Civil Engineering Department

Green Island Reclamation (Part) - Public Dump

Environmental & Traffic Impact Assessment

Final Report (Volume I of II)
Environmental Impact Assessment

January 1995

Scott Wilson Kirkpatrick
CONSULTING ENGINEERS

in association with
Aspinwall & Company
British Maritime Technology
Hydraulics and Water Research Asia Ltd
MVA Asia Ltd

Green Island Reclamation (Part) - Public Dump

Environmental & Traffic Impact Assessment

Final Report (Volume I of II)
Environmental Impact Assessment

Vol. II is TIA

January 1995

LIST OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF ABBREVIATIONS

ANL	:	Acceptable Noise Level
APCO	:	Air Pollution Control Ordinance
AQO	:	Air Quality Objectives
ASD	:	Architectural Services Department
BOD	:	Biological Oxygen Demand
CED	:	Civil Engineering Department
COD	:	Chemical Oxygen Demand
DSD	:	Drainage Services Department
EIA	:	Environmental Impact Assessment
EPD	:	Environmental Protection Department
FDM	:	Fugitive Dust Model
GILFS	:	Green Island Link Preliminary Feasibility Study
GIRFS	:	Green Island Reclamation Feasibility Study
IAR	:	Initial Assessment Report
ISCST	:	Industrial Source Complex Short-Term Model
IWTS	:	Island West Transfer Station
KTIP	:	Kennedy Town Incinerator Plant
MDSTW	:	Mount Davis Sewage Treatment Works
MLS	:	Metroplan Landscape Strategy for Urban Fringe and Coastal Areas
NCO	:	Noise Control Ordinance
NSR	:	Noise Sensitive Receiver
OZP	:	Outline Zoning Plan
PME	:	Powered Mechanical Equipment
RCV	:	Refuse Collection Vehicle
RODP	:	Recommended Outline Development Plan
RSP	:	Respirable Suspended Particulate

SMP	:	Sewerage Master Plan
SSDS	:	Strategic Sewage Disposal Scheme
TSP	:	Total Suspended Particulate
WAHMO	:	Water Quality and Hydrologic Modelling
WCZ	:	Water Control Zones
WQO	:	Water Quality Objectives

SUMMARY

1. This Final Environmental Impact Assessment Report (EIA) has been prepared as part of the Green Island Reclamation (Part) Public Dump Environmental and Traffic Impact Assessment, which has been awarded by the Civil Engineering Department (CED) under Consultancy Agreement No. CE7/93. The primary objective of the report is to fulfill the recommendations for further work identified in the Final Initial Assessment Report (IAR) submitted in October 1993, and the Summary of Key Findings Report (EIA) submitted in November 1993. In addition to the Main Agreement, the Consultants were commissioned to undertake a Supplementary Agreement to assess the environmental impacts associated with the development of a Marine Barging Point for the transfer of materials suitable for public dumping to the Green Island Public Dump. The environmental assessment conducted for the study has been based on the sequence of works which is summarised below.

2. In early 1992, the Fill Management Committee formulated a Public Dumping Strategy which identified those short and long term reclamation sites required to meet the Territorial demand for the disposal of surplus materials suitable for public dumping. The sites identified have been termed "Public Dumps". The Strategy was endorsed by the Land Development Policy Committee on 27 March 1992. The Green Island Public Dump is a key component of the public dumping programme and will provide the only facility for the dumping of materials suitable for public dumping on Hong Kong Island in the period 1996 to 2002. The public dump will comprise a portion of Sulphur Channel between Green Island and Kennedy Town, covering an area of some 37 hectares, and forms part of the larger Green Island Reclamation which will cover a total area of 185 hectares.

3. One of Government's key policy objectives for waste management within Hong Kong is to ensure that proper facilities are available to dispose of all waste in a cost-effective and environmentally acceptable manner. It is broadly recognised that the infilling of areas for reclamation using surplus materials suitable for public dumping is a preferred means of disposal for such waste. By putting this material to positive use the need to dredge or quarry materials for fill is reduced, as are the demands placed on disposal to Hong Kong's existing landfills. However, it is also recognised that the development of such public dumps has the potential to cause adverse impacts on the marine environment and the local community as a result of their construction and subsequent operation. As such, Government procedures require that an environmental assessment be conducted to determine the type and severity of the environmental impacts of these works.

