2 Description of the Project

2.1 General Description of the Project

The development of the NENT Landfill Extension (hereafter referred to "the Project") will involve the following works:

- Site formation and preparation.
- Installation of liner system.
- Installation of leachate collection, treatment and disposal facilities.
- Installation of gas collection, utilization and management facilities.
- Utilities provisions and drainage diversion.
- Operation of landfill.
- Restoration and aftercare in subsequent stages.
- Measures to mitigate environmental impacts as well as environmental monitoring and auditing to be implemented.

2.2 Key Project Requirements

The key project requirements for the NENT Landfill Extension are:

- Development of a sanitary landfill that covers an area of about 70 ha with an estimated void space (landfill capacity) of 19Mm^3;
- Provision of a liner system for the landfill to prevent contamination of land and water resources;
- Provision of a leachate collection, treatment and disposal facilities with sufficient capacity for handling the leachate arising from the landfill extension;
- Provision of landfill gas collection, utilisation and management facilities;
- Provision of utilities, drainage and road network necessary for the proper operation of the Project;
- Provision of facilities (both civil works and electrical & mechanical equipment) for waste reception, inspection, charging, handling and compaction, and plant maintenance;
- Provision of facilities for site administration;
- Operation of the landfill in compliance with all relevant engineering, geotechnical and environmental standards;
- Restoration of the landfill in compliance with all relevant engineering, geotechnical and environmental standards;
- Provision of aftercare for the landfill for a period of about 30 years;
- Carrying out environmental monitoring and audits throughout construction, operation, restoration and aftercare of the landfill; and
- Implementation of environmental measures necessary for the protection of the surrounding environment.

2.3 Need for the Project

2.3.1 Growing Wasteloads

Waste is a common problem of affluent societies. Especially when people can afford greater convenience and more purchases, they tend to generate a higher volume of waste per capita. Hong Kong is no exception to this. Like many other modern cities, Hong Kong has seen its wasteloads increase following the economic growth. Municipal wasteloads have grown on average of about 3% per year since 1986. With the population growth at 0.9% each year, the waste generation rate has risen from 1.96 kg per person per day in 1996, to 2.27 kg in 2004 (Figure 2.1).

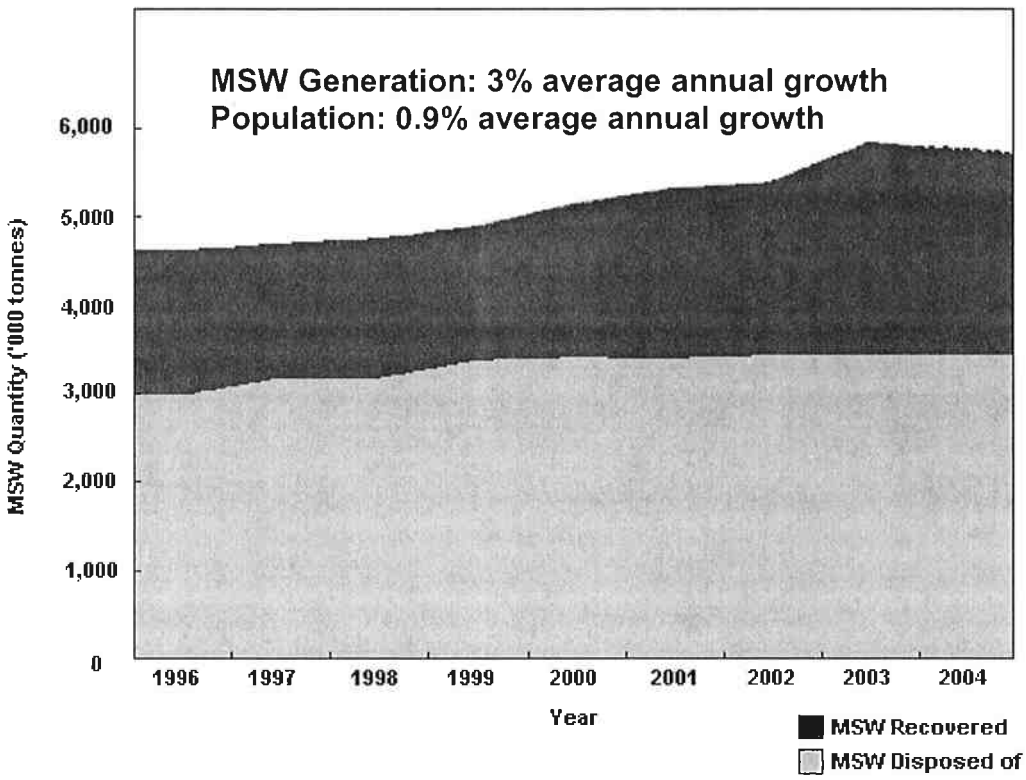

Figure 2.1 Waste line grew from 1996 to 2004 [extracted from EPD" Policy Framework for the Management of MSW (2005-2014)"]

Hong Kong's waste arising have exceeded the expected amount. At the time when the three existing strategic landfills, SENT Landfill, NENT Landfill and WENT Landfill, were planned, it was forecasted that the daily amount of waste to be disposed of at landfills would rise from 12,500 tonnes in 1989, to 14,000 tonnes in 1997 and 16,700 tonnes by 2001. By 1997 the three strategic landfills were already taking in 16,000 tonnes of waste every day. Should this trend continue, the landfills will be full by 2015, instead of lasting until 2020 as they were originally designed for.

