8 WASTE MANAGEMENT

8.1 INTRODUCTION

This Section presents an assessment of the potential environmental impacts from the generation, handling, storage, collection and disposal of wastes arising during the construction and operation of the proposed power station at the Lamma Extension. Options for waste minimisation, recycling, storage, collection and disposal of waste have been examined, and measures for minimising the environmental impacts due to waste handling and disposal of wastes are recommended.

8.2 LEGISLATION AND STANDARDS

8.2.1 *Introduction*

The criteria for evaluating potential waste management implications are laid out in *Annex 7* of the *Technical Memorandum on Environmental Impact Assessment Process (EIAOTM)* under the *EIAO* (Cap. 499).

The following legislation either covers or has some bearing upon the handling, treatment and disposal of wastes in the Hong Kong Special Administration Region (SAR), and will also be considered in the assessment:

- *Waste Disposal Ordinance* (Cap 354);
- *Waste Disposal (Chemical Waste) (General) Regulation* (Cap 354);
- *Crown Land Ordinance* (Cap 28);
- *Public Health and Municipal Services Ordinance* (Cap 132)
  - *Public Cleansing and Prevention of Nuisances (Urban Council) and (Regional Council) By-laws*; and
- *Dumping at Sea Ordinance (1995).*

8.2.2 *Waste Disposal Ordinance*

The *Waste Disposal Ordinance* (WDO) prohibits the unauthorised disposal of wastes, with waste defined as any substance or article which is abandoned. Construction and demolition (C&D) waste is not directly defined in the WDO but is considered to fall within the category of "trade waste". Trade waste is defined as waste from any trade, manufacturer or business, or any waste building, or civil engineering materials, but does not include animal waste.

Under the WDO, wastes can only be disposed of at a licensed site. A breach of these regulations can lead to the imposition of a fine and/or prison sentence. The WDO also provides for the issuing of licences for the collection and transport of wastes. Licences are not, however, currently required to be issued for the collection and transport of C&D waste or trade waste.

8.2.3 *Waste Disposal (Chemical) (General) Waste Regulation*

Chemical waste as defined under the *Waste Disposal (Chemical Waste) (General) Regulation* includes any substance being scrap material, or unwanted substances specified under *Schedule 1* of the *Regulation* if such substance or chemical occurs in such a form, quantity or concentration so as to cause pollution or constitute a danger to health or risk of pollution to the environment.

A person should not produce, or cause to be produced, chemical wastes unless he is registered with the EPD. Any person who contravenes this requirement commits an offence and is liable, upon conviction for a first offence, to a fine of up to HK$200,000 and to imprisonment for up to 6 months.

Producers of chemical wastes must treat their wastes, utilising on-site plant licensed by the EPD, or have a licensed collector take the wastes to a licensed facility. For each consignment of wastes, the waste producer, collector and disposer of the wastes must sign all relevant parts of a computerised trip ticket. This system is designed to allow the transfer of wastes to be traced from cradle to grave.

The *Regulation* prescribes the storage facilities to be provided on site, including labelling and warning signs. To minimise the risks of pollution and danger to human health or life, the waste producer is required to prepare and make available written procedures to be observed in the case of emergencies due to spillage, leakage or accidents arising from the storage of chemical wastes. He must also provide employees with training in such procedures.

8.2.4 *Crown Land Ordinance*

Construction and demolition materials which are wholly inert may be taken to public filling areas. Public filling areas usually form part of land reclamation schemes and are operated by the Civil Engineering Department (CED). The *Crown Land Ordinance* requires that public filling licences are obtained by individuals or companies who deliver inert C&D material (or public fill) to public filling areas. The licences are issued by the CED under delegated powers from the Director of Lands.

Individual licences and windscreen stickers are issued for each vehicle involved. Under the licence conditions public filling areas will accept only inert building debris, soil, rock and broken concrete. There is no size limitation on the rock and broken concrete, and a small amount of timber mixed with other suitable materials is permissible. The material should, however, be free from marine mud, household refuse, plastic, metal, industrial and chemical wastes, animal and vegetable matter and any other materials considered unsuitable by the public filling supervisor.

8.2.5 *Public Cleansing and Prevention of Nuisances by-Laws*

These by-laws provide a further control on the illegal tipping of wastes on unauthorised (unlicensed) sites. The illegal dumping of wastes can lead to fines of up to HK$10,000 and imprisonment for up to 6 months.

8.2.6 *Dumping At Sea Ordinance*

Marine disposal of dredged materials is controlled under the *Dumping at Sea Ordinance* 1995, which has recently replaced the *Dumping at Sea Act 1974*

(Overseas Territories) Order 1975 (App III, p DK1) in its application to Hong Kong SAR.

The *Dumping at Sea Ordinance* stipulates requirements for permits for dumping at sea as well as designating areas within Hong Kong waters as a marine dumping area. A person convicted of dumping without the required permits is liable to a fine of HK$200,000 and to imprisonment for 6 months. Current practice is that dredged materials may be dumped at designated marine dumping sites.

8.2.7 *Additional Guidelines*

Other 'guideline' documents which detail how the contractor should comply with the regulations are as follows:

- *Waste Disposal Plan for Hong Kong (December 1989)*, Planning, Environment and Lands Branch Government Secretariat;
- *Environmental Guidelines for Planning In Hong Kong (1990)*, Hong Kong Planning and Standards Guidelines, Hong Kong Government;
- *New Disposal Arrangements for Construction Waste (1992)*, Environmental Protection Department & Civil Engineering Department;
- *Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes (1992)*, Environmental Protection Department;
- *Works Branch Technical Circular No. 2/93, Public Dumps*, Works Branch, Hong Kong Government;
- *Works Branch Technical Circular No. 16/96, Wet Soil in Public Dumps;*
- *Works Branch Technical Circular No. 6/92, Fill Management;*
- *Works Branch Technical Circular 22/92;* and
- *Technical Circular No. 1-1-92: Classification of Dredged Sediments for Marine Disposal*, Environmental Protection Department.

8.2.8 *Criteria for Classification of Marine Sediment Quality*

Dredged material is classified according to the level of contamination under the EPD *Technical Circular No. 1-1-92*. Dredged sediments destined for marine disposal are classified according to their level of contamination by seven toxic metals, namely cadmium (Cd), chromium (Cr), copper (Cu), mercury (Hg), nickel (Ni), lead (Pb) and zinc (Zn). The classifications are as follows:

- ***Class A:*** Uncontaminated material, for which no special dredging, transport or disposal methods are required beyond those which would normally be applied for the purpose of ensuring compliance with EPD's Water Quality Objectives (WQOs), or for protection of sensitive receptors near the dredging or disposal areas.
- ***Class B:*** Moderately contaminated material, which requires special care during dredging and transport, and which must be disposed of in a manner which minimises the loss of pollutants either into solution or by re-suspension.