4. The Marine Barging Point will be located on the former Kennedy Town Incineration Plant (KTIP) site, and would provide an interim facility for the transfer of materials to the Green Island Public Dump from the beginning of 1996 up until approximately mid 1997. After this date transfer of material to the dump would take place by access road.

5. Key issues of concern which were identified in the Final IAR and subject to preliminary assessment included the following:

- noise;
- air quality;
- sewerage impact;
- water quality and dredged sediments;
- marine ecology;
- terrestrial ecology; and

- visual impact

6. The Final Report EIA provides a quantitative assessment of impact in relation to the key environmental issues identified in the Final IAR report, and where necessary recommends possible mitigation measures which should be incorporated into the design and implementation of the Public Dump and Marine Barging Point works in order to reduce the potential impacts on nearby sensitive receivers. Assessment of cumulative impacts is also provided with respect to each of the key environmental issues. Recommendations are given for environmental monitoring and auditing during the construction, operational and post-completion phases of development. These requirements are augmented in an Environmental Monitoring and Audit Manual prepared separately under this study.

7. The Final EIA Report is presented in the following chapters :

- *Chapter 1* Introduction
- *Chapter 2* The Study Area
- *Chapter 3* Sequence of Works
- *Chapter 4* Noise Impact
- *Chapter 5* Air Pollution
- *Chapter 6* Sewerage Impact
- *Chapter 7* Water Quality and Dredged Sediments
- *Chapter 8* Marine Ecology
- *Chapter 9* Terrestrial Ecology
- *Chapter 10* Visual Impact
- *Chapter 11* Monitoring and Audit Requirements
- *Chapter 12* Conclusions and Recommendations

Environmental Setting and Sensitive Receivers

8. The existing land uses in the vicinity of the proposed reclamation area range from the industrial, residential and recreational environs of Kennedy Town to the west, to a Green Belt Zone of open space, park and amenity area surrounding Mount Davis to the south and east. The existing Victoria Road runs along the headland abutting Lau Wong Hoi Hap (Sulphur Channel), and connects Kennedy Town with Wah Fu. The shoreline of Kennedy Town is marked by a mixed residential, recreational and industrial marine frontage which includes the China Merchants Wharf to the east of the reclamation area, and Urban Services Department Depot to the west. Significant land uses in the immediate vicinity of the reclamation site include a temporary recreation area on Sai Ning Street (football pitches, sitting out area) which is zoned for ultimate use as a Cargo Handling Area, commercial /godown properties, and a bus terminus. The Kennedy Town Incineration Plant located on the junction of Sai Ning Street was decommissioned in March 1993. Other Government, institution and community uses in the area include a mortuary at the eastern end of Sai Ning Street, and an abattoir and wholesale fish and vegetable market to the west of Cadogon Street.

9. There are several sensitive receivers in the vicinity of the proposed reclamation area which have the potential to be adversely affected by the development. The Mount Davis Cottage Area (Kung Man Tsuen), under the control of Housing Department, is a significant existing residential area. Other sensitive receivers in the vicinity include the residential tower, Serene Court, a recreation area and Old Folks Home on Sai Ning Street, the Chung Sing Benevolent Society School, the Kennedy Town Jockey Club Clinic and Welfare Centre on Victoria Road, and the Sam Kindergarten in the Mount Davis area located further west along Victoria Road. It is probable that all of these developments will act as sensitive receivers to all phases of the reclamation. Proposed land uses in the vicinity of the proposed reclamation area include residential development to the seaward side of Victoria Road, and Government, institution and community uses on

the landward side of Victoria Road and at the western end of Sai Ning Street. There is no definite development schedule for these landuses and it is unlikely that they will be sensitive receivers during the construction phase of the reclamation.