Although all measures outlined in the Policy Framework for the Management of Municipal Solid Waste (2005-2014) including source separation, MSW charging, waste recycling, IWMF, etc. would help extend the lives of the three landfills, the residues from the IWMF will still require sites for final disposal and landfill site is therefore necessary.

The reality is that HK, like all other developed cities around the world, will need landfills as the final means of disposal. Assuming the Government's target of reducing the waste going to landfill site from 60% in 2004 to 25% by 2014 will be achieved, some 4000 tonnes per day of waste still needs to be disposed of at landfill sites. Therefore, outlets for landfill sites for final disposal of solid waste are still required. Extensions of existing landfill sites have been identified as an indispensable element for the management of waste in Hong Kong. Justifications of the need for providing additional void space for waste disposal by developing extension at the existing NENT Landfill are provided in the following sections.

2.3.2 Justification of Developing Extension at NENT Landfill

With a clear Government strategy to achieve sustainable management of the MSW in the next 10 years, it is anticipated that the amount of solid waste requiring landfill disposal will start to reduce gradually. Having said that, there will still be millions of tonnes of un-recyclable or unrecoverable waste requiring disposal each year. With the three existing strategic landfills envisaged to be exhausted between Year 2011 to 2015 and the long lead time required for developing new landfills, there is a need to identify an intermediate solution.

EPD had therefore commissioned a study in February 2000 to explore the potential of extending the existing landfills and identify potential new landfill sites.

Given that it will take many years to confirm suitability of a new landfill location, extensions of the existing landfills were considered a practicable, necessary and urgent intermediate solution. Key advantages of the extension schemes include:

- Availability of existing supporting infrastructure and therefore less lead time for the development.
- Availability of existing supporting infrastructure and therefore more cost effective for the development.
- Availability of accurate information and hence lower level of risk in capital and operating costs estimation.
- Availability of existing environmental monitoring data and hence more reliable for confirming environmental acceptability of the Project.
- Availability of existing supporting infrastructure and therefore less requirements on land resumption for the development.
- Availability of existing supporting infrastructure and therefore potentially less impact on the environment in comparison with a new green field site scheme.
- Established site specific procedures for operation and environmental impact control.

These key advantages are recognised at the NENT Landfill for the proposed extension.

2.4 Consideration of Alternatives

2.4.1 Alternative Extension Layout

In working out the most desirable layout for NENT Landfill Extension, a number of layout options were formulated, evaluated and then compared for selection, based on various evaluation criteria and an evaluation framework agreed with relevant stakeholders in advance.

The key issues and constraints identified during the course of study were taken into account in formulation of landfill extension layout options. A total of 4 broad options (as well as related sub-options) were thoroughly evaluated and discussed at a Value Management

Workshop on 2 December 2005, attended by relevant stakeholders. Key features of the various options are recapitulated below.

2.4.2 Broad Layout Option 1

2.4.2.1 Option 1

Option 1 adopts a similar rationale as the proposed conforming scheme in the EPD's preliminary study under "Agreement No. CE45/99, Extension of Existing Landfills and Identification of Potential Waste Disposal Sites, Final Strategic Environmental Assessment Report". It achieves a landfill capacity of 17Mm³, and infringes a minor part of the Tong To Shan Archaeological Site (TTSAS). The area of built heritage affected will only be limited to the secondary features of boulder paths and stone terraces. The main archaeological features will be untouched (see **Drawing No. 24315/01/101** for layout). The key parametric indicators of this option are outlined below in Table 2.1.

Table 2.1: Summary of Option 1

Waste receiving area	60 ha
Maximum fill level	+245 mPD
Site formation complexity	Cut volume 5.9 Mm³, Fill volume 2.3 Mm³
Landfill capacity	17.4 Mm³

2.4.2.2 Option 1a

Option 1a is similar to Option 1 except with the slight extension to the southern boundary and the increase in fill level to meet the target landfill capacity of 19Mm³. The design is achieved by raising the eastern part of the landfill extension by approximate 10m relative to the original design to reach a maximum level of +255mPD (see **Drawing No. 24315/01/102**). The maximum height of the adjacent Wo Keng Shan is about +297mPD. It is envisaged that the visual impact due to a 10m raise would be insignificant. The key parametric indicators of this option are outlined in Table 2.2.

Table 2.2: Summary of Option 1a

Waste receiving area	61 ha
Maximum fill level	+255 mPD
Site formation complexity	Cut volume 6.0 Mm³, Fill volume 2.2 Mm³
Landfill capacity	20.2 Mm³

2.4.2.3 Option 1b

Option 1b is derived based on Options 1 and 1a, with the same encroachment to TTSAS, to further increase the landfill capacity. The design is achieved by the slight extension to the south boundary and the increase in fill level to +300mPD (see **Drawing No. 24315/01/103)**. This roughly matches with the maximum elevation of +297mPD of the adjacent Wo Keng Shan. The key parametric indicators of this option are outlined in Table 2.3.