- *Class C:* Seriously contaminated material, which must be dredged and transported with great care, which cannot be dumped in the gazetted marine disposal grounds, and which must be effectively isolated from the environment upon final disposal.

EPD's criteria for the classification of dredged sediments destined for marine disposal are given in *Table 8.2a*. Permits from the EPD are required for marine disposal of such materials.

Table 8.2a *Classification of Sediments by Metal Content (mg kg^{-1} dry weight)*

	Cd	Cr	Cu	Hg	Ni	Pb	Zn
Class A	0.0-0.9	0-49	0-54	0.0-0.7	0-34	0-64	0-149
Class B	1.0-1.4	50-79	55-64	0.8-0.9	35-39	65-74	150-199
Class C	1.5 or more	80 or more	65 or more	1.0 or more	40 or more	75 or more	200 or more

It should be noted that sediments which exceed the Class C level for any of the seven heavy metals are categorised as Class C. Conversely, to be classified as suitable for unconfined open water disposal, sediments must be below the Class C for all seven heavy metals. The final classification decision and selection of appropriate disposal options, routing and the allocation of a permit to dispose at the designated disposal site are made by EPD, in consultation with the Fill Management Committee (FMC) in accordance with WBTCs 6/92 and 22/92.

In addition, in accordance with *Works Branch Technical Circulars Nos 6/92* and *22/92* and Building Ordinance Office *Practice Note for Authorized Persons and Registered Structural Engineers No 155*, any proposal to remove more than 500,000 m^3 of clean mud or any quantity of contaminated mud must be justified on both cost and environmental grounds and the rationale for such removal should be provided to enable an allocation for disposal to be considered. It is desirable therefore to demonstrate that the proposed mud dredging is the minimum necessary, and to obtain in principle agreement from the GEO at the early stage.

A new set of regulatory guidelines for contaminated sediments will be promulgated by EPD and CED in 1998 and these will include a new set of sediment quality criteria which may include organic pollutants and other toxic substances, as well as a new class of contamination for highly contaminated sediment which is not suitable for marine disposal. However, the existing EPD Circular will be used for this study.

8.3 CONSTRUCTION WASTE

8.3.1 Construction Activities

The construction of the gas-fired power station will involve the following construction works:

- dredging and disposal of marine sediment;
- permanent (both vertical and sloping) seawall construction;
- reclamation/bulk filling;
- building foundations;

- construction of buildings; and
- installation and erection of electrical and mechanical equipment.

8.3.2 *Potential Sources of Impact*

Construction activities will result in the generation of a variety of wastes which can be divided into distinct categories based on their constituents, as follows:

- dredged material;
- excavated material;
- construction and demolition waste;
- chemical waste; and
- general refuse.

The nature and quantity of each of these waste types arising from the construction of the power station are identified below.

Dredged Material

Dredged material will be generated where soft marine sediment needs to be removed and replaced with suitable engineering fill. The quality of the sediment at the reclamation area has been determined in the sediment sampling and testing programme, and results are presented in the *Sediment Quality Report* (see *Annex B8-1*).

The proposed reclamation for the Lamma Extension site will be 500 m wide and 400 m in length, covering an area of approximately 20 ha. Two types of perimeter (sloping and vertical) seawalls will be constructed, depending on their exposure to wave action and the berthing requirements. Sloping seawall will be constructed using rubble rockfill and vertical seawall will be formed by large precast concrete blocks. An engineering study[1] has been conducted to examine various options for the construction of seawall and reclamation, which are summarised in *Table 8.3a*.

[1] *Lamma Power Station Extension - Working Paper on Seawall and Platform Options (0315/REP/002/Draft B)*, Binnie Black & Veatch HK Limited, September 1998

Table 8.3a ***Platform and Seawall Formation Options***

Option	Description	Volume of Sediment to be Dredged
Option 1: All the soft marine mud underneath the seawalls and platform would be improved to the required engineering properties so that no removal is necessary and both the seawalls and platform would be founded on improved soft marine mud	*Alternative 1A:* Deep Cement Mixing (DCM) of all marine mud	Nil
	Alternative 1B: DCM of the soft marine mud underneath the seawalls and pre-compression of the soft marine mud underneath the platform	Nil
	Alternative 1C: Use of stone columns to strengthen all of the soft marine mud	Nil
	Alternative 1D: Use of stone columns to strength the soft marine mud underneath the seawalls and pre-compression of the soft marine mud underneath the platform	Nil
Option 2: Soft marine mud underneath the seawall would be removed so that the seawalls would be founded on the alluvium. The soft marine mud underneath the platform would be improved to the required engineering properties so that no removal would be necessary and the platform would be founded on improved soft marine mud	*Alternative 2A:* Dredging along the seawalls only and DCM of the soft marine mud underneath the platform	2.81 Mm^3
	Alternative 2B: Dredging along the seawalls only and use of stone columns to strength the soft marine mud underneath the platform	3.59 Mm^3
	Alternative 2C: Dredging along the seawalls only and pre-compression of the soft marine mud underneath the platform	3.59 Mm^3
Option 3: Marine mud along the seawalls, underneath the connection platform and the northern half of the main platform would be dredged. Marine mud beneath the southern half of the main platform which will not be developed in the initial phase would be left in place. Ground improvement works would be carried out for the undredged area.		5.21 Mm^3
Option 4: All of the marine mud for construction of the seawalls and platform would be dredged.		6.09 Mm^3

Although the preferred engineering option is to remove all the soft mud underneath the whole reclamation area (Option 4), it is not the preferred environmental option. To balance the engineering objectives with environmental objectives, the partial dredging method has been recommended (Option 3)[2].

[2] For details of the engineering evaluation, please refer to *Lamma Power Station Extension - Working Paper on Seawall and Platform Options (0315/REP/002/Draft B)*, Binnie Black & Veatch HK Limited, September 1998.

This option will involve limited dredging of the marine mud along the seawall, and underneath the connection platform and the northern half of the main platform. The marine mud beneath the southern half of the main platform will be left in place. The ground conditions of the undredged area will be improved by pre-consolidation. It is estimated that approximately 5.21 Mm^3 of marine sediment will need to be dredged. Dredging work is expected to take place between December 1999 to July 2000. The amount of fill required for the reclamation is about 8.7 Mm^3.