Sequence of Works

10. It was concluded from the sequence of works review that the provision of an access road for the start of filling in 1996 would present great difficulties. Furthermore, it is evident that between 1996 and 1998 the fill material available from Government related projects would be predominantly from Kowloon and delivered by barge. Given these conditions, and the preference that if an access road be built then it should be compatible with the proposed Route 7 expressway (Kennedy Town to Aberdeen), which has no firm programme for development, the marine transport of public dump material should be the preferred strategy.

11. The review of sequence of works given in the consultancy brief shows that, in order to start public dumping as soon as possible after contract award in July 1995, it is necessary to have advance works built from imported fill by barge and not access road. It should be noted that imported materials could consist of public dump materials from an existing stockpile, subject to adequate control that all materials are inert. As well as the time constraint, another reason for imported fill is that the rocky foreshore could not readily accommodate a reasonably sized works area - especially if it had to house a rock crushing plant. The need to consider a works area and tight programming requirements with adequate control dictates that advance works constructed with imported material is the appropriate methodology.

12. The advance works should include, at a minimum, the works for Area 1 - a triangular area measuring 300 x 600 m (9.0 hectare area) at the south-west corner of the reclamation, known as the barging platform. Calculations show that the public dump capacity will be over 7.0 million m^3. On the barging platform there would be adequate space for a public dump stockpile, facilities for breaking up oversized material if necessary and areas for carrying out public dump filling during the operational phase.

Noise Impacts

Public Dump

13. Haul Road traffic on the access road is expected to generate facade noise levels in excess of 75 dB(A) (L_{eq}) at noise sensitive receivers (NSRs) near its alignment. If the Disused Track Access Road option is chosen, excessive noise levels are experienced at the Sam Kindergarten and a number of village houses represented by NSRs 1 and 2. If the IWTS Access Road option is chosen, a greater number of village houses are affected. In addition, the highrise Serene Court (NSR4) is affected. The need for mitigation measures is therefore anticipated.

14. Given the expected 8-year lifespan of the filling operation, the installation of partial enclosure over the access road is recommended. An inwardly curved noise barrier along the access road will mitigate the noise impacts on the nearby NSR. The barrier material should have a mass per unit of surface area of at least 7 kg/m^2, and should have acoustic lining. This mass per unit area conforms with British Standards and is deemed sufficient to block the transmission of most construction related noise through the barrier.

15. The barrier will be subject to a detailed design that will consider the effectiveness of topography in providing barrier attenuation. However, the following preliminary information gives some indication of its anticipated height and length.

16. In order to provide effective protection to high-level receivers (either highrise facades or NSRs on elevated ground), the barrier should be curved inward over the access road. Its height will be constrained by the need to provide adequate clearance for dump-related vehicles. The width of the overhang should generally be limited to a single lane on the landward side. However, if the IWTS Access Road option is chosen, a short section of the haul road (approximately 20 m) adjacent to Serene Court may be totally enclosed.

17. The length of barrier required depends on the access road option chosen. If the IWTS Access Road option is chosen, the length of barrier would extend a length of about 200 m from the junction with Victoria road; this would take it approximately to the IWTS inbound road access tunnel turnoff. This length of barrier would protect Serene Court and Regent Heights. A preliminary assessment of the site indicates that the lowrise village receivers in Kung Man Tsuen would be adequately protected by topography.

18. If the Disused Track option is chosen, approximately 80 m of barrier would be required, starting at the junction with Victoria Road. It should be noted that vehicles exiting onto the public road should have adequate sight-lines along that road. For this reason, a full-height barrier cannot extend right up to the edge of Victoria Road. This safety requirement has implications for the effectiveness of the barrier. The school and two residences immediately across from the junction, in particular may require further mitigation measures.

19. The Technical Memorandum on Noise from Construction Work other than Percussive Piling (Ref 4.1) indicates that an effective barrier (ie, one that is of sufficient size and weight, and without gaps) reduces noise at the receivers by about 10 dB(A). This would be sufficient to bring noise levels at NSRs near the access roads to levels within the daytime construction noise criteria as advised by the Environmental Protection Department.

20. If the land use permits, an alternative to the purpose-built barrier is an earth embankment. Like the purpose-built barrier, an embankment would have to be of adequate height to screen noise sensitive facades from a direct line of sight to the access road.