Table 2.3: Summary of Option 1b

Waste receiving area	61 ha
Maximum fill level	+300 mPD
Site formation complexity	Cut volume 6.0 Mm³, Fill volume 2.2 Mm³
Landfill capacity	25.2 Mm³

2.4.3 Broad Layout Option 2

2.4.3.1 Option 2

Option 2 avoids the encroachment on TTSAS and keeps the peak level the same as Option 1 (i.e. +245mPD). This will reduce the actual landfill capacity to 16.8Mm³ (see **Drawing No. 24315/01/104**). The key parametric indicators of this option are outlined in Table 2.4.

Table 2.4: Summary of Option 2

Waste receiving area	55 ha
Maximum fill level	+245 mPD
Site formation complexity	Cut volume 4.7 Mm³, Fill volume 2.0 Mm³
Landfill capacity	16.8 Mm³

2.4.3.2 Option 2a

Similar to Option 2, Option 2a also avoids the encroachment on TTSAS and again falls short of meeting the target capacity of 19Mm³. The design deviates from Option 2 by raising the eastern part of the landfill extension by approximate 10m to reach a maximum level of +255mPD (see **Drawing No. 24315/01/105**). The key parametric indicators of this option are outlined in Table 2.5.

Table 2.5: Summary of Option 2a

Waste receiving area	55 ha
Maximum fill level	+255 mPD
Site formation complexity	Cut volume 4.7 Mm³, Fill volume 2.0 Mm³
Landfill capacity	18.4 Mm³

2.4.4 Broad Layout Option 3

Archaeological survey conducted on the site has identified a number of large graves in the heart of the landfill extension. Option 3 is developed with extensive reinforced earth wall at the northern boundary to avoid the need for clearance of these existing large graves (**Drawing No. 24315/01/106**). The landfill capacity will however be reduced to only 11.1Mm³. The key parametric indicators of this option are outlined in Table 2.6.

Table 2.6: Summary of Option 3

Waste receiving area	50 ha
Maximum fill level	+245 mPD
Site formation complexity	Cut volume 3.7 Mm³, Fill volume 2.8 Mm³
Landfill capacity	11.1 Mm³

2.4.5 Broad Layout Option 4

Option 4 is developed with the northwestern and southeastern boundary extended to reach the ridgeline to maximize the landfill capacity. The northern boundary is also set back to minimize the impact to woodland as well as TTSAS (see **Drawing No. 24315/01/107**). The landfill capacity can achieve 21.4Mm³ while encroachment on the Lin Ma Hang catchment can be totally avoided. The key parametric indicators of this option are outlined in Table 2.7.

Table 2.7: Summary of Option 4

Waste receiving area	63 ha
Maximum fill level	+255 mPD
Site formation complexity	Cut volume 6.2 Mm³, Fill volume 2.2 Mm³
Landfill capacity	21.4 Mm³

2.4.6 Selection of Preferred Scenario

2.4.6.1 Evaluation Criteria

These options were evaluated / assessed in accordance with the following factors and main criteria :

- Waste management needs of 19Mm^3 void space for the NENT Landfill Extension;
- Engineering considerations including site formation complexity, constructability, drainage impact and maintenance;
- Environmental issues such as noise, air quality, ecology, landscape and visual, waste management, cultural heritage, water quality, etc.
- Social issues such as afteruse flexibility, cost of disposal, land resumption and graves clearance.

2.4.6.2 Waste Management Needs

Under the previous study "Agreement No. CE45/99, Extension of Existing Landfills and Identification of Potential Waste Disposal Sites, Final Strategic Environmental Assessment Report", the "Strategic Plan" for the development of NENT Landfill Extension required a void space (landfill capacity) of 19Mm^3 to be provided. Options 1, 2, 2a and 3 cannot achieve this target volume. Options 1a, 1b and 4 can achieve this target and are therefore preferred.

2.4.6.3 Engineering Considerations

The major engineering considerations relate to construction practicability, drainage impact to downstream rivers and requirements on operation and maintenance of the various facilities are discussed as follows:

Construction Practicability

The optimum engineering design of a landfill site is to maintain a balance in cut and fill material over the entire construction and operation periods. Importing or exporting construction material is not preferred. In this regard, all the four broad options including sub-options can achieve this requirement.

According to the recent ground investigation (GI) data, there is no particular geological constraint in the proposed landfill extension site. Site formation and retaining structures for all options are feasible to construct. All options will experience the same founding condition and reinforced fill slopes will be adopted for retaining structures taller than 10m.

Although Options 1, 1a, 1b, 2, 2a and 4 require the construction of reinforced earth wall, they do not affect the site formation planning and are therefore preferred. By contrast, Option 3 requires construction of a long reinforced earth wall at the north within a small site area, hence imposing great difficulties on the phasing and sequencing of the site formation works. Option 3 is therefore less preferable.