Excavated Material

Excavated material is defined as inert virgin material removed from the ground and sub-surface. The types of foundation for the power plant equipment and buildings will depend on the intensity of loads, the bearing capacity of the subsoil and the tolerance of the installations on differential settlement. There will be pile foundation and shallow foundation (such as raft or pad footing). Shallow foundations are small in scale and will not require significant excavation. The amount of excavated material arising from the construction of shallow foundation works will therefore be minimal.

A combination of bored piles and driven steel piles will be constructed to support the power plant equipment and building. Minimal excavation will be required for the construction of steel piles. Detailed design information on the bored pile foundation is not available at this stage, however, it is expected that the amount of excavated material arisings will not be significant.

Construction and Demolition Waste

The principle buildings to be constructed will include:

- main station buildings;
- chimneys;
- switching station;
- cooling water intake and culvert; and
- administration and control buildings.

The superstructure of the building works will be formed either by structural steel or concrete or a composite of steel and concrete.

Surplus construction material will comprise unwanted materials generated during construction, including rejected structures and materials, materials which have been over ordered or are surplus to requirements and materials which have been used and discarded. Surplus construction material will arise from a number of construction and maintenance activities and may include:

- wood from formwork and falsework;
- equipment and vehicle maintenance parts;
- materials and equipment wrappings;
- unusable/surplus concrete/grouting mixes; and
- damaged/contaminated construction materials.

The quantity of C&D material to be generated from the construction of the gas-fired power station will depend on the operating procedure and construction site practices, and cannot be determined at this stage. However, with respect to the nature of construction activities and the types of superstructure, it is anticipated

that the quantity will be small. C&D material contains a mixture of inert and non-inert material. The inert portion is "public fill" and the non-inert portion is the C&D waste.

The disposal of bentonite slurry generated during construction works should follow the requirements of *ProPECC Note 1/94: Construction Site Drainage.*

To conserve the capacities of landfill sites, C&D waste with more than 20% (by volume) inert material should not be disposed of at landfills. It is therefore good practice to segregate inert and non-inert materials at the construction sites before disposing of the inert material (or public fill) at public filling areas or other reclamation areas and the degradable waste (C&D waste) at landfills. It should be emphasised that the sorting of C&D materials into public fill and C&D waste should be done on-site as far as possible before disposal.

Chemical Waste

Chemical waste, as defined under the *Waste Disposal (Chemical Waste)(General) Regulation,* includes any substance being scrap material, or unwanted substances specified under *Schedule 1* of the *Regulation.* A complete list of such substances is provided under the *Regulation,* however substances likely to be generated by construction activities for the gas-fired power station will, for the most part, arise from the maintenance of construction plant and equipment. These may include, but need not be limited to the following:

- scrap batteries or spent acid/alkali from their maintenance;
- used engine oils, hydraulic fluids and waste fuel;
- spent mineral oils/cleaning fluids from mechanical machinery; and
- spent solvents/solutions, some of which may be halogenated, from equipment cleaning activities.

Chemical wastes may pose serious environmental and health and safety hazards if not stored and disposed of in an appropriate manner as outlined in the *Waste Disposal (Chemical Waste) (General) Regulation* and the Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes. These hazards include:

- toxic effects to workers;
- adverse effects on air, water and land from spills;
- fire hazards; and
- disruption to sewage treatment works due to damage to the sewage biological treatment systems if waste is allowed to enter the sewerage system.

It is difficult to quantify the amount of chemical waste which will arise from the construction activities as it will be highly dependent on the Contractor's on-site maintenance practices and the numbers of plant and vehicles utilised. However, it is anticipated that the quantity of chemical waste, such as lubricating oil and solvent produced from plant maintenance, will be small and in the order of a few hundred litres per month.

General Refuse

The presence of a construction site with large numbers of workers and site offices and canteens will result in general refuse requiring disposal. This will mainly consist of food wastes, aluminum cans and waste paper.

The storage of general refuse has the potential to give rise to adverse environmental impacts. These include odour if the waste is not collected frequently (eg daily), windblown litter, water quality impacts if waste enters water bodies, and visual impact. The sites may also attract pests, vermin, and other disease vectors if the waste storage areas are not well maintained and cleaned regularly. In addition, disposal of wastes at sites other than approved landfills can also lead to similar adverse impacts at those sites.

It is expected that about 1,000 workers could be working on-site during the peak construction period (2001 to 2002). Based on a waste generation rate of about 0.6 kg per person per day, it is estimated that the amount of general refuse to be generated daily will be in the order of 600 kg.

8.3.3 *Evaluation of Impacts*

The nature of wastes arising from the construction of the power station and the potential environmental impacts which may arise from their handling, storage, transport and disposal are discussed below for each waste type.

The assessment of potential environmental impacts associated with waste management is based on following factors:

- type of waste generated;
- amount of principal waste types generated; and
- proposed recycling, storage, transport and disposal methods, and the impacts of these methods.

Dredged Materials

The characteristics of marine sediments within the proposed dredging boundaries have been determined as part of the EIA Study and reported in the *Sediment Quality Report* (see *Annex B8-1*) In accordance with EPDTC No 1-192, a sediment testing programme was undertaken at 16 vibrocore stations to determine the quality of the marine sediments. Results indicated that samples obtained from all 16 stations and at all depths are classified as Class A. *Figure 8.3a* shows the sampling locations and *Table 8.3b* summarises the strata depths and thicknesses at the sampling locations.

