, Hong Kong relies on three strategic landfills to dispose of solid waste. In 2007, about 5.1 million tonnes (or about 14,000 tonnes per day) of solid waste were disposed of in the three landfills. The Environmental Protection Department (EPD) estimates that, even with effective reduction and recycling measures as well as modern waste incineration achieving bulk waste reduction as stated in the Policy Framework, the three landfills will be filled up progressively in the next

decade, with SENT Landfill full by around 2012/13, North East New Territories (NENT) Landfill and West New Territories (WENT) Landfill by 2015/16. According to the current programme, the first Integrated Waste Management Facilities (IWMF), which will substantially reduce the volume of waste requiring disposal at the landfills, can only be commissioned in mid 2010s. Therefore, the extension of all three landfills will be required in the early 2010s to mid 2010s to provide the necessary landfill capacity to serve as the final repositories for non-recyclable waste and residual waste after treatment. In this connection, we have already completed the feasibility and environmental impact assessment studies for the extension of the NENT Landfill and SENT Landfill, while those for the WENT Landfill are still in progress.

PROPOSED EXTENSION OF THE SENT LANDFILL

4. The EPD has studied five options to extend the SENT Landfill with a view to reducing the environmental impacts as much as possible and at the same time providing the necessary filling capacity. Three of the options do not encroach upon the CWBCP and the other two options have an encroachment of three hectares and five hectares respectively. After evaluating the merits and drawbacks of each option, EPD recommends the option with an encroachment of five hectares upon the CWBCP due to the following considerations -

(a) the Environmental Impact Assessment (EIA) concluded that the recommended option would have no adverse residual ecological impact with the implementation of the recommended mitigation measures; and

(b) in terms of provision of landfill capacity to meet the demand, this option will provide the highest capacity of 17 million cubic metres which will extend the life of the SENT Landfill by six years to tie in with the commissioning of the IWMF in mid 2010s and the development of the longer term waste transfer and handling facilities in the south-east region of the territory in late 2010s.

5. Under this option, the SENT Landfill Extension will occupy a narrow strip of the CWBCP. The location of the existing SENT Landfill and the proposed extension is shown in the map at **Annex A**. The EPD had consulted the Country and Marine Parks Board (the CMPB) and its Country

Parks Committee several times from December 2005 to May 2007 on this option. At its meeting on 22 May 2007, the CMPB agreed to this option, subject to EPD presenting the results of the EIA and demonstrating its commitment to press ahead with a series of waste management strategies including the commissioning of the IWMF by 2014.

ENVIRONMENTAL IMPACT ASSESSMENT

6. An EIA was conducted to assess the impact of the SENT Landfill Extension. The EIA assessed the potential impacts on air quality (including odour), ecology, noise, water quality, waste management, landfill gas hazard as well as visual and landscape aspects due to the proposed Extension. The assessment concluded that, with the implementation of recommended mitigation measures, the anticipated environmental impacts were acceptable and would meet the relevant requirements under the Environmental Impact Assessment Ordinance (EIAO). The findings and recommendations of the EIA are described in more detail in the attached EIA Report – Executive Summary at **Annex B**. Among the issues assessed, odour and ecological impacts were the two key issues which attracted significant attention. The key findings of these two issues are summarized below.

Odour Impact

7. The design of the Extension incorporated a stringent odour management and control system. New and improved odour management and control requirements would be included in the future contract of the Extension. These include enclosing all the leachate storage and treatment tanks (except for the biological treatment tank to avoid overheating and killing of the micro-organisms for the biological process), covering the areas not in use with impermeable liner, enclosing the weighbridge area and provision of full body washing facility for refuse collection vehicles. In addition, no sewage sludge would be accepted for disposal at the Extension.

8. With the implementation of the above odour management and control measures, the predicted odour concentrations at the representative air sensitive receivers (ASRs) in the surrounding areas and the residential developments in Tseung Kwan O Town area would meet the required odour criterion which is 5 odour units over 5-second intervals. Residual impacts (i.e. slight exceedances of the 5-second odour criterion) were predicted in a small area zoned for industrial development in Tseung Kwan O Area 137

and Tseung Kwan O Industrial Estate adjacent to the Extension site boundary. The frequency of the exceedance at this small area would be reduced through rephasing the waste tipping activity during the hot and wet months between July and November so that there will be no waste tipping at the northern portion of the Extension that is closer to the ASRs. With the implementation of the recommended mitigation measures, it is expected that the number of exceedances at the small area would be diminished to zero as the separation distances and heights between the active tipping face and the ASRs increase over the operation period.

9. The residual impacts were considered acceptable taking into account (i) the nature of the small area affected; (ii) the small number of people affected; and (iii) the transient nature, low frequency and magnitude of the exceedances.

10. To the users of CWBCP, the Extension site would be further away than the existing SENT Landfill and separated from the hiking trail by a mountain ridge. However, the Extension might be seen by users at some parts of the hiking trail. Mitigation measures such as advance tree planting would be taken to screen off the visual impact and further minimize the potential odour transmission to CWBCP.

Ecological Impact

11. The terrestrial and aquatic ecological resources recorded within the Study Area (i.e. the Extension site itself plus an area 500 metres outside the Extension site boundary) included plantation, shrubland, grassland, developed area, seasonal stream and sub-tidal habitats, as well as associated wildlife. Of these habitats, shrubland had a moderate ecological value while other habitats were of low or low to moderate ecological value. The ecological value of the developed area was negligible. The majority of the proposed Extension would be located in developed areas including the existing SENT Landfill and the fill bank in Tseung Kwan O Area 137. The proposed Extension would encroach into a small strip (approximately 5 hectares) of the CWBCP, which comprises shrubland and grassland habitats of low to moderate ecological value. The potential impacts on the natural habitats within the CWBCP were considered to be low to moderate. With the implementation of the recommended mitigation measures, no adverse residual impact was expected. As far as wildlife is concerned, a survey conducted under the EIA recorded 11 wildlife species of conservation

interest (including birds, butterflies, bat and reptile [Note 1]) within the Study Area. As these species were highly mobile and there was a large extent of similar habitat in the vicinity of the proposed Extension, the impacts on wildlife were considered to be minimal.

12. The EIA Report was submitted to the EIA Authority under the EIAO in December 2007. Public inspection of the EIA Report took place between the period 26 February 2008 to 26 March 2008 before the consideration of the report by the EIA Subcommittee of the Advisory Council on the Environmental (ACE) at its meeting on 17 March 2008. The key issues discussed at the meeting were odour impact, ecological impact and traffic impact assessments and efficient use of the landfill extension site. The EIA Report was further considered and discussed by the ACE at its meeting on 14 April 2008. With respect to the statutory role of the ACE under the EIAO, the ACE endorsed the EIA Report with the following conditions -

(a) a community liaison group comprising representatives of potential sensitive receivers should be set up to deal with and manage the potential odour problem;

(b) no sewage sludge would be disposed of at the SENT Landfill Extension; and

(c) a coherent restoration and ecological enhancement plan for the SENT Landfill Extension site should be submitted to the Agriculture, Fisheries and Conservation Department (AFCD) for vetting and endorsement.

13. Taking into account the ACE's recommendations and the public comments received, the EIA Authority approved the EIA Report on 6 May 2008 and granted the Environmental Permit for the SENT Landfill Extension

---

Note 1

Species of Conservation Interest

Mammals	Japanese Pipistrelle (普通伏蝠)#, *Pipistrellus abramus*; Brown Noctule Bat (褐山蝠), *Nyctalus noctula*
Birds	Brown Hawk Owl (鷹鴞)#, *Ninox scutulata;* Greater Coucal (褐翅鴉鵑)#, *Centropus sinensis;* Common Buzzard (普通鵟)#, *Buteo buteo;* Black Kite (蛇鷹), *Milvus lineatus*
Butterflies	White-edged Blue Baron (尖翅翠蛺蝶)#, *Euthalia phemius;* Indian Fritillary (斐豹蛺蝶)#, *Argyreus hyperbius;* Swallowtail (柑橘鳳蝶)#, *Papilio xuthus;* Toothed Sunbeam (尖翅銀灰蝶)#, *Curetis dentate*
Reptiles	Common Rat Snake (水律)#, *Ptyas mucosus.*

The species that is found at the shrubland within the encroached area of CWBCP is denoted as #.

on 5 August 2008.

14. The approved EIA Report set out the mitigation measures that were proposed in accordance with the principle of avoidance, minimization and compensation as set out in the Technical Memorandum of the EIAO. The mitigation measures included the adoption of surface water, groundwater, leachate and landfill gas management systems, good construction practices and provision of off-site screen planting near the country park hiking trail. Some 18 hectares of mixed woodland planting would be provided in the Extension site, including a compensation for the loss of six hectares of shrubland due to the Extension. In addition, a mosaic of grassland and shrubland will be provided in the remaining areas of the Extension site. These measures would reduce potential disturbances to the surrounding environment and would also help provide a habitat of higher ecological value than that of the existing site.

PROGRESSIVE RESTORATION AND ECOLOGICAL ENHANCEMENT

15. In order to minimize the landscape and visual impacts due to the Extension and to enhance the ecological and landscape values of the area, a progressive restoration approach would be adopted. .