Drainage Impact to Downstream

All options affect the existing landform and may have impact to the adjacent drainage systems at both Lin Ma Hang Stream and Ping Yuen River.

According to the Drainage Impact Assessment (DIA) conducted for this Project, the diversion of catchment in some options will result in increased water level in Ping Yuen River and decreased water level in Lin Ma Hang Stream. In other words, the less the impact on stream and river, the more preferable the option.

Options 2, 2a, Option 3 and Option 4 that have no drainage impact to Lin Ma Hang Stream are therefore preferred. Option 1, 1a and 1b have drainage impact to both Lin Ma Hang Stream and Ping Yuen River and are therefore less preferable.

Operation and Maintenance

The operation and maintenance requirements for various facilities such as treatment facilities, drainage system, E&M equipment, water quality, leachate and landfill gas monitoring equipment, etc. are similar for all the 4 options.

Option 1, 1a and 1b are preferred as they have only a small section of reinforced earth wall, which requires less maintenance works. Options 2, 2a, 3 and 4 require more substantial maintenance works for the reinforced earth wall and the associated drainage system, and are therefore less preferable.

2.4.6.4 Environmental Issues

The major environmental considerations relate to water quality, ecology, archaeology and cultural heritage, landscape and visual etc. at various project phases are discussed as follows:

Water Quality Impact

Some of the landfill extension options may encroach to both Lin Ma Hang and Ping Yuen Catchments. There may be certain degree of influence of water flow/yield on Lin Ma Hang Stream and Ping Yuen River. In case of any accidental overflow from the treatment plant or accidental leakage through the liner, there might be short-term impact on the adjacent streams.

Options 2, 2a, 3 and 4 with no encroachment to Lin Ma Hang Catchment are therefore preferred whereas, Option 1, 1a and 1b with encroachment to both Lin Ma Hang Catchment and Ping Yuen Catchment are less preferable.

Ecological Impact

Some of the landfill extension options may cause minor ecological impacts to the Lin Ma Hang Stream due to reduction in water level and loss of woodland and shrubland. Option 1, 1a and 1b will cause minor ecological impacts to Lin Ma Hang Stream due to a 15mm drop in water level and are therefore less preferable. Options 2, 2a, 3 and 4 will have neither encroachment nor ecological impacts on Lin Ma Hang Stream, and are preferred options.
Woodland of over 1 ha is considered as an important habitat. Option 1, 1a and 1b will cause a significant loss of woodland of more than 5ha and are thus less preferable. For other options, the impact on loss of woodland, ranging from 2 to 4 ha, are considered to be moderate in term of ecological value. Compensatory woodland planting would be provided. These options are therefore preferred with mitigation measures being in place.

With consideration of a cumulative combination of ecological impacts (drop in water level and loss in woodland), Options 1, 1a, 1b and 4 are less preferable. Options 2, 2a and 3 are preferred.

Archaeological and heritage Impact

Some of the landfill extension options may encroach into TTSAS affecting secondary features such as boulder paths and boulder terraces. A total of 21 graves including 10 old graves will be affected and will need to be removed. In terms of impacts to graves, all options have the same grade as these can be mitigated by detailed preservation by record as agreed with AMO, LCSD.

Option 1, 1a and 1b will encroach into TTSAS by about 5 ha, affecting of 200m boulder paths and 2 numbers of boulder terraces. Nonetheless, these affected areas comprise mainly secondary features and can be mitigated by detailed preservation by record (as agreed with AMO). Therefore, these options are less preferable.

Options 2, 2a and 3 will have no impact to the TTSAS and are therefore preferred. Similarly, Option 4 affects only 30m of boulder path (secondary feature only) which can be mitigated by detailed preservation by record. The impact on Option 4 is therefore also minimal and this option is preferred.

Landscape and Visual Impact

Option 1a will have a total area of about 61 ha which encroaches into about 5.16 ha of woodland near the ridge of Wong Mau Hang Shan, Shui Ngau Tso and northeast of Wo Keng Shan. The final height of the landfill is about +255mPD.

Option 2a will have a total area of about 54 ha which encroaches into about 3.08 ha woodland near the ridge of Shui Ngau Tso and northeast of Wo Keng Shan. The final height of the landfill is about +255mPD.

Option 3 will have a total area of about 50 ha which encroaches into about 3.05 ha of woodland near Shui Ngau Tso and northeast of Wo Keng Shan. The final height of the landfill is about +245mPD which is similar to the adjacent Wong Mau Hang Shan.

Option 4 will have a total area of about 63 ha and encroach into about 3.7ha of woodland near the ridge of Shui Ngau Tso and northeast of Wo Keng Shan.

In fact, the visual impact to the adjacent areas for all options is similar with slight impact (also see Chapter 8).

Other environmental considerations

Other environmental considerations, including air, noise, waste, landfill gas, have been reviewed. The potential impacts for all options are similar in order and can all be mitigated by suitable mitigation measures.