Table 8.3b ***Summary of Strata Depths and Thickness***

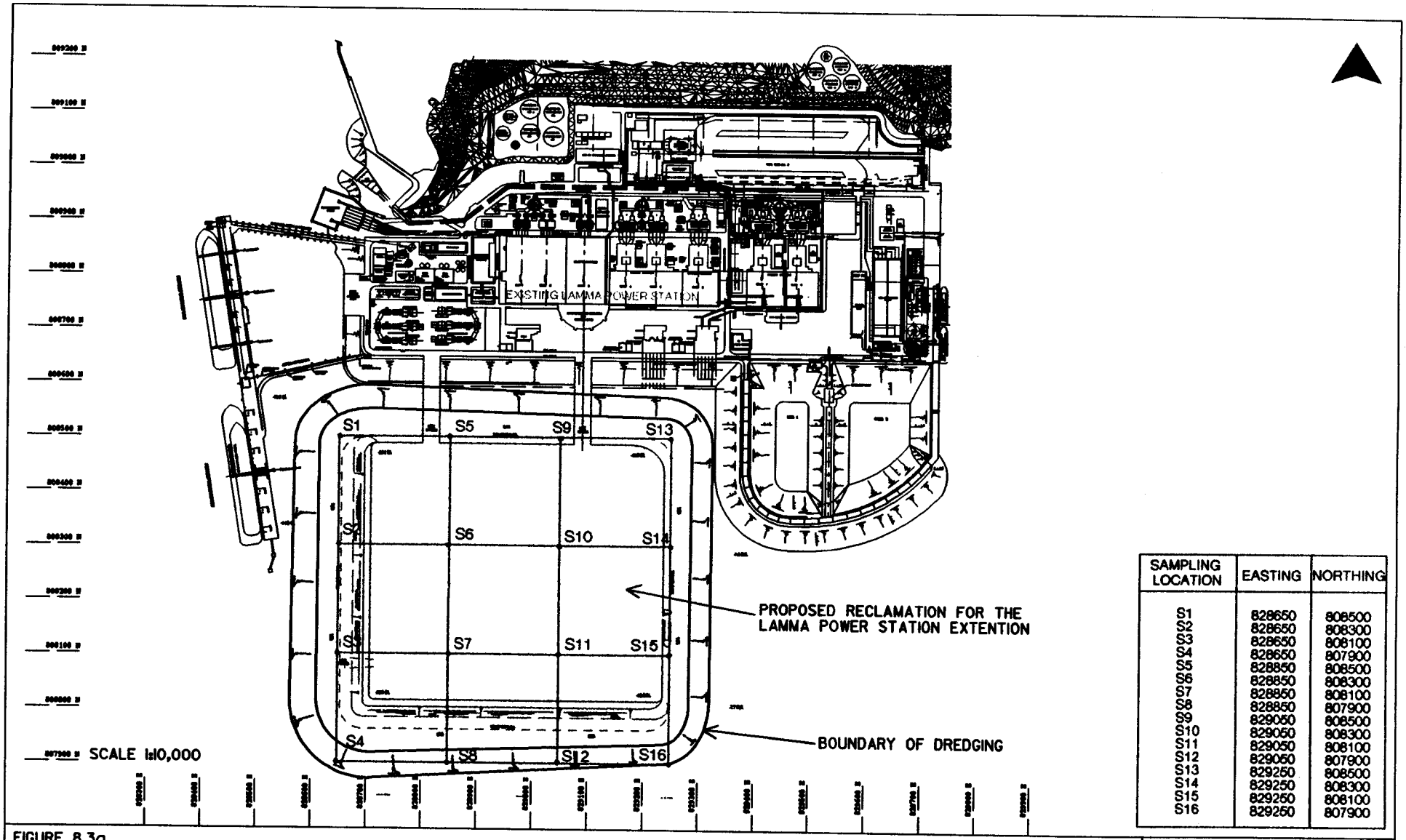
Location	Easting	Northing	Seabed Level (m PD)	Marine Deposit	
				Levels (mPD)	Thickness (m)
S1	828650.00	808500.00	-10.82	-10.82 to -21.62	10.80
S2	828650.00	808300.00	-10.98	-10.98 to -25.18	14.20
S3	828650.00	808100.00	-10.01	-10.01 to -23.61	13.60
S4	828650.00	807900.00	-13.13	-13.13 to -22.13	9.00
S5	828850.00	808500.00	-10.22	-10.22 to -26.62	16.40
S6	828850.00	808300.00	-9.77	-9.77 to -23.17	13.40
S7	828850.00	808100.00	-9.48	-9.48 to -22.98	13.50
S8	828850.00	807900.00	-9.51	-9.51 to -22.41	12.90
S9	829050.00	808499.00	-9.10	-9.10 to -24.10	15.00
S10	829050.00	808300.00	-8.38	-8.38 to -22.88	14.50
S11	829050.00	808100.00	-8.36	-8.36 to -20.16	11.80
S12	829050.00	807900.00	-8.90	-8.90 to -21.80	12.90
S13	829250.00	808500.00	-7.65	-7.65 to -19.65	12.00
S14	829249.68	808300.00	-8.53	-8.53 to -20.53	12.00
S15	829250.00	808100.00	-8.44	-8.44 to -22.74	14.30
S16	829250.00	807900.00	-8.55	-8.55 to -20.55	12.00

Sediment samples were analysed for the seven heavy metals (including Cu, Cd, Cr, Pb, Ni, Zn and Hg). Details of the laboratory results are given in *Annex B8-1* and summarised in *Table 8.3c*.

Table 8.3c ***Summary of Sediment Sampling Results (mg kg^{-1} Dry Weight)***

Location	Cu	Cd	Cr	Pb	Ni	Zn	Hg	Classification
S1	<10	<0.5	19-31	20-21	<6-20	27-72	<0.4	A
S2	<10-20	<0.5	25-36	20-39	14-22	65-87	<0.4	A
S3	<10-20	<0.5	26-36	<15-35	16-22	59-79	<0.4	A
S4	<10-21	<0.5	31-34	20-33	18-30	64-85	<0.4	A
S5	<10-23	<0.5	8-32	<15-36	<6-19	17-85	<0.4	A
S6	<10-24	<0.5	27-36	<15-36	17-21	54-86	<0.4	A
S7	<10-24	<0.5	19-46	<15-24	11-30	42-130	<0.4	A
S8	<10-20	<0.5	26-42	20-33	16-23	48-78	<0.4	A
S9	<10-10	<0.5	8-33	<15-22	<6-20	28-74	<0.4	A
S10	<10-10	<0.5	8-36	<15-28	<6-23	18-75	<0.4	A
S11	<10	<0.5	17-38	<15-21	7-21	33-76	<0.4	A
S12	<10-20	<0.5	11-35	<15-33	<6-22	<15-79	<0.4	A
S13	<10	<0.5	7-33	<15-21	<6-20	<15-75	<0.4	A
S14	<10-10	<0.5	18-35	<15-33	11-23	58-77	<0.4	A
S15	<10-10	<0.5	17-33	<15-27	<6-23	<15-75	<0.4	A
S16	<10-10	<0.5	26-35	<15-26	15-22	52-76	<0.4	A

As the sediment in the proposed reclamation area is classified as Class A, the dredged sediment can be disposal of at designated marine dumping grounds. As the Container Terminal 9 project has been approved, the availability of the



SAMPLING LOCATION	EASTING	NORTHING
S1	828650	808500
S2	828650	808300
S3	828650	808100
S4	828650	807900
S5	828850	808500
S6	828850	808300
S7	828850	808100
S8	828850	807900
S9	829050	808500
S10	829050	808300
S11	829050	808100
S12	829050	807900
S13	829250	808500
S14	829250	808300
S15	829250	808100
S16	829250	807900

FIGURE 8.3a

SEDIMENT SAMPLING LOCATION

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south Tsing Yi disposal site will be limited. FMC has indicated[3] that the south Cheung Chau and east of Ninepins disposal sites will be available for the disposal of dredged marine sediment for this project between the end of 1999 and mid-2000. FMC advised that there is no limit on the dumping rate at these two sites. Dredging will be undertaken 24 hours per day, six days per week. It is estimated that the average sediment disposal rate will be about 44,000 $m^3 d^{-1}$.