16. As mentioned in paragraph 14 above, planting in the form of a mixture of woodland, grassland and shrubland was recommended to diversify the habitats to support the wildlife, in particular butterflies, birds and herpetofauna, and to blend into the existing undisturbed areas in the vicinity. Indigenous plant species with a shallow root system, softwood in nature and adaptive to sea shore habitat were recommended to be used in the restoration plan. These species included *Gordonia axillaris* (大頭茶), *Phyllanthus emblica* (餘甘子), *Celtis sinensis* (朴樹) and *Macaranga tanarius* (血桐), which had been well established in coastal areas with exposure to strong wind and salt spray, and with a sandy soil base. Food plants of butterfly species (in particular for butterfly species of conservation interest recorded within CWBCP) such as *Ischaemum aristatum* (鴨嘴草), *Microstegium ciliatum* (剛莠竹), *Miscanthus floridulus* (五節芒), *Ficus superba* (筆管榕), *Phoenix hanceana* (刺葵) and *Zanthoxylum nitidum* (兩面針) were also recommended to enhance the butterfly population in the area. The progressive restoration and ecological enhancement plan would

therefore enhance the ecological value of the restored Extension site.

17. The Extension and the encroachment area after restoration will achieve a higher amenity value and thus could be returned to country park use or put to other passive recreation uses for the enjoyment of the public.

ENVIRONMENTAL MONITORING AND AUDIT

18. The EIA Report includes an Environmental Monitoring and Audit (EM&A) Manual which recommends an EM&A programme during the construction, operation, restoration and aftercare phases of the Extension.

PUBLIC CONSULTATION

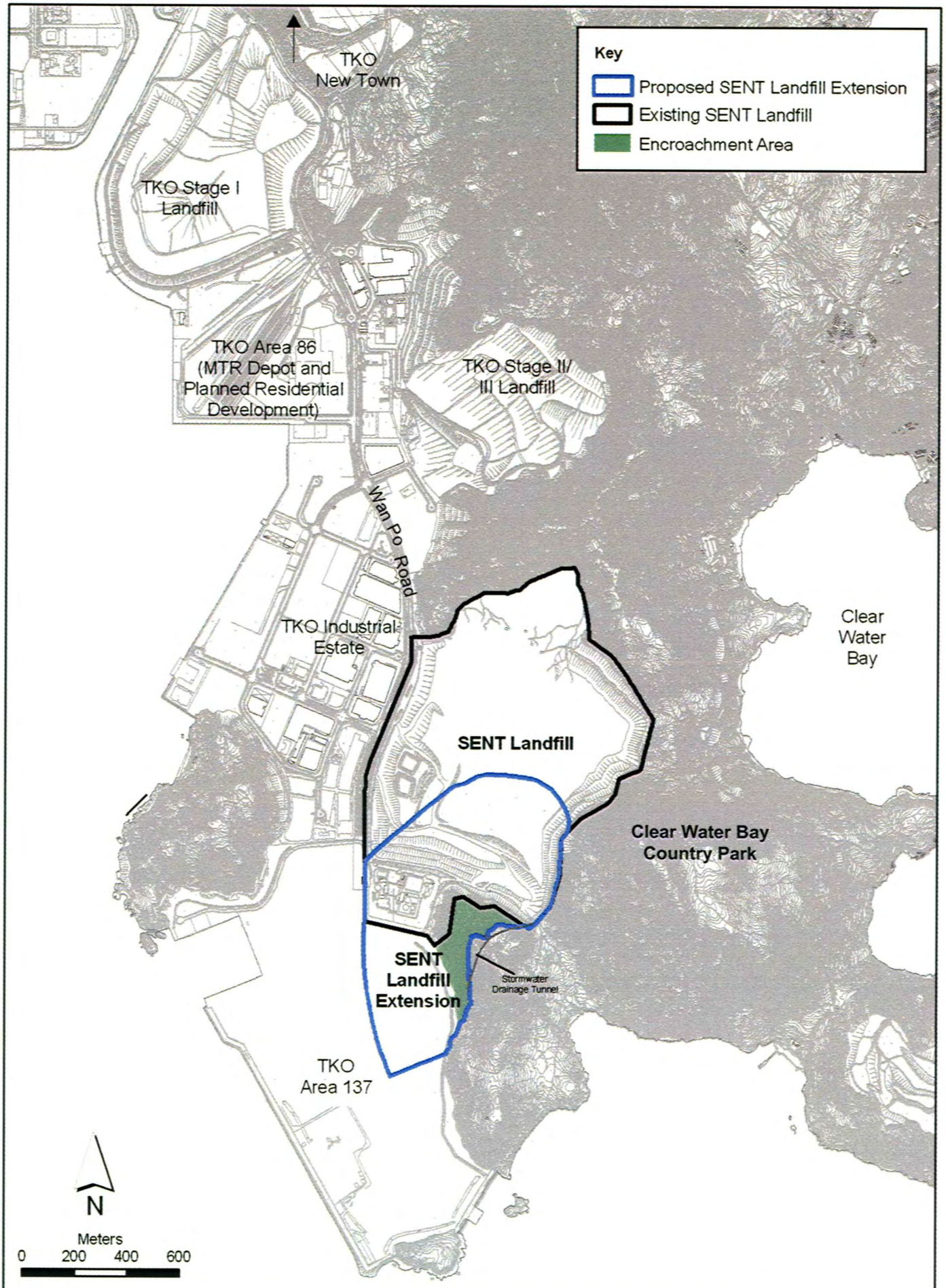
19. During the EIA process of the SENT Landfill Extension project, EPD has adopted a "Continuous Public Involvement" approach. Close liaison with Sai Kung District Council members, community organisations and rural committee/village representatives have been maintained and their suggestions have been incorporated into the scope of the assessment. The ACE was also consulted on the EIA report of SENT Landfill Extension and endorsed the report in April 2008. The Sai Kung District Council (SKDC) was consulted on several occasions from December 2005 to September 2008. The SKDC has expressed grave concern on the possible odour, traffic and environmental problems associated with the proposed Landfill Extension, and set up a dedicated committee to follow up on the odour issues arising from the SENT Landfill. The CMPB has been consulted on the proposed encroachment of five hectares of land within the Country Park. At the meeting of 11 September 2008, the CMPB advised that the area affected by the SENT Landfill Extension should be excised from the CWBCP under section 15(1) of the Country Parks Ordinance.

ADVICE SOUGHT

20. Members are invited to note the contents of this paper.

Environmental Protection Department
October 2008

Annex A

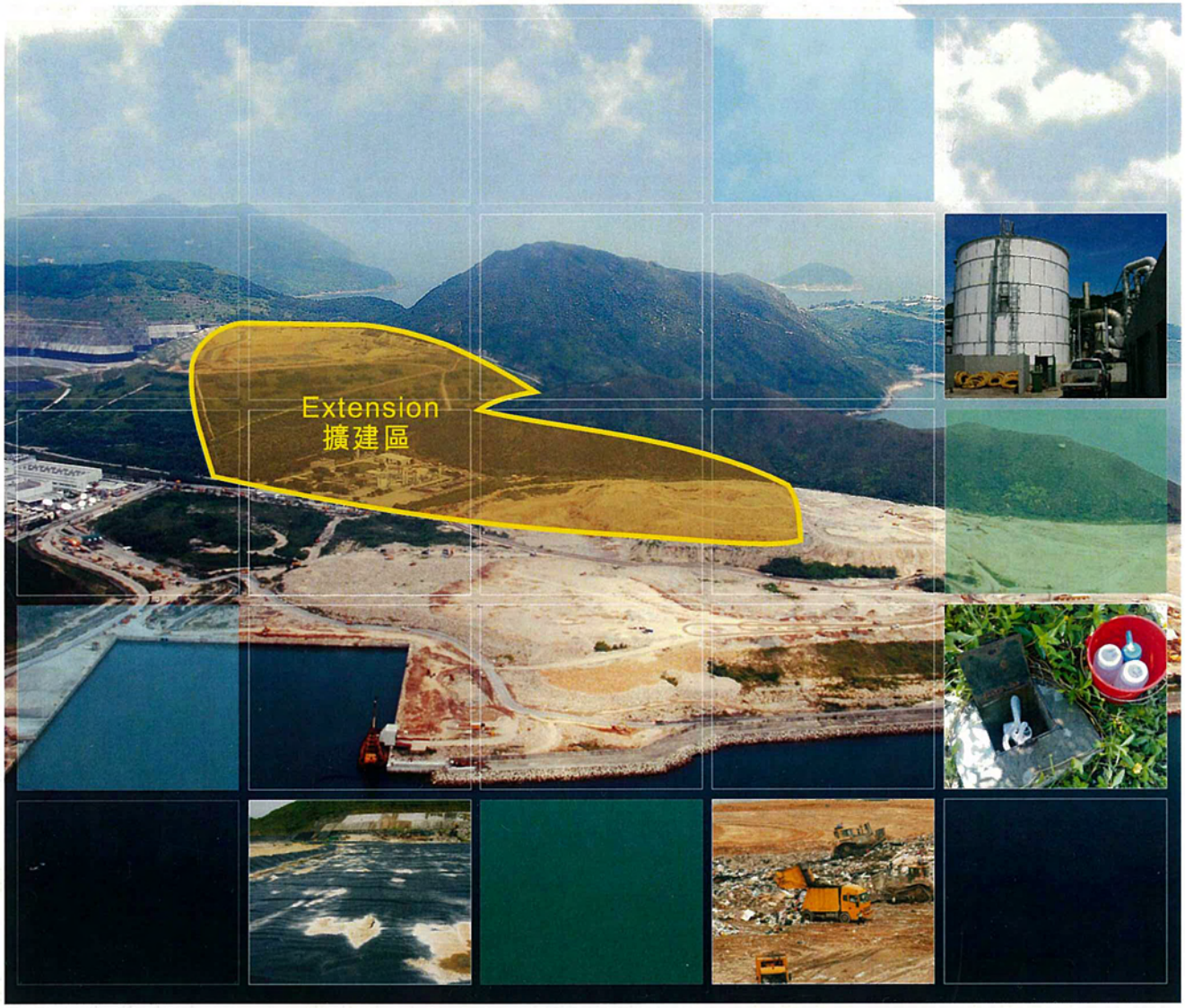


Location Plan - South East New Territories (SENT) Landfill and Extension

Environmental Protection Department

EXECUTIVE SUMMARY
行政摘要

Annex B
附件 B



環境保護署
Environmental Protection Department
The Government of the Hong Kong
Special Administrative Region