2.4.6.5 Impact on Community

The major community considerations relate to flexibility for aftercare, unit cost per disposal, needs for land resumption and needs for graves clearance at various project phases are discussed as follows:

Flexibility for Afteruse

The proposed extension is expected to last for about 10 to 12 years. Options that can offer higher flexibility to the potential afteruse of the landfill are preferred.

Options 1, 1a, 1b and 4 will cover areas of 60 ha to 63ha in size. The gradients of the final landfill profile for these options are gentle and suitable for all type of afteruse activities. These options would not impose any restriction/limitation to the afteruse planning. They are the preferred options.

Option 2 and 2a will cover an area of 55 ha only. The gradient of the final landfill profile is gentle with slight variation. This option would not impose any restriction/limitation to the afteruse planning. However, this option has less planning flexibility in view of the smaller landfill area and is therefore less preferable.

Similarly, Option 3 has the smallest landfill area of only 50 ha with steep gradient at certain locations. The steep slope may inevitably impose additional constraints to the potential afteruse and the planning flexibility of other facilities such as bowling greens and multi-purposes grass pitches. This option is therefore also less preferable.

Unit Cost per Disposal

The unit cost per disposal is the capital cost divided by the actual landfill capacity, which is the cost required to produce a $1m^3$ landfill capacity. The higher the unit cost per disposal, the higher the chance of illegal dumping.

The anticipated unit cost per disposal (m^3) for Options 1, 1a, 1b, 2, 2a and 4 are of similar order, which is about half of that for Option 3. Based on the above cost estimation, Options 1, 1a, 1b, 2, 2a and 4 are "preferred"; while Option 3 is "less preferable".

Needs for Land Resumption

All Options will affect the same number of private lots. Nonetheless, Option 1, 1a and 1b affect a Government Hilltop Survey Tri-Station (GLA) and are therefore less preferable. Hence, Options 2, 2a, 3 and 4 are preferred.

Needs for Graves Clearance

According to recent survey, there are a large number of graves including some old graves lying within the extension site. All options affect almost the same number of graves including old graves except for Option 3 which affect a much smaller number of graves (9 to 10 graves less). Option 3 is therefore preferred. All other options are less preferable since a longer lead time would be required on liaison in the graves clearance process.

2.4.6.6 Overall

Amongst the three options in Broad Layout Option 1, Option 1a is the most preferred. Similarly, Option 2a is the most preferred option under Broad Layout Option 2. Accordingly, Option 1a and Option 2a were therefore directly compared with Option 3 and Option 4, so as to arrive at the most favourable layout for NENT Landfill Extension. A summary of the final round of layout options selection is tabulated below.

Table 2.8: Summary of reasons for option evaluation

Criteria	Option 1a	Option 2a	Option 3	Option 4
(A) Waste Management Needs	20.2 Mm^3 - achieving the target requirement of 19Mm^3. (Preferred)	18.4 Mm^3 - marginally falls short of meeting target requirement of 19Mm^3. (Less Preferred)	11.1 Mm^3 - falls short of meeting target requirement of 19Mm^3. (Less Preferred)	21.4 Mm^3 - achieving the target requirement of 19Mm^3. (Preferred)
(B) Engineering				
Construction Practicability	No imported fill material is required for the site formation works; Require short (100m) reinforced earth wall with max. height of 15m. (Preferred)	No imported fill material is required for the site formation works; Require relatively long (400m) reinforced earth wall with max. height of 25m. (Preferred)	No imported fill material is required for the site formation works; Require relatively long reinforced earth wall (with max. height of 25m) in a relatively small site and impose difficulties in site formation phasing. (Less Preferred)	No imported fill material is required for the site formation works; Require relatively long reinforced earth wall (with max. height of 25m) but will not impose difficulties in site formation phasing. (Preferred)
Drainage Impact to Downstream	Impact to both Lin Ma Hang Stream and Ping Yuen River. (Less Preferred)	Impact to Ping Yuen River (no impact on Lin Ma Hang). (Preferred)	Impact to Ping Yuen River (no impact on Lin Ma Hang). (Preferred)	Impact to Ping Yuen River (no impact on Lin Ma Hang). (Preferred)
Operation and Maintenance	Require maintenance of a short reinforced earth wall and associated drainage system (100m). (Preferred)	Require maintenance of a relatively long reinforced earth wall and associated drainage system (400m). (Less Preferred)	Require maintenance of a relatively long reinforced earth wall and associated drainage system (510m). (Less Preferred)	Require maintenance of a relatively long reinforced earth wall and associated drainage system (590m). (Less Preferred)
(C) Environmental				
Water Quality Impact	Impact to both Lin Ma Hang Stream and Ping Yuen River (Less Preferred)	Impact to Ping Yuen River (no impact on Lin Ma Hang) (Preferred)	Impact to Ping Yuen River (no impact on Lin Ma Hang) (Preferred)	Impact to Ping Yuen River (no impact on Lin Ma Hang) (Preferred)