21. In addition to the partial access road enclosure, good site practices to minimise noise are recommended. Good site practices during construction and operation can be encouraged through the inclusion of noise control clauses as shown in Appendix 1 of this report.

Marine Barging Point

22. Target noise criteria for Kenndy Town Jockey Club Clinic and for Lui Ming Choi Memorial School are exceeded for both NSRs during the construction period of the Marine Barging Point. However, existing buildings and additional mitigation measures can be expected to reduce noise impacts to levels below the daytime target noise criteria. For example, the presence of bus maintenance workshops to the forefront of Kennedy Town Jockey Club Clinic, which remove the line of sight to the construction site, will reduce noise levels by between 5 to 10 dB (A) thereby resulting in noise compliance. Other measures including a reduction in the number of powered mechanical equipment (PME) items in use at any single time, and the erection of suitable temporary screening structures will serve to protect Lui Ming Choi Memorial School. It is recommended that construction works be scheduled to avoid examination times at the school to avoid exceedance of the relevant daytime target noise criteria.

23. The predictions for construction noise impacts on NSRs are dependent on the exact requirements of PME for construction of the barging point which have yet to be specified.

24. It is expected that the dominant noise source associated with the redevelopment of the site will be associated with the demolition of the former Kennedy Town Incineration Plant, which is outside the scope of this assessment. It is recommended that any noise barriers used to achieve satisfactory noise level at NSRs during demolition work should therefore be maintained for the duration of the construction works.

25. Noise impacts in exceedance of the relevant noise criteria during the operation of the barging point are not envisaged, provided that operations are restricted to day time working hours. Noise impacts associated with traffic serving the barging point are minor given existing and future traffic flows on Victoria Road and would only increase noise levels under a worst case scenario by approximately 1.5 dB (A).

Air Quality Impacts

Public Dump

26. Dispersion modelling studies of dust emissions from on-site activities show that sensitive receivers are unlikely to be adversely affected by particulate levels, and concentrations will be below recommended air quality guidelines and ensure compliance with the 24-hour TSP level. The contractor should adhere strictly to recommended dust mitigation measures.

27. TSP and RSP monitoring should be undertaken at Receiver 13 and another suitable site (ie Receiver 1, 7 or 9) to ensure that AQOs and guidelines are complied with.

28. The assessment of odours from sewage laden stagnant water has indicated that sensitive receivers to the north of Victoria Road may be affected. However, the predicted zones are likely to be an over estimate and the water is likely to become stagnant for only part of the tidal cycle and would not persist for more than two hours. The proposed development of the SSDS works and its associated interception of drainage waters should further mitigate the potential for odour impacts from the stagnant water area.

29. Based on a worst-case dilution factor (D) for assessment, it is concluded that a short term odour problem may be detectable due to the embayment of stagnant water. It will be neccessary to undertake odour assessment using an odour panel upon receipt of public complaints associated with the works to detect any unacceptable impacts during the operational phase of the Public Dump.

30. Emissions from Public Dump vehicles were found to be insignificant.

Marine Barging Point

31. Air quality assessment on the proposed Marine Barging Point has shown that worst case total suspended particulates (TSP) 1-hour concentrations of up to about 400 $\mu g/m^3$ can be expected during construction. This is less than the guideline value of 500 $\mu g/m^3$, and respective standards for 24-hour (260 $\mu g/m^3$) and annual (80 $\mu g/m^3$) are also not exceeded at the nearest sensitive receiver. Actual dust concentrations can be reduced substantially by limiting the working area of the site and implementing dust suppression measures (eg watering site surface twice daily)

32. Operational impacts associated with the handling and tipping of public dump material at the barging point will result in lesser dust impacts at sensitive receivers than construction activities. Operational impacts can be effectively minimised by the enclosure of the tipping operation to eliminate wind drift. Increases in ambient vehicle pollutant (eg CO, NO_x) concentrations from traffic associated with the barging point alone willbe negligible.

Sewerage Impacts

Public Dump

33. There are five stormwater discharges that would be directly affected by the Green Island Public Dump. The feasibility of intercepting and diverting these southwards towards the western seawall of the Green Island Public Dump has been assessed as an appropriate permanent or semi-permanent measure. The discharge to fast flowing waters there will aid dispersion and dilution and thereby avoid deterioration of water quality. The northernmost of these existing outfalls may, in the long-term, be more appropriately diverted to future collector drains along the alignment of the existing Kennedy Town seawall which would transfer the effluent eastwards.