Agreement No. CE 10/2005 (EP)
South East New Territories (SENT) Landfill Extension
- Feasibility Study:
Environmental Impact Assessment Report
- Executive Summary

合約編號CE10/2005(EP)
新界東南堆填區擴建工程可行性研究:
環境影響評估報告-行政摘要

二零零七年十二月
December 2007

Environmental Resources Management
21/F Lincoln House
Taikoo Place 979 King's Road
Island East Hong Kong
Telephone 2271 3000
Facsimile 2723 5660

www.erm.com

Delivering sustainable solutions in a more competitive world

ERM

Environmental Protection Department

Agreement No. CE 10/2005 (EP)
South East New Territories (SENT) Landfill Extension - Feasibility Study: Environmental Impact Assessment Report – Executive Summary

December 2007

Reference #0036286

For an on behalf of
Environmental Resources Management

Approved by: Dr Andrew Jackson

Signed:

Position: Managing Director

Date: 14 December 2007

CONTENTS

1 INTRODUCTION

1.1 BACKGROUND

The existing South East New Territories (SENT) Landfill site is located close to major urban areas. It receives about 6,200 tonnes waste each day. Based on the predicted waste input rate, it is anticipated that its capacity will be exhausted around 2012. As the planning, tendering and contract arrangement, detailed design, construction and commissioning of the landfill extension will take several years, it is essential to establish the environmental acceptability and engineering feasibility of the proposed SENT Landfill Extension ("the Extension") now.

ERM-Hong Kong, Ltd (ERM) has been commissioned by the Environmental Protection Department (EPD) to undertake the *South East New Territories (SENT) Landfill Extension – Feasibility Study* (the "Assignment") under *Agreement No. CE 10/2005(EP)*. As part of the Assignment, an Environmental Impact Assessment (EIA) Study has been prepared in accordance with *EIA Study Brief* (No. ESB-119/2004) issued under the *Environmental Impact Assessment Ordinance (EIAO)*.

The EIA Report addresses potential environmental impacts associated with the construction, operation, restoration and aftercare of the Extension ("the Project"). This *Executive Summary* summarises the key findings of the EIA.

1.2 JUSTIFICATION FOR THE NEED OF THE EXTENSION

Hong Kong is facing an imminent waste problem as our three existing strategic landfills are expected to be filled up within the next decade. In December 2005, the Government published the waste policy document "A Policy Framework for the Management of Municipal Solid Waste (2005-2014)" ("the Policy Framework"). This document sets out a comprehensive strategy for the management of municipal solid waste (MSW) in Hong Kong with clear targets and a ten-year (2005-2014) timetable for change. The strategy embraces the concepts of sustainable waste management and continues to adopt the three-tiered waste hierarchy with avoidance and minimization as top priorities, followed by reuse, recovery and recycling and with bulk waste reduction and landfill disposal at the bottom of the hierarchy.

The Government is therefore actively promoting initiatives to reduce waste generation and promote waste recycling. When comparing the waste statistics for 2006 with those of previous years, the amount of MSW disposed of at the three strategic landfills (WENT, NENT and SENT) dropped by 1% against an economic growth of 6.8% in 2006. Equally encouraging is the increase in the recovery rate of domestic waste from 16% in 2005 to 20% in 2006. At the same time, the overall recovery of MSW has also increased from 43% in 2005 (2.59 million tonnes) to 45% in 2006 (2.84 million tonnes), three

years ahead of the target stated in the Policy Framework. There are however areas of concern. Even though the amount of MSW landfilled was reduced by 1% in 2006, there is still a long way to go in achieving the Policy Framework's target of reducing the total MSW landfilled to less than 25%. In addition, despite EPD's efforts in waste reduction and recovery, the amount of MSW generated remains on an increasing trend. This is likely to be the result of growth in commercial, industrial and tourism-related activities in 2006 which has led to an increase of about 4% in commercial and industrial waste generation. Therefore, despite the progress achieved for source separation and waste recycling, it is important to press ahead with the other initiatives in the Policy Framework such as Producer Responsibility Schemes (PRSs), MSW charging, integrated waste management facilities (IWMF) and landfill extensions.

At the same time, the Government is also looking into building modern large scale integrated waste management facilities that would employ thermal treatment as a core technology as it is clearly not sustainable to continue to rely on landfilling alone for the disposal of untreated MSW. The IWMF are planned to be commissioned in the mid 2010s, assuming that good progress is made. As mentioned in the Policy Framework, landfills will still be required as the final repositories for non-recyclable waste, inert waste and waste residues after treatment. Taking into account the waste reduction and treatment initiatives in the Policy Framework,, it has been estimated that the demand for landfill space from 2006 to 2025 is around 200 million tonnes, while the remaining landfill capacity, at the end of 2004 was 90 million tonnes. The provision of sufficient landfill space by extending the capacity of the three existing landfills is an important and integral part of the waste management strategy in Hong Kong and is necessary to meet the shortfall of landfill capacity. Indeed, the Policy Framework recommended that commissioning of these extensions will be required in the early 2010s to mid-2010s.

In addition to the need for landfill capacity on a territory-wide basis, there is a need to meet the regional demand for waste disposal outlets. The three landfills are at strategic locations in Hong Kong and the extension of all three is necessary to maintain the overall waste disposal plan which is based on bulk waste transfer to avoid excessive number of waste collection vehicles travelling in the urban areas (1). Due to its close proximity to the urban areas,

(1) According to the White Paper "Pollution in Hong Kong – A Time to Act" issued on 5 June 1989 and the subsequent waste disposal strategy under the Waste Disposal Plan approved by the Governor in Council on 12 December 1989, there should be three new landfills in Hong Kong distributed on a regional basis for the following reasons:

- the daily quantity of MSW could not be handled by one or two landfills simply because of the strain that would be placed on the surrounding road network and on the landfill sites themselves;
- the increases in MSW were projected for the western and north-eastern New Territories and provision of disposal facility in each of these areas would help reduce transportation costs; and
- there would continue to be a need for a final disposal facility in reasonable proximity to Hong Kong Island in order to contain the transportation cost for waste arising from urban areas.

The existing 3 strategic landfills were therefore located at the western, north-eastern and south-eastern New Territories regions within the territory in the absence of other alternative site available in Kowloon and Hong Kong Island.

the SENT Landfill is the most highly used waste disposal facility amongst the three landfills, particularly by private waste collectors for commercial, industrial as well as construction wastes. It receives about 6,200 tonnes of municipal, construction and special wastes every day. If the SENT Landfill is closed, waste will have to be diverted to the NENT and WENT Landfills. This will require vehicles collecting waste from the catchments of the SENT Landfill to travel an additional hundred thousand kilometres per day in total through the built-up areas to the remotely located NENT and WENT Landfills, thus resulting in additional environmental impacts such as increased traffic movements, vehicular emissions and noise impacts on many more sensitive receivers en-route. To reduce these impacts, we would need a succession plan by developing new waste transfer and/or handling facilities in the south-east region of the territory, such as new handling facility for construction waste (ie the Construction Waste Handling Facility (CWHF)) and refuse transfer station for MSW (ie the South-East Kowloon Material Recovery and Transfer Station (SEKTS)). As the planning (including the site search), feasibility study, statutory environmental impact assessment process, tendering and contract arrangement, detailed design, construction and commissioning of these facilities would take equally long time as the landfill extension scheme, it further strengthens the importance of maximising the capacity of Extension where feasible in order to minimize those impacts as far as we could manage.

Projecting the time at which these new facilities will be available is very uncertain as the site for the CWHF will unlikely be available in the early 2010s and the site selection for the SEKTS has not yet been started. It will be a long planning and public consultation process to secure suitable waterfront sites at the Tseung Kwan O and South East Kowloon areas which are acceptable to the public for the development of these waste transfer/handlling facilities, but without compromising the overall planning and development of these two areas. In addition, the funding for developing these facilities has not been secured. Under an optimistic set of conditions to form a target programme at the present stage, they could possibly be in place by 2017. With SENT expected to be full by 2012, at least six years of additional void space is necessary. It is important to extend the lifespan of the SENT Landfill so that the Government can have time to plan and develop these new waste handling facilities.

1.3 OBJECTIVES OF AND APPROACH TO THE EIA STUDY

The Project is classified as a Designated Project under Schedule 2, Category G.1 and Q.1 of the *EIAO* and therefore the construction, operation, restoration and aftercare of the Extension will require an Environmental Permit.

The objectives of the EIA Study are to provide information on the nature and extent of environmental impacts arising from the Extension; to recommend appropriate mitigation measures to control the potential environmental impacts so that it complies with the requirements of the *Technical Memorandum on Environmental Impact Assessment Process of the EIAO* (EIAO-TM); and to

confirm the environmental acceptability of the Extension. Key environmental issues identified in the EIA Study Brief include air quality, noise, water quality, waste management, landfill gas hazards, ecology and landscape and visual impacts.

The EIA was conducted in accordance with the guideline on assessment methodologies provided in the *EIAO-TM*. The general approach for the assessment includes description of baseline environmental conditions for the impact assessment, identification and evaluation of potential impacts and recommendation of mitigation measures and an environmental monitoring programme. The assessments in this EIA Study are conducted using well-proven and internationally accepted methods based on reasonable worst-case conditions.