Criteria	Option 1a	Option 2a	Option 3	Option 4
Ecology Impacts	Minor impact to the Lin Ma Hang Stream & its catchment; Relatively large scale of woodland loss (5.16ha); No impact to Lin Ma Hang Lead Mines; Minor impact to the Robin's Nest countryside; (Less Preferred)	No impact to the Lin Ma Hang Stream & its catchment; Small scale of woodland loss (3.08ha) No impact to Lin Ma Hang Lead Mines; Minor impact to the Robin's Nest countryside; (Preferred)	No impact to the Lin Ma Hang Stream & its catchment; Small scale of woodland loss (3.05ha) No impact to Lin Ma Hang Lead Mines; Minor impact to the Robin's Nest countryside; (Preferred)	No impact to the Lin Ma Hang Stream & its catchment; Medium scale of woodland loss (4.01ha) No impact to Lin Ma Hang Lead Mines; Minor impact to the Robin's Nest countryside; (Less Preferred)
Archaeological and Heritage Impact	Encroach into small (non-core) portion of TTSAS (5ha). Affect 21 graves including 10 old graves (no impact on cultural heritage value). (Less Preferred)	No impact to TTSAS. Affect 20 graves including 9 old graves (no impact on cultural heritage value). (Preferred)	No impact to TTSAS. Affect only 9 graves and avoid all old graves (no impact on cultural heritage value). (Preferred)	Encroach into very small (non-core) portion of TTSAS (2ha). Affect 20 graves including 9 old graves (no impact on cultural heritage value). (Preferred)
Landscape & Visual	Total landfill area is 61ha; final fill level at +255mPD. (Insignificant landscape & visual impact)	Total landfill area is 55ha; final fill level at +255mPD. (Insignificant landscape & visual impact)	Total landfill area is 50ha; final fill level at +245mPD. (Insignificant landscape & visual impact)	Total landfill area is 63ha; final fill level at +255mPD. (Insignificant landscape & visual impact)
Other Environmental Considerations, such as air, noise, landfill gas, waste	Neutral to various options – minor impact which can be mitigated by suitable mitigation measures. (similar impact to other options)	Neutral to various options – minor impact which can be mitigated by suitable mitigation measures. (similar impact to other options)	Neutral to various options – minor impact which can be mitigated by suitable mitigation measures. (similar impact to other options)	Neutral to various options – minor impact which can be mitigated by suitable mitigation measures. (similar impact to other options)
(D) Impact on Community				
Flexibility for afteruse	Largest landfill area (61ha) with gentle slopes/ gradient – good for all kinds of afteruse. (Preferred)	Smaller landfill area (55ha) with gentle slopes/gradient, but vary in landfill profile and hence less planning flexibility. (Less Preferred)	Smallest landfill area (50ha) with steep slope and extensive earth wall. Hence, impose constraints to the potential afteruses. (Less Preferred)	Highest landfill area (63ha) with gentle slopes/ gradient – good for all kinds of afteruse. (Preferred)
Unit Cost per Disposal	Comparable with other options except Option 3. (Preferred)	Comparable with other options except Option 3. (Preferred)	Higher disposal cost leading to higher chance of illegal dumping. (Less Preferred)	Comparable with other options except Option 3. (Preferred)
Need for Land Resumption	Affect private lands and survey station (Less Preferred)	Affect only private lands (no impact on survey station) (Preferred)	Affect only private lands (no impact on survey station) (Preferred)	Affect only private lands (no impact on survey station) (Preferred)
Need for Graves Clearance	Affect 21 graves including 10 old graves (no impact on cultural heritage value) (Less Preferred)	Affect 20 graves including 9 old graves (no impact on cultural heritage value) (Less Preferred)	Affect 9 graves and aovid all old graves (no impact on cultural heritage value) (Preferred)	Affect 20 graves including 9 old graves (no impact on cultural heritage value) (Less Preferred)

As Option 4 was evaluated as a preferred option for the largest number of aspects, it was selected as the overall most preferred option. See Drawing No. 24315/01/107 for the layout of Option 4.

2.4.7 Alternative Construction Methods and Sequences of Works

Different construction methodology and sequences of works were studied, giving careful consideration on environmental impacts including noise, ecology, archaeology, etc.

It is recommended to adopt a balanced cut-and-fill site formation for constructing the landfill bowl within the existing valley.

The NENT Landfill Extension will be developed in three phases to allow progressive use of the overall landfill area. Each phase will be constructed, operated and restored at a rate dependent on the delivery of waste. Simultaneous construction, operation and capping activities will therefore occur in different parts of the site.

During the construction stage, mobilisation & preparation / establishment will be carried out by the DBO Contractor. A balance between cut-and-fill quantities will be adopted to optimise the reuse of excavated materials, i.e. to minimise import or export of materials. The process involves temporarily stockpiling of excavated materials on site for use as daily cover during the operation phase and final capping during the restoration phase. This will reduce construction materials / waste to be delivered to public fill bank. Where necessary (to be triggered by EM&A programme), daily cover and temporary cover will be provided to reduce potential impact on air and water qualities during the operation phase of the Project.