34. The locations and flow rates of all existing foul and stormwater discharges within the study area have been established and pollution loads estimated. There are several major infrastructure projects in the planning stage in the vicinity of Green Island which will each have some impact on the adjacent sewerage systems. Proposed changes to the sewerage systems have been identified and their impacts assessed, particularly in the case of the Belcher Bay Reclamation which impacts on the existing outfalls with the greatest pollution loadings. Findings have been incorporated into the water quality assessment.

35. There are no significant cumulative sewerage impacts in relation to the Island West Transfer Station barging point.

36. Recommendations for the diversion and interception of stormwater drains during the construction and operational phases are provided.

37. There are as yet no proposals to divert the existing small diameter foul sewer outfall discharging opposite Davis Street. The effect of this outfall has been addressed as part of the water quality assessment (Chapter 7).

38. Under the Water Pollution Control Ordinance, the discharge of effluents within a Water Control Zone (WCZ) is subject to obtaining a licence from EPD and complying with the conditions stated therein.

Marine Barging Point

39. The development of the Marine Barging Point will not result in the diversion of sewers or stormwater outlets, or result in the embayment of containmated marine waters. As such no impact on sewerage is envisaged.

Water Quality and Dredged Sediments

Public Dump

40. WQOs have been identified for the gazetted Western Buffer and Southern WCZs. Parts of the Victoria Harbour WCZ, have now also been gazetted in 1995, but the area around Green Island is not expected to be gazetted until 1996, when appropriate WQOs will be applied.

41. With the exception of the photoplankton, nutrients and total inorganic nitrogen there is compliance with the WQOs of the Southern and Western Buffer WCZs.

42. In Victoria Harbour TIN and dissolved oxygen in the bottom water would not comply with the WQOs if the same objectives as for the Southern and Western Buffer WCZs

were applied to the Victoria Harbour WCZ.

43. There are no sensitive receivers in the immediate works area. The nearest sensitive receiver which could be impacted by the works is the Kennedy Town salt water pumping station.

44. The maximum suspended solids concentrations in Victoria Harbour exceed the target guidelines for water to be taken for flushing purposes (10 mg/l) but are below the guideline value for pump wear (140 mg/l). Concentration maxima currently reach 57mg/l.

45. Sediment plume modelling has shown that the mariculture zones at Ma Wan, Sok Kwu Wan and Lo Tik Wan, and the power station intakes at Tsing Yi and Lamma Island lie outside the +1mg/l suspended solids increase plume contour. The proposed sea water pumping station at Telegraph Bay, the existing stations in West Kowloon and along the north shore of Hong Kong Island are similarly outside that contour. Based on these results, the suspended solids elevation will not be detactable and will have no impact on them.

46. The environmental impacts on adjacent water bodies are considered to be minimal and acceptable based on the results of the modelling work. Nevertheless, after the modelling work had been completed, and in order to mitigate as far as possible any environmental impacts which might result from the occasional encroachment of the plume on the eastern shore of Green Island or in the East Lamma Channel, it was agreed between CED and EPD that the western seawall would be built as early as possible in the programme, and that dumping operations would take place only on a rising or slack tide.

47. The latest sediment surveys of the area, which investigated the depth of contamination using triplicate samples, confirmed that the samples were within the "Class A" category. As a result no special measures will be required during transport and disposal.

48. It is predicted that the suspended solids concentration at the Kennedy Town salt water pumping station will not increase above background levels. However, increases of a few mg/l may be expected a short distance offshore from the intake. It is recommended that precautionary provision be made that, should the measured flood difference concentration of suspended solids at the monitoring station offshore of the Kennedy Town salt water pumping station increase by more than 10mg/l above the baseline flood difference as a result of the works, then a silt screen should be installed around the station intake.

49. Predicted sediment deposition rates of 0.3-0.7mm/d will not significantly affect the sediment benthic in fauna beneath the plume.