Provided that the mitigation measures recommended in *Section 8.5* are properly implemented and the sediments are disposed of at the approved disposal sites, it is anticipated that the environmental impacts associated with the handling and disposal of sediment will not cause unacceptable environmental impacts. The potential water quality impacts associated with dredging and disposal of marine sediments are addressed in *Section 5* of *Part B* of this Report.

Excavated Materials

As the power station is to be located on newly reclaimed land, the excavated material arising from construction of bored pile foundations will consist of previously placed marine sand fill and is expected to have high moisture content. Detailed design of the bored pile foundation is not available at this stage, so it is not possible to estimate the material arisings. However, it is expected that the quantity will be small and it can be reused for the later phase of the reclamation or sent to public filling areas or other reclamation sites for reuse.

Construction and Demolition Waste

If not properly managed, the storage, handling, transport and disposal of C&D material have the potential to create visual, water, dust and traffic impacts.

The C&D waste will mainly arise from the construction of new buildings and structures. *Table 8.3d* presents the buildings and structures to be constructed.

[3] Meeting with GEO on 21 July 1998.

Table 8.3d ***Proposed Buildings and Equipment for the Lamma Extension***

Building Name	Plant Dimension (m)	No of Storey	GFA (m^2)	C&D Materials (m^3) [a]
Main Station Building				
Unit 9				
- Switchgear Building	15 x 34	N/A[c]	4884	488
- Turbine Hall	66 x 34		total	
- Loading Bay	66 x 10			
Unit 10				
- Switchgear Building	15 x 34	N/A[c]	3774	377
- Turbine Hall	66 x 34		total	
Unit 11				
- Switchgear Building	15 x 34	N/A[c]	3774	377
- Turbine Hall	66 x 34		total	
Unit 12				
- Switchgear Building	15 x 34	N/A[c]	4884	488
- Turbine Hall	66 x 34		total	
- Loading Bay	66 x 10			
Unit 13				
- Switchgear Building	15 x 34	N/A[c]	3774	377
- Turbine Hall	66 x 34		total	
Unit 14				
- Switchgear Building	15 x 34	N/A[c]	3774	377
- Turbine Hall	66 x 34		total	
Maintenance Workshop	50 x 20	2	2,000	200
C W Pump Control Room	18 x 23	1	414	41
C W Intake	40 x 50	Underground	N/A	Detailed design information is not available and the likely quantity of C&D materials cannot be determined at this stage
Gas Receiving Station	280 x 50	N/A	N/A	N/A
- Flare Stack	⌀ = 1.5	N/A	N/A	N/A
Demineralisation Plant Room				
- No. 1	25 x 35	1	875	87.5
- No. 2	25 x 35	1	875	87.5
Dangerous Goods Store	15 x 26	1	390	39
Fire Pump Room	15 x 26	1	390	39
Administration Building				
- Units 9 to 12	30 x 68	3	8,160	816
- Units 12 to 14	30 x 68	3	8,160	816
Sewage Plant Control Room	23 x 16	1	368	36.8
Footbridges	40 x 5	1	200	20
Chimneys	OD Top = 18.6 Btm = 21.8	2 Nos.	6,000 m^3 of concrete per chimney	1,320[b]
Raw Water Tank	⌀ = 18	N/A	N/A	N/A
Light Oil Storage Tank	⌀ = 25 each	N/A	N/A	N/A

Building Name	Plant Dimension (m)	No of Storey	GFA (m^2)	C&D Materials (m^3) [a]
Effluent Treatment	23 x 32	Underground	N/A	Detailed design information is not available and the likely quantity of C&D materials cannot be determined at this stage
Neutralization Tank	23 x 32	Underground	N/A	Detailed design information is not available and the likely quantity of C&D materials cannot be determined at this stage
Site Office	10 x 20	1	200	20
Car Park				
(Site Office)	10 x 50	N/A	500	50
(No 3 Admin Bldg)	25 x 30	N/A	750	75
C W Outfall				
- No 3	43 x 30	Underground	N/A	Cannot be determined at this stage
- No 4	43 x 30	Underground	N/A	
275kv S/G Bldg.				
- Stage I	60 x 25	NA	3,000	300
- Stage II	40 x 25	NA	2,000	200
Short Circuit Limiting Coupler				
- Bay 1	45 x 25	1	1,125	112.5
- Bay 2	45 x 25	1	1,125	112.5
- APX No 1 to No 4	12 x 12	1	144	14.4
- QBX No 1 to No 3	12 x 12	1	144	14.4
275kV Cable Landing Point	45 x 22	Underground	990	100
C&D materials generated based on available information				**6985.6 m^3**

Notes:
(a) Generation rate for C & D materials assumed to be 0.1 m^3 m^{-2} [c]
(b) Generation rate assumed to be equal to concrete wastage ≈ 11% [c]
(c) Source: *Reduction of Construction Waste Final Report, Hong Kong Polytechnic, 1993*
(d) N/A = Not Applicable

It is assumed that all of the supporting infrastructures will be built during the first phase (ie the first generating unit) of the power station development. The foundation and civil works will be commenced in November 2000 and completed in December 2002. The civil works will overlap with the reclamation works for about 9 months. It is recommended that C&D materials should be sorted on-site and the inert material should be used, as far as practicable, for the reclamation. If on-site use is not practicable, the inert C&D material should be delivered to public filling areas.

The disposal of inert C&D material (or public fill) at public filling areas or other reclamation sites is unlikely to raise any long term concerns because of the inert nature of the material. Disposal of C&D waste to licensed landfill will not cause unacceptable environmental impacts. Wherever practical, the production of C&D wastes should be minimised by the careful control of ordering procedures and the segregation of materials. It will also assist in minimising costs should landfill charges be introduced.

C&D wastes currently account for approximately 35% of the annual consumption of limited landfill void available in Hong Kong (although this proportion has varied widely over recent years). Therefore, it is important to minimise, wherever possible, the wastes to be disposed of to landfill.