Alternative construction methods such as blasting have also been evaluated but found to be not desirable from an engineering perspective. The balancing of cut-and-fill limits the usable area of the landfill site and therefore the amount of stockpiled materials. Blasting will generate a significantly larger volume of excavated and stockpiled materials, and the usable area of the landfill site will be much reduced. There is also a safety concern if blasting is conducted in close proximity to the tipping area, as refuse collection vehicles and operators might be at risk if the buffer distance provided is not sufficient.

2.5 Site Location and Site History

2.5.1 Site Location

The landfill extension site of the selected layout is approximately 70 ha in size and located in a valley to the south of the existing NENT Landfill. The valley is encircled by three ridgelines and exits to the southwest through a small gorge, at approximately +50mPD.

On its south-eastern side, the site is enclosed by a major ridgeline, which runs from Wo Keng Shan (+297mPD) to Robins Nest (+492mPD). A smaller ridge intersects this main ridgeline and forms the northern flank of the Project area. This ridge overlooks To Tong Shan Settlement District and Lin Ma Hang Village. It reaches an elevation of +205mPD at its western end, just beyond the boundary between the existing NENT Landfill and the extension site. Two saddles, with minimum elevations of approximately +120mPD, are located about half way along this smaller ridge.

The ridge separating the site from the existing NENT Landfill forms the north-western boundary of the Project area. This ridge runs from an elevation of +205mPD at its northern end to a level of +65mPD at the point where it intersects the existing haul road in the south-western corner of the site (**Drawing No. 24315/01/001**).

The slopes overlooking the main valley of the site are sparsely vegetated with a cover of grass and shrubland. Occasional groups of pine trees and localised dense vegetation are also found along stream courses.

2.5.2 Site History

The proposed extension is mainly covered by the existing NENT Landfill Stockpile and Borrow Area that was formed to the east of the existing landfill as part of the original landfill development. The aerial photographs of the site reveals that several large cut slopes, many of which have been subsequently covered with stockpiled material, and a haul road (Shek Tsai Ha Road) have been formed within. The stockpile area is mostly located within the eastern portion of the site and is bound by concrete drainage channels. Other than the haul road and scattered gravesites, the remaining site area comprises natural terrain that has seen little interference from human activity.

2.6 Nature, Scope and Benefits of the Project

2.6.1 Nature of the Project

The nature of the Project is to develop a landfill extension for waste as defined in the Waste Disposal Ordinance (Cap. 354).

2.6.2 Scope of the Project

The scope of the Project is to provide a landfill extension of about 70 hectares with a target void space of at least 19 million cubic metres on the eastern side of the existing NENT Landfill. On top of site formation and preparation works; there will be provision of installation of liner system; leachate collection, treatment and disposal; gas collection and management; utilities provisions; drainage diversion; restoration and aftercare. Environmental mitigation measures, monitoring and auditing are provided.

2.6.3 Benefits of the Project

The development of NENT Landfill Extension ensures the continued provision of final disposal site for solid waste after the three existing landfills are full by 2015.

It also avoids illegal dumping of construction waste and municipal waste that may cause serious environmental problems.

With waste-to-energy facility (such as Landfill Gas Export Scheme), landfill gas can be converted to reusable energy that brings benefits to the community.

The Project site is equipped with waste handling facilities at NENT Landfill, waste recycling factories in the nearby area, sewage treatment facility at Shek Wu Hui Sewage Treatment Works, and a landfill gas waste-to-energy facility nearby. The availability of these existing supporting facilities can shorten the lead time and land resumption requirement for a new landfill development in a green field site.

Substantial saving in cost can also be achieved by pooling together the existing NENT Landfill infrastructure and facilities by carrying out suitable conversion works under suitable contractual arrangement.

There are some small-scale waste recycling factories around the existing NENT Landfill, skilful workers and special equipments have been allocated in the region. Therefore, there will be social and economic benefit of the Project, if these workers and equipments can be tied in with the NENT Landfill Extension (e.g. sustainable for local employment).

2.7 Size, Scale, Shape and Design of the Project

The landfill extension site is a bowl-shape area with a large void space in the middle for waste filling. The northwestern and southeastern boundaries of the landfill extension site follow the ridgelines to maximize the landfill capacity. Some set back of the northern boundary is included to minimize the impact to woodland and Lin Ma Hang Catchment. The total site area is about 70 ha and the final height of the landfill would be +255mPD (see **Drawing No. 24315/01/107**).

The key design features are listed as follows and summarised in Table 2.10:

- Bottom liner system - to separate rubbish and leachate from groundwater;
- Landfill cells – to store waste within the unit;
- Storm water drainage system - to collect rain water run off on the landfill;
- Leachate collection system - to collect liquid leaching from the waste mass and convey it to a leachate treatment plant prior to discharging to Shek Wu Hui Sewage Treatment Works;
- Gas collection system - to collect gases formed during the decompositon of waste. These gases will be treated and utilised for production of electricity on site.
- Covering and capping - to seal off the top of the landfill with a gas venting layer, an impermeable mineral layer, a drainage layer of at least 0.5 metre and at least one metre of top soil.