50. The additional oxygen demand imposed on the water column by dispersed sediment resulting from dredging will range between 0.05 and 0.25 mg/l. Existing oxygen demand levels are in the range 1-2 mg/l and this increase is unlikely to have any significant effect on water quality.

51. The construction, operation and completion of the public dump reclamation give rise to no significant or unacceptable deteriorations in bacteriological quality of the marine waters in the immediate vicinity of the works and hence further afield. No mitigation measures are therefore necessary.

52. Floating booms with skirts should be used to retain floating timber, insulation material and plastics adjacent to the dumping area. Accumulated material should be removed daily.

53. The construction of the submerged seawalls and the subsequent filling will not give rise to measurable deterioration in water quality due to the storm and foul sewer discharges into the harbour.

54. The present surface water discharges into the works area from Victoria Road should be diverted to the south of the western seawall where currents exceed 0.2m/s.

55. Sewage derived from residential blocks built on the final reclamation should be treated at the Strategic Sewage Treatment works at Mount Davis.

Marine Barging Point

56. Soundings for the water depth in the basin adjacent to the loading area taken in 1984 and updated in 1994 show that there is insufficient depth for barge access immediately adjacent to the seawall. However, it is considered that the need for dredging can be avoided by the use of an extended loading ramp or use of a lighter barge and it has been stipulated by CED that the construction contract for the site will not allow dredging. Marine water quality construction impacts are therefore expected to be negligible.

Marine Ecology

Public Dump

57. The public dump will result in the destruction of a significant part of Victoria Harbour's last stretch of natural rocky shores. These shores house the remnants of the biological community, in particular the intertidal fauna, which pre-date development in the harbour. The species on these shores are generally much larger in size than their counterparts in other shores in Hong Kong. For example, individuals of the limpet *Cellana grata* found in the mid- to high intertidal are about double the average size of their conspecifics elsewhere in Hong Kong. Similarly, the chiton *Liolophura japonica* is about 30-40% larger than their counterparts elsewhere in Hong Kong. The reasons for these large species size are not fully understood, therefore this habitat is of interest to scientists keen to understand the factors which have promoted such growth in species size.

58. Protection of the remnants of the shore life on Green Island and the Hong Kong Island site may be enhanced by minimizing disturbance to the north-west shoreline of Green Island. This shoreline may be afforded some natural protection as a result of its inaccessibility, however additional measures are considered necessary to safeguard this area in the future. During the construction phase restrictions should be applied to prevent these shores being used as storage areas for construction materials or temporary stockpiling areas for construction or other wastes. In addition, the recommendation of the Final Report of the Green Island Reclamation Feasibility Study (Ref 8.11) to create an Urban Fringe Park on Green Island is endorsed by this study with respect to marine ecology. It is further proposed that within the proposed Urban Fringe Park that access to the foreshore is restricted.

59. The amount of suspended matter in the water resulting from the construction activities should be effectively reduced by the use of suitable mitigation measures as described in Chapter 7. These include ensuring that barges are loaded in such a way as to prevent spillage during transport; the use of automatic self monitoring systems to discourage 'short dumping'; and ensuring that direct discharges from surface and storm water outfalls and unsewered discharges are intercepted prior to discharge. These will reduce the direct impact of the construction phase on the biological community and permit time for rehabilitation and mitigation measures to be implemented.

60. The translocation of a representative community of fauna from the affected shores to the north-western quarter of the island is recommended, preferably during Stage I or Stage II of the work. Species such as *Liolophura japonica* and *Cellana grata*have long life-spans in undisturbed environments and may therefore benefit from the translocation. Translocation also increases the local density of these species and may assist survival of these populations following the destruction of their other habitats on Green Island. The translocation is unlikely to be effective, however, unless the area is accorded some protection to ensure the proposed development, together with the accompanied stresses (eg. human disturbance) do not offset the translocation effort. The steep gradient of the northern shores of Green Island should provide some natural protection to the translocated populations.