Chemical Waste

The chemical waste to be generated from the construction activities will be readily accepted at the Chemical Waste Treatment Centre (CWTC) at Tsing Yi.

Storage, handling, transport and disposal of chemical waste should be arranged in accordance with the Code of Practice on the Packaging, Labelling and Storage of Chemical Waste published by EPD. Provided that this occurs, the potential environmental impacts arising from the handling, storage and disposal of a small amount of chemical wastes generated from the construction activities will be negligible.

General Refuse

The amount of general refuse to be generated is small (approximately 600 kg daily). Provided that the mitigation measures recommended in *Section 8.5* are adopted, the environmental impacts caused by storage, handling, transport and disposal of general refuse are expected to be minimal.

Summary of Construction Waste Impacts

The potential environmental impacts associated with the management of waste arising from the construction of the power station are summarised in *Table 8.3e.*

Table 8.3e ***Summary of Waste Management Impacts During Construction Phase***

Waste Type	General Evaluation
Dredged Material	Approximately 5.21Mm^3 of Class A (Uncontaminated Materials) marine sediment will need to be dredged for the formation of seawall and platform for new gas-fired power station. No adverse environmental impacts associated with the handling and disposal of marine sediment are envisaged.
Excavated Material	The amount of excavated material to be generated from the construction of bored pile foundation cannot be determined at this stage, however, it is expected to be small. With respect to the inert nature of the excavated material and its small quantity, it is expected that all the materials can be used on-site. Therefore, no surplus excavated material will be generated.
C & D Material	Based on available information, at least 6,990m^3 of C&D material will be generated from the construction of superstructures for the new power station within a period of 2 years This material should be sorted on-site into public fill which can be used for the reclamation, and C&D waste for landfill disposal.
Chemical Waste	A small volume (about a few hundreds of litres per month) of chemical waste such as used lubricating oil and solvent will be generated. Storage, handling, transport and disposal of chemical waste should be in accordance with the Code of Practice on the Packaging, Handling and Storage of Chemical Wastes. Provided that this occurs, and chemical wastes are disposed of at a licensed facility, the contractor should be in compliance with all relevant regulations and no adverse environmental impact is envisaged.
General Refuse	About 600 kg of general refuse will be generated daily from the workforce. Provided proper storage, collection and disposal arrangements are adhered to, no adverse environmental impact is envisaged.

8.4 OPERATIONAL WASTE

8.4.1 *Identification of Waste Generation Activities*

The operation of the new power station will involve the following waste generating activities:

- operations of the power generation units;
- plant maintenance; and
- office activities.

8.4.2 *Potential Sources of Impact*

The above activities will result in the generation of a variety of wastes which can be divided into distinct categories based on their constituents, as follows:

- industrial waste;
- chemical waste;
- sewage; and
- general refuse.

The nature and quantity of each of these waste types arising from the operations of the new gas-fired power station are discussed below.

Industrial Waste

Industrial waste will be generated from maintenance activities. Materials may include scarp metals, packaging materials for spare parts and cleaning materials.

Chemical Waste

The types and quantities of chemicals to be used and wastes to be generated from the operation of a 1,800 MW gas-fired power station are given in *Tables 8.4a* and *Table 8.4b*, respectively. Chemical wastes will arise from used, surplus and expired chemicals. As discussed for the construction phase, these chemical wastes may pose significant environmental and health and safety hazards if they are not properly managed.

Table 8.4a ***Chemicals to be Used for the Operation of Gas-fired Power Station***

Facility	Chemical	Estimated Annual Consumption
Main Station Buildings	• Sodium hydroxide (98% solid)	30 kg
	• Trisodium phosphate (98% solid)	30 kg
	• Hydrazine, 99% as hydrazine hydrate	600 kg
	• Ammonia, 25% solution	30 kg
Boiler House[a]	• Hydrochloric acid, 33% solution	13,000 kg
	• Acid inhibitor, 100% liquid	500 kg
	• Surfactant MC 300B, 100% liquid	25 kg
	• Citric acid, 99% solid	90 kg
	• Sodium hydroxide, 98% solid	10,000 kg
	• Hydrazine, 99% as hydrazine hydrate	120 kg
	• Ammonia, 25% solution	400 kg
Demineralisation Plant	• Sulphuric acid, 98% solution	160,000 kg
	• Sodium hydroxide, 98% solid	82,000 kg
	• Sodium chloride, 98% solid	7,000 kg
	• Hydrochloric acid, 33% solution	10,000 kg
	• Sodium Sulphite, 98% solid	200 kg
	• PAC (Coagulant), 98% solid	150 kg
	• Cationic resin	1,000 litres
	• Anionic resin	1,500 litres
Effluent Treatment Plant	• Sulphuric acid, 98% solution	2,500 kg
	• Sodium hydroxide, 98% solid	8,000 kg
Light Oil Storage Tanks (Four tanks, 25 m in diameter and 22 m high each)	• Light gas oil, sulphur content of less than 0.5% and viscosity of not greater than 6 centistokes at 40°C	Varies
Dangerous Goods Store	• Sodium hydroxide (98% solid)	NA
	• Hydrochloric acid, 33% solution	
	• Sulphuric acid, 98% solution	
	• Citric acid, 99% solid	
	• Ammonia, 25% solution	
	• Hydrazine, 99% as hydrazine hydrate	

Notes:
(a) Chemicals for one set of steam generator; only required at the commissioning of the plant and thereafter once every 10 years for each unit
(b) NA = not applicable

Table 8.4b ***Waste Produced From Operation of the Gas-fired Power Station***

Facility	Waste	Estimated Annual Quantity
Maintenance Workshop	• Waste lube oil	240,000 litres
	• Spent Resin	2,000 litres
	• Spent Solvent	1,000 litres
	• Spent batteries	Varies

Sewage

Domestic waste, mainly sewage, will be generated by staff working at the Lamma Extension site. The sewage may be diverted to the sewage treatment plant at the existing Lamma Power Station for treatment. Approximately 65 tonnes of sludge slurry (1% solid) is generated every two months from the sewage treatment plant serving over 900 staff at the existing power station. The sludge slurry is currently disposed of at the coal yard and is burnt with the coal. Approximately 90 staff will be working at the Lamma Extension site and hence an additional 10% of sludge (about 3.3 tonne per month) is likely to be generated.

General Refuse

General Refuse will arise from daily activities of staff working at the site. General refuse will include food waste, paper waste and office waste. The storage of general refuse has potential to give rise to adverse environmental impacts. These include odour if waste is not collected frequently, windblown litter and visual impact. The site may also attract pests and vermin of the waste storage area is not well maintained and cleaned regularly.