Table 2.10: Summary of key design elements

Total size	63 ha
Final height	+255 mPD
Shape	Bowl shape at the existing NENT Landfill Stockpile and Borrow Area
Site formation complexity	Cut volume 6.2 Mm^3, Fill volume 2.2 Mm^3
Actual waste capacity	21.4 Mm^3
Key elements of design	• Site formation and preparation • Installation of liner system • Installation of leachate collection, treatment and disposal facilities • Installation of gas collection, utilization and management facilities • Utilities provisions and drainage diversion

Various activities during construction, operation, restoration and aftercare of landfill are discussed in the following sub-sections.

2.7.1 Construction Phase and Activities

Simple excavation and slope formation works will be carried out during the construction stage. The permanent works comprise cut and fill earthworks, slope formation and earth wall construction. The temporary works will involve the formation of temporary ditches along the sides of the excavations and associated drainage works, and material storage areas.

During site formation, sediment will be contained in permanent detention ponds/silt traps that will be constructed according to landfill phasing. Final design and location of sediment traps are yet to be decided, but are likely to be down gradient of each landfill phase or in the downstream valleys near the existing waste reception area. Where possible they will be maintained during the operation of each phase to ensure the effective control of operational soil erosion problem.

2.7.2 Operation Phase and Activities

During operation, waste will be disposed of at individual landfill cells. Deposited waste will be compacted to thin layers. The works will be maintained at a gradient of not greater than 1 in 3 to ensure the effectiveness of the compaction equipment. Daily cover (about 150mm if soil cover used) will be applied to control environmental nuisances such as windblown litter, odour, vermin, flies and birds.

There are other more effective alternative biodegradable materials for use as daily cover. They include:

- heavy duty reusable and biodegradable sheets;
- non reusable plastic films;
- geotextiles; and
- foams and sprays.

Advantages of using alternative daily cover over traditional methods include preservation of landfill capacity and soil material; biodegradable and less permeable to water and gas (reduce water infiltration, odour and dust emission).

2.7.3 Restoration Phase and Activities

Restoration is a process to restore a landfill site to a condition suitable for afteruse.

After completion of waste filling, final capping will be applied to minimise infiltration of rainwater into the waste body thus reducing the amount of leachate generated. The capping system normally includes a number of components including topsoil, subsoil, drainage layer and barrier layer.

2.7.4 Aftercare Phase and Activities

Aftercare is the work done after the replacement of the soil and includes cultivations, fertilisation, planting, construction of pathways, access points, vegetation maintenance and monitoring.

Landscaped berms will be created and tree planting will be provided during the aftercare period for aesthetic purpose.

2.8 Project Timetable

The Landfill Extension will start receiving waste only when the existing NENT Landfill has ceased operation. The timing of this has yet to be determined as it depends on the rate of waste deliveries in the forthcoming period. Based on current prediction, the Existing Landfill will probably run out by early-to-mid next decade, by which time the Landfill Extension shall start operation.

Taking account of the time needed for mobilization and preparatory works prior to commencement of receipt of waste, it may be necessary to award the Landfill Extension contract towards the end of this decade, in order to ensure that new landfill space will be available before the capacity of the existing landfill runs out.

It is anticipated that the DBO (Design-Build-Operate) contract form, which has hitherto worked well for the existing waste management contracts (notably the three strategic landfill contracts and the refuse transfer station contracts), will be adopted for NENT Landfill Extension. Detailed design and formulation of technical details for the construction, operation, restoration and aftercare of the NENT Landfill Extension will be carried out by the DBO Contractor, in accordance with requirements stipulated in the Specification and other documents of the DBO Contract.

Even though there will not be any overlapping in operation between the Landfill Extension and the Existing Landfill, the two contracts will still overlap. Clearly the initial development (notably the initial site formation) for the NENT Landfill Extension will overlap and hence interface with the final operational period of the Existing NENT Landfill as well as part of its restoration & aftercare, whereas the early operation period of the NENT Landfill Extension plus continuation of its development works will overlap/interface with the remaining restoration of the Existing Landfill and the main part of its aftercare.

A tentative outline programme for implementation of the NENT Landfill Extension is shown in **Appendix 2.2**. As pointed out above, the exact timing of the various activities may vary, depending on actual volume of waste to be delivered in the forthcoming years.

2.9 Related Projects

The existing NENT Landfill would be the only related project for the purpose of this study.

2.10 "No Project" Scenario

The current site mainly located within the borrow area of the existing NENT Landfill. Based on the site inspection, some of the nearby areas are used for waste recycling activities. Under the "no project" scenario, the site will be operated as a restored landfill for 30 aftercare period. During this period, raw leachate will still be generated and collected to the open lagoons. Landfill gas will also generate during this period. Part of the LFG will be extracted for leachate treatment in the Ammonia Stripping Plant. Restoration planting will be carried out in phase after the final capping. Maintenance vehicle will be visiting the site for periodic inspection and maintenance. Subject to the detailed design for restoration, the area might be used for recreational use in the medium-term future after the soil is settled and stabilised.