2.1 CONSIDERATION OF DIFFERENT EXTENSION OPTIONS

EPD identified 15 hectares of land in TKO Area 137 together with an adjoining narrow strip of land within the Clear Water Bay Country Park (CWBCP) as a potential site for the extension of the SENT Landfill. *Figures 2.1a* to *2.1e* show the five extension options identified and examined under the Assignment. The key information of each extension option is summarised in *Table 2.1a.*

Table 2.1a Key Information of Extension Options

Options	Characteristics	Net Void Space (million m^3)	Encroachment into CWBCP (hectares)	Estimated Construction Cost (HK$ per tonne of waste)	Additional Lifespan (years)
Option 1a	• Stand-alone landfill • No sharing of Infrastructure	1.3	0	350	<1
Option 1b	• Stand-alone landfill • Sharing of infrastructure with existing landfill	1.6	0	200	<1
Option 2	• Piggy-back landfill • Sharing of infrastructure with existing landfill	10	0	80	4
Option 3a	• Piggy-back landfill • Sharing of infrastructure with existing landfill	15	3	60	5
Option 3b	• Piggy-back landfill • Sharing of infrastructure with existing landfill	17	5	50	6

Note:
Construction cost of existing strategic landfill is about HK$60 per tonne.

2.2 OPTIONS EVALUATION

Five criteria were used to evaluate the five extension options:

- Landfill capacity offered;
- Efficiency of use of land;
- Cost effectiveness;
- Level of encroachment into Country Park; and
- Potential environmental impacts.

Engineering measures and additional landtake in TKO Area 137 have also been considered to maximise the void space while not encroaching the CWBCP.