About 90 staff will be working at the site at any one time during the operational phase of the power station. Based on a daily waste generation rate of about 0.6 kg per person, it is estimated that the amount of general refuse will be in the order of 54 kg d^{-1}.

8.4.3 *Evaluation of Impacts*

Industrial Waste

The amount of industrial waste to be generated during the operational phase of cannot be determined at this stage.

Metals have high scrap value and may be sold for recycling. Other general industrial waste such as packaging materials can be collected together with the general refuse and disposed of at licensed waste transfer or disposal facilities.

Provided that scrap materials are collected regularly, it is not expected that storage, handling, transport and disposal of industrial waste will cause any significant environmental impact.

Chemical Waste

Provided that chemical wastes are managed in accordance with the *Code of Practice on the Packaging, Labelling and Storage of Chemical Waste* published by the EPD, they should not cause unacceptable impacts.

Sewage

Sludge from sewage treatment, if not handled and disposed of properly, can cause adverse environmental impact including odour and water quality impact. An additional 10% of sludge will be generated from the staff of the new power station. The additional sludge will also be disposal of at the coal yard. Since the coal yard operates a closed loop water system for water spraying and no water is discharged from the coal yard, no water quality impact is envisaged. The current sludge disposal method at the coal yard has not caused adverse odour nuisance and it is not envisaged that the additional sludge will cause any nuisance.

General Refuse

With respect to the small amount of general refuse to be generated from the operation of the new gas-fired power station, it is proposed that the refuse collection service of the existing new power station be extended to the Lamma Extension site. Provided that the mitigation measures recommended in *Section 8.5* are adopted, the environmental impacts caused by storage, handling, transport and disposal of general refuse are expected to be minimal.

8.5 MITIGATION MEASURES

This section sets out recycling, storage, transportation and disposal measures which are recommended to avoid or minimise potential adverse impacts associated with waste arising from the construction and operation of the new gas-fired power station. Upon appointment of the contractor for the construction of the Lamma Extension, the contractor should prepare a comprehensive on-site waste management plan for the construction works which should take into account the recommended mitigation measures in the EIA report. Such a management plan should incorporate site specific factors, such as the designation of areas for the segregation and temporary storage of reusable and recyclable materials. HEC should develop a waste management plan for the operation of the Lamma Extension which should incorporate the recommended mitigation measures of the EIA report. Upon commissioning of the first unit of the gas-fired power station, HEC should implement the waste management plan for the proper management of waste arising from the Lamma Extension site.

8.5.1 *Waste Management Hierarchy*

The various waste management options can be categorised in terms of preference from an environmental viewpoint. The options considered to be more preferable have the least impacts and are more sustainable in a long term context. Hence, the hierarchy is as follows:

- avoidance and minimisation (ie avoiding or not generating waste through changing or improving processes, practices and design);
- reuse of materials, thus avoiding disposal (generally with only limited reprocessing);
- recovery and recycling, thus avoiding disposal (although some form of reprocessing is usually required); and
- treatment and disposal, according to relevant laws, guidelines and good practice.

The Waste Disposal Authority should be consulted by the Contractor on the final disposal of wastes.

This hierarchy should be used to evaluate waste management options, thus allowing maximum waste reduction and often reducing costs. For example, by reducing or eliminating over-ordering of construction materials, waste is avoided and costs are reduced both in terms of purchasing of raw materials and in disposing of wastes.

8.5.2 *Dredged Material*

All vessels for marine transportation of dredged sediment should be fitted with tight fitting seals to their bottom openings to prevent leakage of materials. In

addition, loading of barges and hoppers should be controlled to prevent splashing of dredged material into the surrounding water, and barges or hoppers should under no circumstances be filled to a level which will cause the overflowing of materials or polluted water during loading or transportation.

Other suitable mitigation measures for handling of dredged material are dealt with in *Section 5* of Part B.

8.5.3 ***Excavated Materials***

Excavated materials are not considered likely to cause adverse impacts with respect to their disposal, since they will be reused on-site as far as possible. If surplus excavated material does arise, it can be delivered to public filling areas or other reclamation sites for reuse.

Excavated materials should be segregated from other wastes to avoid possible contamination, thereby allowing reuse on-site or at the public filling areas. The amount of excavated material to be generated from the construction activities will be small. The priority for off-site disposal of surplus excavated material, if any, should be as follows:

- transport to other land formation sites near Lamma Island; and
- transport to public filling areas.

8.5.4 ***Construction and Demolition Waste***

In order to minimise waste arisings and keep environmental impacts within acceptable levels, the mitigation measures described below should be adopted.

Careful design and planning and good site management can minimise over ordering and generation of waste materials such as concrete, mortars and cement grouts. The design of formwork should maximise the use of standard wooden panels so that high reuse levels can be achieved. Alternatives such as steel formwork or plastic facing should be considered to increase the potential for reuse.

The Contractor should recycle as much as possible of the C&D material on site. Proper segregation of wastes on site will increase the feasibility that certain components of the waste stream can be recycled by specialised contractors. Concrete and masonry, for example, can be crushed and used as fill and steel reinforcing bar can be used by scrap steel mills. Different areas of the worksites can be designated for such segregation and storage, depending on site-specific conditions.

C&D materials should be segregated on site into different waste and material types. Wherever possible, materials should be reused or recycled with the remaining inert materials before being disposed of at public filling areas. Waste containing putrescible materials should be disposed of at landfill. At present, Government is developing a charging policy for the disposal of waste to landfill. When it is implemented, this will provide additional incentive to reduce the volume of waste generated and to ensure proper segregation to allow free disposal of inert material to public filling areas.

In order to minimise the impacts of demolition works, these wastes must be cleared as quickly as possible after demolition. The demolition and clearance works should therefore be undertaken simultaneously.

The requirements for the handling and disposal of bentonite slurries should

follow the *Practice Note For Professional Persons: Construction Site Drainage,* Professional Persons Consultative Committee, *1994 (ProPECC PN 1/94).*

8.5.5 *Chemical Waste*

For those processes which generate chemical waste, it may be possible to find alternatives which generate reduced quantities or even no chemical waste, or less dangerous types of chemical waste.