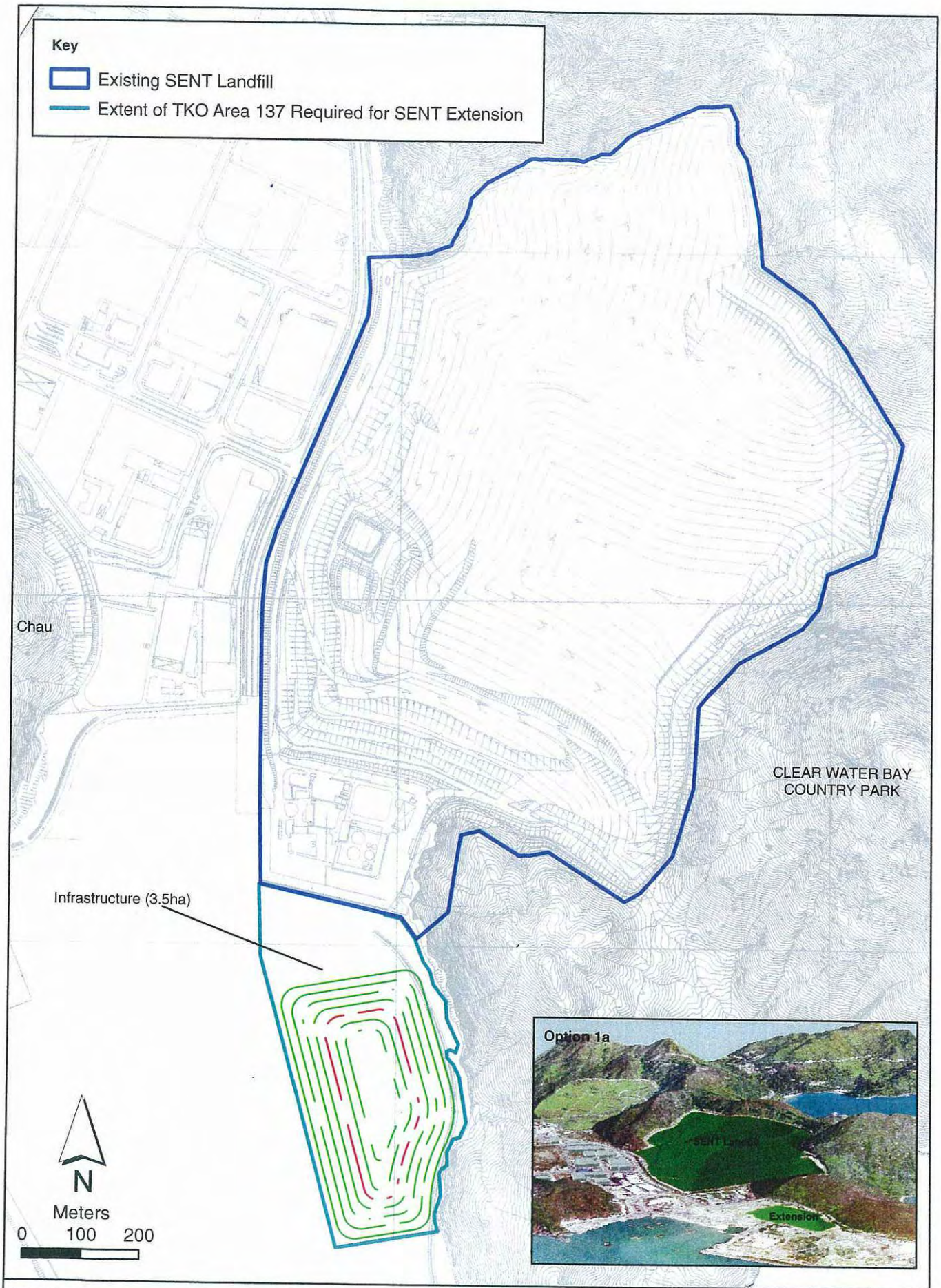


FIGURE 2.1a

Option 1a

File: 0036286_Option1a_1.mxd
Date: 09/01/2007

Environmental Resources Management

ERM

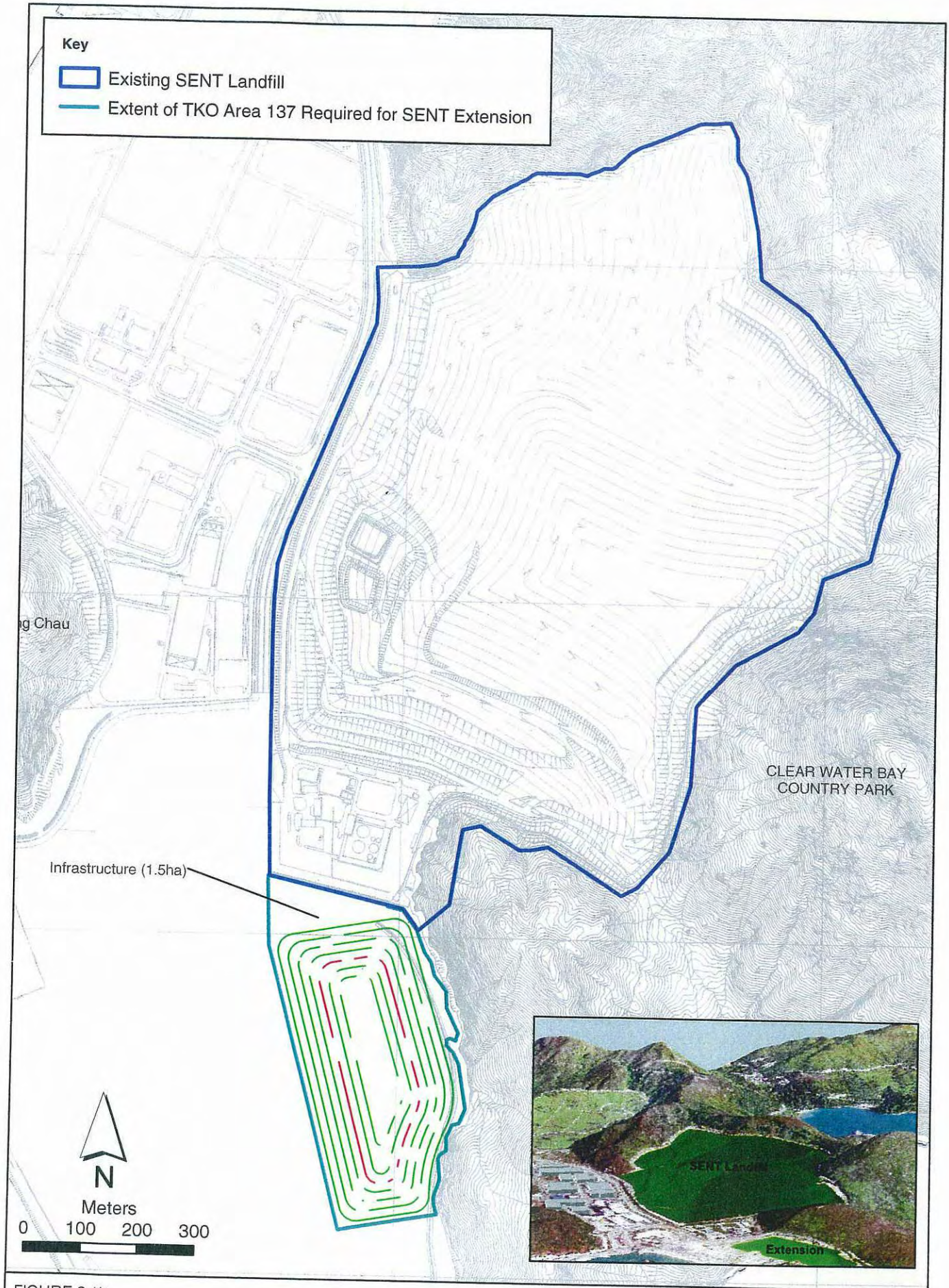


FIGURE 2.1b

Option 1b

File: 0036286_Option1b.mxd
Date: 09/01/2007

Environmental Resources Management

ERM

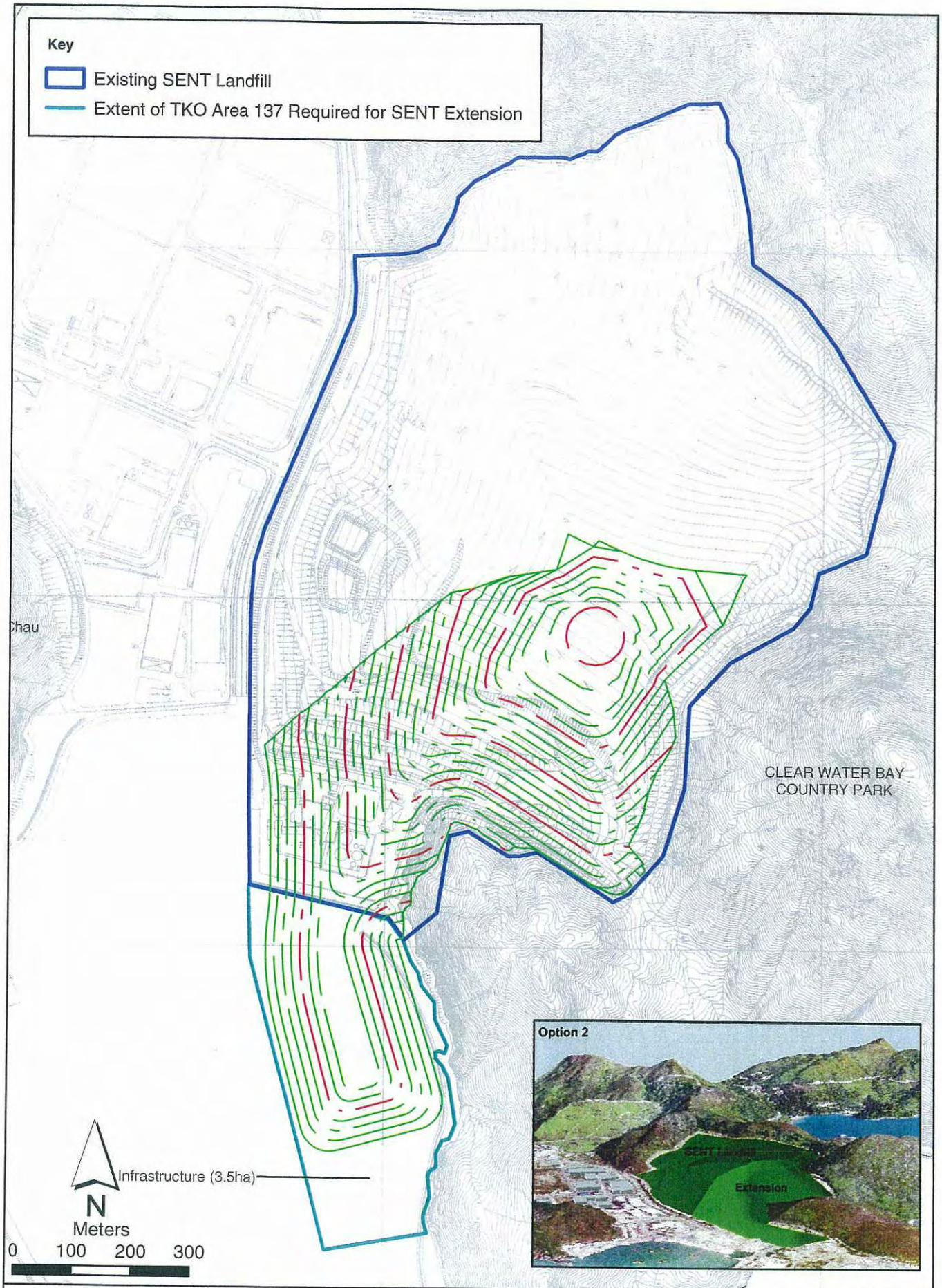


FIGURE 2.1c

Option 2

File: 0036286_Option2_1.mxd
Date: 09/01/2007

Environmental Resources Management

ERM

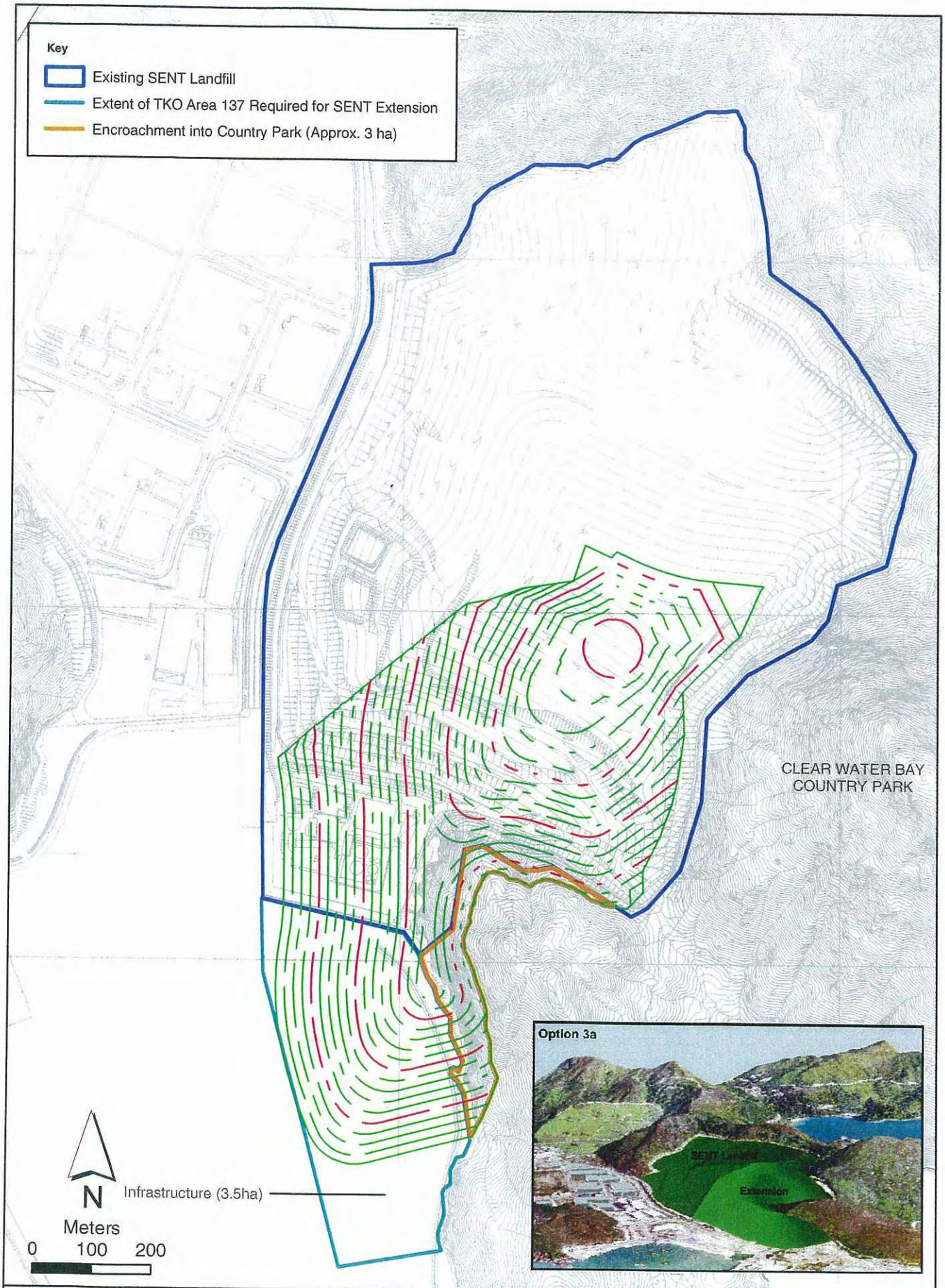


FIGURE 2.1d

Option 3a

File: 0036286_Option3a_2.mxd
Date: 04/12/2007

Environmental Resources Management

ERM

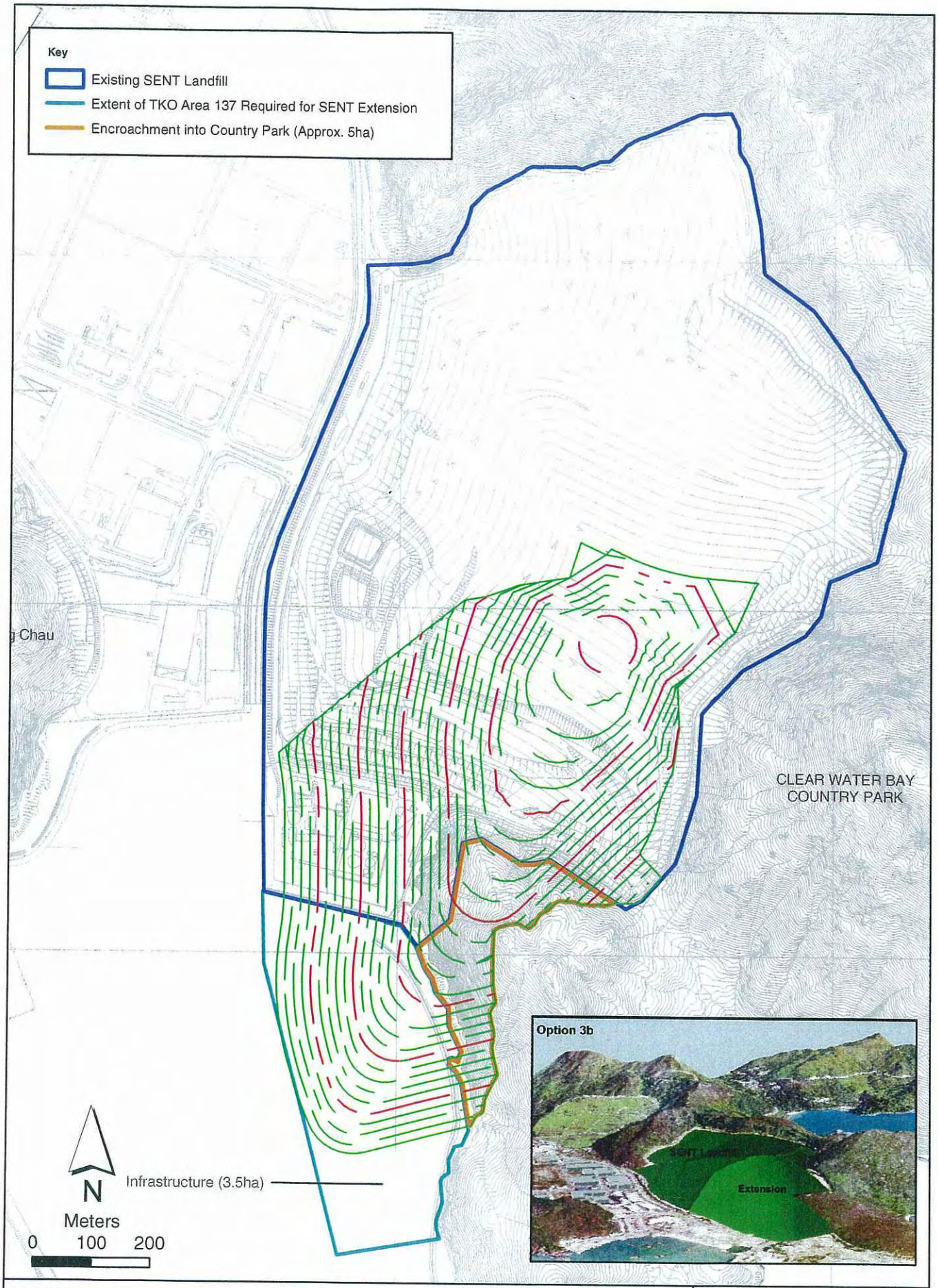


FIGURE 2.1e

Option 3b

File: 0036286_Option3b_2.mxd
Date: 09/01/2007

Environmental Resources Management

ERM

2.2.1 *Landfill Capacity*

The stand-alone options (Options 1a and 1b) provide very low void capacity, equivalent to an extended lifetime for the SENT Landfill of less than one year. The piggyback options (Options 2, 3a and 3b) provide significantly higher void capacity. Option 3b provides the highest void capacity of all options evaluated and provides sufficient time for the new generation of waste management facilities to come into operation.

2.2.2 *Efficient Use of Land*

All options make use of the 15 hectares of land in TKO Area 137 that adjoins the southern end of the existing SENT Landfill. Options 3a and 3b require additional land to be borrowed from the CWBCP area. As Option 3b will deliver the greatest void capacity per unit site area, it presents the most efficient use of the land that could be made available.

2.2.3 *Cost Effectiveness*

The stand-alone options have the highest unit capital cost (per tonne of waste). Option 3b has the lowest capital cost and is thus the most cost effective option.

2.2.4 *Encroachment into Country Park*

Options 1a, 1b and 2 will not encroach into the CWBCP and hence will have no direct impact on the CWBCP. Options 3a and 3b will make temporary encroachments of approximately 3 ha and 5 ha respectively. These options will therefore have a direct impact on the habitat of CWBCP and wildlife within the country park. It is noted that the potential encroachment area is a cliff face dominated by shrubland and grassland. At present, there are no hiking trails or formal footpaths in the area. The area can only be accessed from the existing SENT Landfill or the fill bank in TKO Area 137 and has not been used for recreational and educational purposes. The 9-month ecological baseline survey identified that the affected habitats within CWBCP comprise shrubland and grassland that is not of high ecological value. While some wildlife species of conservation interest (including birds, butterflies, bats and reptiles) were recorded within the direct impact area, all of these species were found to be highly mobile and were found to have access to an abundant number of similar habitats close by and within the CWBCP area.

2.2.5 *Environmental Impacts*

Due to their smaller scale, Options 1a and 1b will have lower environmental impacts at local level when compared with the other options. However, their shorter lifespan may mean that diversion of waste collection vehicles to other landfills will be required for a longer period, thus generating more environmental impacts at a territorial level. Conversely, the larger scale Options 2 and 3a will have greater environmental impacts at the local scale but, due to their longer lifespan, lower environmental impacts at territorial level. With careful design and good site management and progressive

restoration, local environmental impacts can be mitigated. Option 3b, as the largest extension option, will generate greater environmental impacts at the local scale than the other four and will impact upon the natural habitats within the CWBCP. Impacts on the CWBCP can be mitigated by compensatory planting and appropriate afteruse development of the encroached area to enhance educational and recreational value.

2.2.6 Engineering Measures Considered

Engineering measures that would increase void space but avoid the extension encroaching into the CWBCP were considered. These included building a retaining wall or earth bunds around the waste mound. To make these measures effective, the retaining wall or earth bund would need to be over 40m tall. Such measures would have considerable cost implications and the earth bund itself may consume a significant portion of landfill voidspace. The standalone feature would also be difficult to integrate with the surrounding landscape and visually difficult to accept. Such engineering measures were therefore not put forward for further consideration.

2.2.7 Additional Landtake in TKO Area 137

An option to increase the amount of land that is used within TKO Area 137 has been investigated, to investigate whether encroachment into the CWBCP could be avoided. To develop an extension of capacity equivalent to that in Option 3b without encroachment into the CWBCP would require approximately double the size of the identified site in TKO Area 137 to be used. Due to high demand of land in TKO Area 137, additional allocation of land is not feasible. Also, to extend the SENT Landfill further south adjacent to the CWBCP can only provide limited additional void space.

2.2.8 Selection of the Preferred Option

With reference to Clause 3.3.2 of the Study Brief, consideration was given to avoid or minimize the encroachment onto the CWBCP and the disturbance to the ecosystems in the adjacent areas including the CWBCP. Hence, Options 1a, 1b and 2, which do not encroach upon the CWBCP are considered first.

Of the five options examined, Options 1a and 1b would have the least impacts on CWBCP and the sensitive receivers in the vicinity in terms of both construction and operation. However, the additional landfill void capacity provided by these options is very small, making them inefficient in terms of cost and use of available land. The lifespan of these options is also short and thus will result in longer period where waste collection vehicles move waste to the more remote landfills, in turn resulting in more environmental impacts at territorial level. These options are thus not recommended.

Option 2's void capacity is 6 times than that of Option 1b and will not require additional land within the CWBCP. However, the void capacity will only be 10 Mm^3 (ie still well below the target void capacity), and the construction cost will be more expensive than that of the existing strategic landfills. Compared with Options 3a and 3b, the void space provided by Option 2 is 50% less than

these encroachment options. To maximise utilisation of the existing landfills, some diversion of the waste collection vehicles to the other two landfills will be required, hence will still creating environmental impacts at a territorial level. Option 2 would have similar local environmental impacts to Options 3a and 3b, except that no natural habitat would be impacted directly. Visually, Option 2 does not blend with the surrounding environment as well as Options 3a and 3b. Use of engineering measures to increase voidspace whilst avoiding encroachment was found to be expensive and likely to result in an adverse visual impact. The resulting gain in void space is small.

As Options 1a, 1b and 2 cannot provide sufficient landfill voidspace to help meet demand in Hong Kong for the next 20 years, Option 3a and 3b, which require temporary encroachment into the CWBCP were considered further.

Options 3a and 3b will both have direct impacts on the CWBCP. In terms of maximising void capacity, making the most effective use of available land and achieving the highest cost effectiveness, Option 3b performs the best. The local environment impacts, similar to those associated with Option 2, can be mitigated by careful design and good site practices. The temporary encroachment area is primarily a cliff face without any hiking trail and proper access. It is unlikely that public enjoyment of CWBCP would be affected. In terms of impacts on natural habitats, the encroachment area is of low to moderate ecological value with flora and fauna commonly found within the CWBCP. When the temporary encroached area is restored together with the fully restored landfill in the vicinity after the completion of landfill operation, it is anticipated that the restored Extension could be enriched to enable a higher amenity value for public enjoyment.

It is understood that there is a public need for both landfill space and country park. The loss of void space as a result of not maximising the use of this Extension Site will be reprovided at other landfills, as a result of reduction of landfill space in other landfills as well as an overall shortfall of landfill space in Hong Kong within the next 20 years and the environmental impacts caused by longer journey to these landfills. When balancing all of the above considerations, Option 3b, giving the largest void space and lifespan while able to control environmental impacts to more acceptable levels with proper design and mitigation, is recommended as the preferred option for detailed EIA.

2.3 CONSIDERATION OF ALTERNATIVE CONSTRUCTION METHODS AND SEQUENCE OF WORKS

2.3.1 Site Formation

It is recommended that the Extension Site at TKO Area 137 and the existing SENT Landfill Infrastructure Area will be formed by filling, instead of excavation in the SENT Landfill Infrastructure Area and the TKO Area 137. This method will ensure smaller amount of excavated material to be generated

and avoid the base of the landfill intercepting groundwater level, which is relatively shallow in TKO Area 137.

2.3.2 Slope Formation

The construction methods identified for the slope formation work, their respective environmental benefits and dis-benefits have been examined. Blasting techniques are preferred over non-explosive methods. Though blasting is associated with relatively higher magnitude of environmental impacts, these are very short lived and can be mitigated. In contrast, impacts associated with non-explosive methods or open excavation (including continual use of noisy hydraulic breakers) would be longer lived and are therefore not preferred. Blasting would also be more cost effective and help ensure the timely completion of the works.