Chemical waste that is produced, as defined by *Schedule 1* of the *Waste Disposal (Chemical Waste) (General) Regulation*, should be handled in accordance with the Code of Practice on the Packaging, Handling and Storage of Chemical Wastes. Containers used for the storage of chemical wastes should:

- be suitable for the substance they are holding, resistant to corrosion, maintained in a good condition, and securely closed;
- have a capacity of less than 450 l unless the specifications have been approved by EPD; and
- display a label in English and Chinese in accordance with instructions prescribed in *Schedule 2* of the *Regulations*.

The storage area for chemical wastes should:

- be clearly labelled and used solely for the storage of chemical waste;
- be enclosed on at least 3 sides;
- have an impermeable floor and bunding, of capacity to accommodate 110% of the volume of the largest container or 20% by volume of the chemical waste stored in that area, whichever is the greatest;
- have adequate ventilation;
- be covered to prevent rainfall entering (water collected within the bund must be tested and disposed of as chemical waste if necessary); and
- be arranged so that incompatible materials are adequately separated.

Disposal of chemical waste should:

- be via a licensed waste collector; and
- be to a facility licensed to receive chemical waste, such as the Chemical Waste Treatment Facility which also offers a chemical waste collection service and can supply the necessary storage containers; or
- be to a reuser of the waste, under approval from EPD.

The Centre for Environmental Technology operates a Waste Exchange Scheme which can assist in finding receivers or buyers.

8.5.6 *General Refuse*

General refuse generated on-site should be stored in enclosed bins or compaction units separate from construction and chemical wastes. A reputable waste collector should be employed by the Contractor to remove general refuse from

8.5.6 *General Refuse*

General refuse generated on-site should be stored in enclosed bins or compaction units separate from construction and chemical wastes. A reputable waste collector should be employed by the Contractor to remove general refuse from the site, separately from construction and chemical wastes, on a daily or every second day basis to minimise odour, pest and litter impacts. The burning of refuse on-site is prohibited by law.

General refuse is generated largely by food service activities on site, so reusable rather than disposable dishware should be used if feasible. Aluminium cans are often recovered from the waste stream by individual collectors if they are segregated or easily accessible, so separate, labelled bins for their deposit should be provided if feasible.

Office wastes can be reduced through recycling of paper if volumes are large enough to warrant collection. Participation in a local collection scheme should be considered if one is available.

8.5.7 *Summary*

This section describes waste management requirements and provides practical recommendations which should be implemented to minimise the impacts arising as a result of the generation, storage, handling, transport and disposal of wastes.

Waste reduction is best achieved at the planning and design stage, as well as by ensuring that processes are developed and operated efficiently. Good management and control can prevent the generation of significant amounts of waste. For unavoidable wastes, reuse and optimal disposal are recommended as follows:

- disposal of dredged material at designated marine disposal sites;
- use of excavated material (inert) suitable for reclamation or fill;
- disposal of inert C&D material (public fill) for on-site reclamation or reuse at public filling areas;
- disposal of C&D waste at landfills;
- consignment of chemical waste to the CWTC or other approved facilities for treatment and disposal; and
- disposal of general refuse at landfills.

The criteria for sorting solid waste is described in New Disposal Arrangements for Construction Waste. Waste containing in excess of 20% by volume of inert should be segregated from waste with a larger proportion of putrescible material.

Proper storage and site practices will minimise the damage or contamination of construction materials. On-site measures may be implemented which promote the proper disposal of wastes once it is moved off site. For example having separate skips for inert (rubble, sand, stone, etc) and non-inert (wood, organics, etc) wastes would help to ensure that the former are taken to public filling areas,

while the latter are properly disposed of at controlled landfills. Since waste brought to public filling areas will not attract a charge, while that taken to landfill may attract some future charge, separating waste may also help to reduce waste disposal costs, should landfill charging be introduced.

Specifically, it is recommended that:

- wastes should be handled and stored in a manner which ensures that they are held securely without loss or leakage thereby minimising the potential for pollution;
- only reputable waste collectors authorised to collect the specific category of waste concerned should be employed;
- removal of demolition wastes should be arranged to coincide with the demolition work;
- appropriate measures should be employed to minimise windblown litter and dust during transportation of waste by either covering trucks or by transporting wastes in enclosed containers;
- the necessary waste disposal permits should be obtained from the appropriate authorities, if they are required, in accordance with the *Waste Disposal Ordinance* (Cap 354), *Waste Disposal (Chemical Waste) (General) Regulation* (Cap 354), the *Crown Land Ordinance* (Cap 28) and *Dumping at Sea Ordinance* (1995);
- collection of general refuse should be carried out frequently, preferably daily;
- waste should only be disposed of at licensed sites and site staff and the civil engineering Contractor should develop procedures to ensure that illegal disposal of wastes does not occur;
- waste storage areas should be well maintained and cleaned regularly;
- records should be maintained of the quantities of wastes generated, recycled and disposed (determined by weighing each load or by another method); and
- during demolition, the Contractor should adopt selective demolition measures so that reusable material, like wood and metal, can be disposed of at landfills, and inert demolition materials can be reused on site or delivered to public filling areas, public filling points or land formation sites.

Training and instruction of construction staff should be given at the site to increase awareness and draw attention to waste management issues and the need to minimise waste generation. The training requirements should be included in the site waste management plan.

8.6 EM&A REQUIREMENTS

It is recommended that auditing of each waste stream should be carried out periodically by an Independent Party to determine if wastes are being managed in accordance with approved procedures and the site waste management plan and to see if waste reduction could be enhanced. The audits should look at all

aspects of waste management including waste generation, storage, recycling, transport, and disposal.

8.7 SUMMARY AND CONCLUSIONS

The quantities of waste expected to arise during construction are summarised in *Table 8.3e*. They include about 5.21 Mm^3 of dredged materials, some excavated materials to be generated from the construction of the building foundations which can be reused on site, at least 6,990m^3 of C&D material based on available information, small volumes of chemical waste, and about 600 kg d^{-1} of general refuse.

During the operational phase, industrial wastes will be generated which have high scrap value (ie metals). Chemical wastes (eg 240,000 litres of waste lube oil, 2,000 litres of spent resin, and 1,000 litres of spent solvent per year) will also be generated, and should be disposed at licensed disposal facilities or licensed recycling facilities. Any sewage sludge will be burnt with coal at the existing power station, and approximately 54 kg of daily general refuse will be generated and disposed of at strategic landfills.

Mitigation measures relating to good practice have been recommended to ensure that adverse environmental impacts are prevented and that opportunities for waste minimisation and recycling are followed.

If the recommendations of this report are implemented, the storage, handling, collection, transport, and disposal of wastes arising from the construction and operation of the power station should comply with regulatory requirements and no unacceptable environmental impacts should occur.