2.3.3 Drainage Tunnels

Similarly, alternative methods for constructing the two small drainage tunnels have been examined. Tunnel boring is preferred over blasting. Both options have similar environmental impacts, most of which will be confined within the tunnel. Tunnel boring, however, has higher productivity and a better controlled excavation profile while blasting brings with it potential safety concerns over the use of explosives in a confined space in close proximity to potential sources of landfill gas.

2.3.4 Sequencing

The sequence of constructing the Extension is:

1) construction of a new infrastructure area which will also be designed to treat leachate and landfill gas from the existing SENT Landfill;
2) demolition of the infrastructure at the existing SENT Landfill; and
3) formation and lining of the entire base of the landfill, including the slope formation, prior to commencement of waste placement.

This works sequence will ensure uninterrupted operation of the existing SENT Landfill, a smooth transition of operations to the extension and safe operation during landfilling.

2.3.5 Phasing

The Extension will be developed in Phases. Within each Phase, it is proposed that filling should start on the western side (ie the side closest to Wan Po Road and the nearby sensitive receivers). The western perimeter of the Phase will be filled to its intended height, and the outward face of the landfill will be progressively restored. This completed portion of the Phase will then act as a screen to minimise noise, visual and air quality impacts from the tipping operations within the remaining part of that Phase.

3.1 DESIGN OF THE EXTENSION

A layout plan of the preferred extension option is shown in *Figure 3.1a*. The Extension is a "piggyback" landfill occupying the existing SENT Landfill infrastructure area, 15 hectares of TKO Area 137 and approximately 5 hectares of the CWBCP. The infrastructure area will be located at the southern end of the Project Site.

The Extension covers an area of around 50 hectares (including the area required for site infrastructure). Discounting the void space required for engineering works, daily and intermediate cover, the total net void capacity for waste is around 17 Mm^3. The lifespan of the Extension is estimated to be around six years, with operations starting in 2013 (1).

The design of the Extension includes:

- A landfill liner and cap – these are made of impermeable materials and are designed to contain waste, leachate and landfill gas within the waste boundary.

- A landfill gas management system – this comprises a number of landfill gas collector wells and pipelines to gather the landfill gas and a landfill gas treatment facility. Together, these elements will control landfill gas build-up and prevent migration of landfill gas off the site and into the surrounding area.

- A leachate management system – this comprises a number of leachate collection and extraction points, pipelines and a treatment plant. This system will control the leachate level within the landfill and ensure that treated leachate complies with the effluent discharge standard set for the Extension.

- A surface water management system – this comprises surface water cut off channels constructed around the perimeter of the landfill site and drainage tunnels. These features will prevent surface water from upland areas from entering the Extension and will also prevent contaminated runoff of the Extension from discharging to the surrounding area.

- A groundwater management system – this comprises a specially designed drainage layer below the liner at the base of the landfill. This layer is designed to collect and transport groundwater away from the liner to the collection sumps at the boundary of the Extension.

(1) All engineering and environmental assessments in this Assignment are based on the assumption that the existing SENT Landfill will be closed by about 2012 and the extension will commence operation in 2013. This timetable is subject to change and will be determined based on the actual closure date of the existing SENT Landfill.

- Odour management and control system – key features comprise enclosing all the leachate storage and treatment tanks (1), applying deodorizers or odour suppression agents at the active tipping face and at the western site boundary, minimising the sizes of the active tipping face and special waste trench, provision of mobile cover for the special waste trench, covering the non-active tipping face with impermeable liner, prompt covering of MSW with soil or selected inert materials, enclosing the weighbridge area, provision of vehicle washing facility and progressive restoration of areas reaching the finished profile.

- Site infrastructure – this includes waste reception facilities (eg weighbridge, reception kiosk); vehicle wash facilities; offices and visitor centre; a laboratory; maintenance workshops; a storage area; the landfill gas treatment facility and leachate treatment plant described above.

3.2 IMPLEMENTATION PROGRAMME

The key dates of the implementation programme are shown in *Table 3.2a*.

Table 3.2a Key Dates of Implementation Programme

Key Stage of the Project	Indicative Date
Start construction	2011
Commissioning of new infrastructure facilities	2011
Demolition of existing infrastructure facilities	2012
Stop taking waste at the existing SENT Landfill	2012
Start waste intake at the Extension	2013
Stop taking waste at the Extension	2018
End of aftercare for the Extension	2048

(1) Except the Sequential Batch Reactor (SBR) tanks to avoid overheating of the wastewater which would affect the biological treatment process.

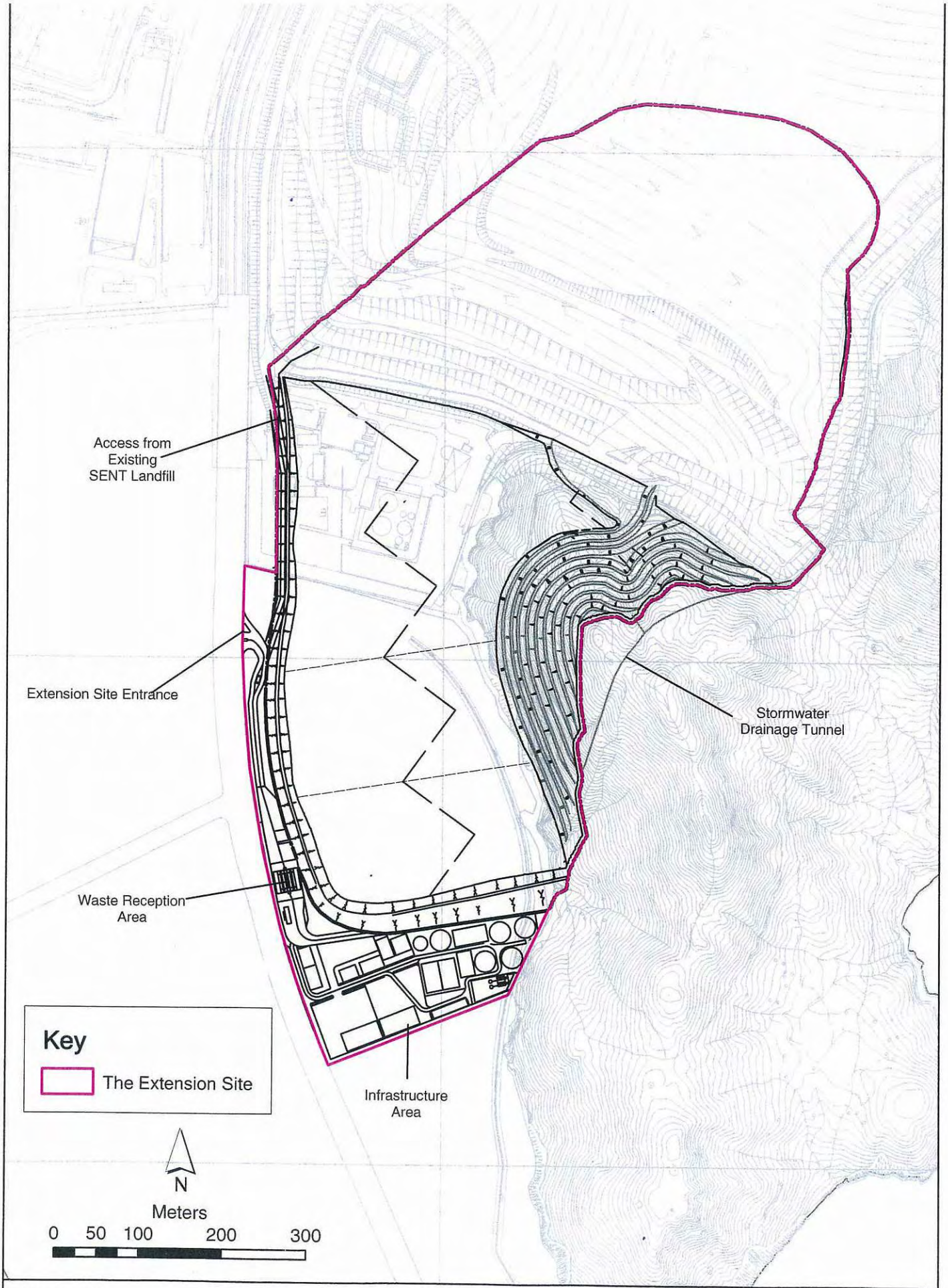


FIGURE 3.1a

Layout Plan of the Extension

File: 0036286_Extension_Layout02.mxd
Date: 25/09/2007

Environmental Resources Management ERM

This page is left intentionally blank.

4 ENVIRONMENTAL IMPACTS

The potential environmental impacts associated with the Project are summarised in the following sections.

4.1 AIR QUALITY

Potential dust nuisance from construction activities and gaseous emissions from plant have been evaluated. With the implementation of the recommended dust control measures and good construction site practices, it is not anticipated that the construction of the Extension will cause adverse dust and air quality impacts.

The concentrations of gaseous emissions predicted to be generated by the landfill gas treatment facility, the leachate treatment plant and the LFG generator are within the relevant Air Quality Objectives (AQOs), international chronic and acute reference guidelines and health risk guidelines at air sensitive receivers (ASRs) taking into account other gaseous emissions within 500m from the Extension site boundary and the general background contributions. The volatile organic compounds (VOCs) emissions from the Extension are predicted to be low at the site boundary and that levels are within the respective trigger levels. It is therefore not envisaged that the operation of the Extension will cause adverse air quality impact to the identified ASRs with respect to potential VOCs emissions from the landfill.

The design of the Extension has incorporated a stringent odour management and control system (see *Section 3.1*). Good site practices and housekeeping would be stipulated in the operation contract.

With the exceptions of those ASRs in the immediate vicinity of the boundary of the Extension, no exceedances of the odour criterion were predicted with the implementation of the odour management and control system. Residual impacts were predicted in a small area zoned for industrial development covering part of TKO Area 137 and TVB City adjacent to the Extension boundary.

The frequency of the exceedances at TVB City will be reduced through the adoption of rephrasing of waste tipping activity (1). Over the six year operation period, the number of exceedances at TVB City is expected to diminish to zero as the separation distances and heights between the active tipping face and the ASRs increases. It should be noted that the odour emission rate of the special waste trench adopted in the assessment based on uncovered trench scenario is conservative and the actual emissions will be much lower as the trench will be covered and the air trapped inside the trench will be scrubbed prior to discharge to the atmosphere. Furthermore, no sludge from sewage treatment works will be received in the Extension.

(1) No waste tipping activity at the northern sector of the Extension between July and November.

Hence, it is anticipated that the actual odour level and number of exceedances will be much less than that predicted in this assessment. The residual impacts are considered acceptable taking account of (i) the nature of the places affected, (ii) the small number of people impacted, and (iii) the transient nature, low frequency and magnitude of the exceedances.

During the aftercare phase, air emission sources are primarily associated with the landfill gas management facility and the LFG generator. The Extension will be sealed with a capping system (including an impermeable liner) and the entrapped landfill gas will be extracted for utilisation or flaring. The vent gas produced in the enclosed tanks will be either diverted to the flares or to an air scrubber. The scrubbed vent gas will be used as part of the air intake for the aeration system of the SBR tank. The odour sources will be limited to the sequential batch reactor tanks of the leachate treatment plant. As the emission strength and scale of the Extension operation during this phase are significantly reduced compared to the operation and restoration phases, no adverse odour impact is anticipated. The impact from gaseous emissions from the landfill gas treatment facility and the LFG generator is predicted to be within the AQO criteria, reference acute and chronic concentrations and health risk guidelines at any of the identified ASRs. It is therefore concluded that the aftercare of the Extension will not cause adverse air quality impacts to the identified ASRs.

The requirements of regular monitoring of dust, odour, ambient VOCs, ammonia and hydrogen sulphide, and gaseous emissions from stacks have been recommended and detailed in the *EM&A Manual*.

4.2 NOISE

The predicted construction noise levels at identified noise sensitive receivers (NSRs) are well below the noise criteria specified in the *EIAO-TM.* Hence, no adverse construction noise impact is anticipated.

The predicted operation noise levels due to the Extension, including the fixed plant items, at the representative NSRs are within the noise criteria mentioned in relevant TMs. Following the closure of the landfill, noise impact during the aftercare phase is anticipated to be negligible.

The road traffic noise at NSRs due to Wan Po Road, Chiu Shun Road and the future Cross Bay Link have been predicted. The off-site road traffic noise contribution due to the Extension is considered insignificant.

While no adverse noise impacts are expected during the operation and restoration phases of the Extension, it is recommended that good site practices be implemented to further minimise any noise impact.

4.3 *WATER QUALITY*

With the implementation of the mitigation measures set out in the EIA and good construction site practices, there will be no adverse impacts on water quality.

A surface water drainage system will be constructed around the active tipping area to prevent stormwater from entering the landfill and get contaminated, and vice versa prevent contaminated rainwater from discharging off the site. Contaminated runoff will be collected by this system and treated with leachate. A comprehensive leachate containment system will be installed to contain leachate generated from the landfill. Construction quality control and assurance procedures will be implemented to ensure that joints are properly sealed and to avoid damage to the impermeable liner during construction of this system.

The hydrogeological assessment concludes that, while the landfill cap remains intact and leachate control is maintained, there will be no adverse impacts on groundwater quality. Even in the very long term (on a timescale of several hundred years), when the landfill cap degrades and the active leachate control can no longer perform their full function, the potential impacts on groundwater quality are predicted to be slight. Under such conditions, the quality of groundwater discharges to Junk Bay would still comply with the effluent discharge standards set out in the *Water Pollution Control Ordinance*.

Leachate and sewage collected from the Extension will be treated at the on-site leachate treatment plant. Effluent will be discharged to the public sewer for conveying to the Government treatment works for further treatment. Treated effluent entering the sewer will comply with the effluent discharge standards set out in the *Technical Memorandum Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Inshore Waters*. There will be no adverse water quality impact.

4.4 *WASTE MANAGEMENT*

The waste arisings during the construction, operation, restoration and aftercare phases include excavated material, construction and demolition material, general refuse from daily operations, chemical waste from maintenance of plant and equipment and sludge from the leachate treatment plant. The quantity, quality and timing of these waste arisings have been identified. With good site practices, the potential environmental impacts associated with the storage, handling, collection, transport and disposal of the identified waste arisings from the Extension will be within acceptable limits set out in the *EIAO-TM*. No adverse waste management impacts are anticipated.

4.5 *LANDFILL GAS HAZARD*

The potential hazards associated with sub-surface migration of landfill gas from the existing SENT Landfill to the Extension and from the Extension to the adjacent existing and future developments have been assessed. Both the existing SENT Landfill and the Extension are considered as a "medium" source. Comprehensive and proven landfill gas control measures have been installed in the existing SENT Landfill and will be installed in the Extension. The source-pathway-target analysis shows that landfill gas risk posed by the SENT Landfill and the Extension is medium to high during both construction and operation phases within the Extension Site. Whereas the risk posed by the Extension to the adjacent developments ranges from very low to low depending on the nature and location of the these developments.

In general, underground rooms or voids should be avoided as far as practicable in the design of the infrastructure area of the Extension. Other precautionary and protection measures during construction, design, operation and restoration phases of the Extension have been recommended. It is expected that with the proposed precautionary measures in place, the potential risk of landfill gas migration to the respective targets will be minimal. Regular monitoring of landfill gas in perimeter landfill gas monitoring wells and service voids along the Extension Site boundary will be undertaken to ensure that no unacceptable off-site migration of landfill gas occurs.

4.6 *ECOLOGY*

The terrestrial and aquatic ecological resources recorded within the Study Area (including the Extension Site and the 500m buffer area) include plantation, shrubland, grassland, developed area, seasonal stream and subtidal habitats, as well as associated wildlife. Of these habitats, shrubland has a moderate ecological value, whilst other habitats are of low or low to moderate ecological value. The ecological value of the developed area is negligible.

The majority of the proposed Extension will be located in habitats which have already disturbed or developed including the existing SENT Landfill and the fill bank in TKO Area 137. The proposed Extension will encroach into a small strip (approximately 5 ha) of the CWBCP, comprising shrubland and grassland habitats of low to moderate ecological value. The potential impacts on these natural habitats within the CWBCP are considered to be low to moderate. With the implementation of the recommended mitigation measures, no adverse residual impact is expected. There are no marine works involved and no marine habitats and species will be affected.

A survey recorded 11 wildlife species of conservation interest (including birds, butterflies, bat and reptile) at the Extension Site. As these species are highly mobile and as there is a large extent of similar habitat in the vicinity of the Extension, the impacts on wildlife are considered to be minimal.

The EIA sets out mitigation measures to reduce ecological impacts. These include the adoption of surface water, groundwater, leachate and landfill gas management systems, good construction practices and provision of compensatory planting. These measures will reduce potential disturbance to the surrounding environment and will also help provide a habitat of higher ecological value than that of the existing site.

4.7 LANDSCAPE AND VISUAL IMPACT

With mitigation measures in place, the landscape impacts would range from "insubstantial" to "substantial" at landscape resources during construction phase. The landscape impacts will be reduced to "insubstantial to moderate" during the operation and restoration phases and further reduced to "insubstantial to slight" at year 10 of the aftercare phase when the restored landscape is fully mature. There will be "Slight positive" landscape impacts on the reclaimed TKO Area 137.

Most of the sensitive residential receivers are relatively distant from the Extension. With mitigation measures in place, the visual impacts to the sensitive residential receivers would range from "Insubstantial" to "slight" at the visual sensitive receivers during construction phase and slightly worsen to "Insubstantial to moderate" during the operation and restoration phases as the volume and height of the landfill gradually increase. During the aftercare phase, the impact will be reduced to "Insubstantial to slight" on day 1 of the aftercare phase, when landfilling operations have ceased; and further reduced to "Insubstantial" as the landscape restoration gradually matures.

4.8 ENVIRONMENTAL MONITORING AND AUDIT

Environmental monitoring and audit requirements have been identified and recommended to implement to ensure the effectiveness of the recommended mitigation measures. These requirements are specified in the *EM&A Manual*. The monitoring requirements cover the area of dust, organic emissions, odour, gaseous emissions, surface water, groundwater, leachate and landfill gas. Regular site audits throughout the construction, operation, restoration and aftercare of the Extension have also been recommended.

This page is left intentionally blank.

5 OVERALL CONCLUSION

The environmental impact assessment (covering air quality, noise, water quality, waste management, landfill gas hazards, ecology and landscape and visual impacts) has concluded that no unacceptable environmental impacts are envisaged as a result of the construction, operation, restoration and aftercare of the Extension, provided that the recommended mitigation measures are implemented. It is predicted that there will be residual odour impact on air sensitive receivers in the immediate vicinity of the Extension Site boundary. Taking account of the nature of the developments affected, the number of people impacted, the transient nature, low frequency and magnitude of the exceedances, the residual impacts are considered acceptable.

Recommendations for an environmental monitoring and audit programme have been prepared to ensure the effectiveness of the recommended mitigation measures.