61. Further quantification of the occurrence and distribution of species within the affected area will be required before detailed proposals can be made for translocating and monitoring of the marine community. A pre-construction phase study to determine the potential success of translocating fauna is therefore recommended. The proposed scope of further investigations is presented in Table 3 of Appendix 2. The transfer of fauna to the north-western shores is regarded as the only feasible mitigation measure due to the entire loss of the shoreline habitat on other parts of Green Island.

62. The subtidal community of Sulphur Channel will be destroyed by construction of the Public Dump. However, the results of the study by Fill Management Committee of CED have shown that the importance of this community is small.

Marine Barging Point

63. Marine ecological impacts associated with the development of the Marine Barging Point have not been assessed, as the urban foreshore and immediate marine environment are not considered to retain any significant ecological value.

Terrestrial Ecology

Public Dump

64. The flora of Green Island was found to be very species-rich, with an advanced succession comprising many woodland species. This is thought to reflect a lack of disturbance by fire and other factors. One protected plant species, *Pavetta hongkongensis*, was found. A full four season survey of bird fauna was not undertaken, but is not expected that many rare species are present. No large native mammals are present on the island. The invertebrate fauna were not surveyed in detail but may be of interest due to the high plant diversity, lack of disturbance and the dispersal barrier presented by the sea.

65. The direct impacts resulting from construction activities and the operation of the Public Dump will be a loss of vegetation along the southern shores of Green Island. Indirect effects following completion of the Public Dump will result from disturbance due to increased human access to the 'Island', the risk of fire, and the risk of invasion by predatory and exotic species. Proposed mitigation measures include prohibiting open fires, smoking and the storage of flammable materials on-site during the construction and operational phases; to prohibit the storage of construction materials and other wastes on Green Island other than within the works area; and a tree survey should be carried out by the contractor prior tc the commencement of any works. Replacement planting of damaged or destroyed vegetation should be carried out on both Green Island and along the Hong Kong Island shoreline and should be consistent with the recommendations for landscape works proposed in Chapter 10.

66. On Stonecutters Island proposed mitigation for the loss of coastal habitat to reclamation involved construction of an artificial boulder shore for the displaced Reef Egrets and Night Herons. However, in view of access problems and the threat to other habitats this proposal has been changed to provision of pontoon-bridge rafts, from which the birds are expected to fish. Breeding takes place on large-boulder shores, with nests located at the foot of large (greater than 2 m) boulders on flat surfaces above sea level. Thus unless disturbance increases, adverse impacts on the Green Island population could be compensated, in the long term, by provision of an equivalent area of large-boulder shore on the reclamation. This would also benefit rocky shore invertebrate species displaced from southern Green Island. The constructed rocky shore should be fenced off to prevent animal-collectors and other human disturbance. In addition it is suggested that perches, such as floating rafts or buoys, are provided near the shore as foraging posts.

Access Routes

67. From a botanical and ecological point of view, the IWTS Access road option would cause less detrimental impact to the environment than the Disused Track option. This option represents a well-grown secondary woodland habitat composed of native and exotic tree species and is likely to provide a suitable habitat for various animal groups.

68. If the Disused Track option is adopted, special care must be taken to minimize the damage to the natural woodland down-slope of the track (i.e. between the track and the shoreline) when engineering work is carried out. Consideration should also be given, where possible, to limit the potential alteration in plant species composition as a result of increased light penetration or changes in the water table, for example. This can only be achieved by careful selection of the road alignment to avoid ecologically sensitive species.

69. Any trees destroyed during development should be replaced with native species, with the provision of nursing/pioneer species as appropriate, to assist in the succession to woodland coverage. A compensatory landscape scheme will be required by Government at the detailed design stage to recompense for the loss of trees. Aesthetically and ecologically important shrubs and trees should be fenced off for protection if they are exposed by the clearance of adjacent vegetation.

70. It is recommended that the ecological effects of all construction and operational activities be monitored. Monitoring and audit requirements are given in Chapter 11 of this report.

Marine Barging Point

71. Terrestrial ecological impacts associated with the development of the Marine Barging Point have not been assessed, as the site does not have any natural habitats and is not considered to retain any significant ecological value.

Visual Impacts

Public Dump

72. The construction of the Public Dump will be one of the earlier projects that will gradually transform this last remaining section of undisturbed Hong Kong shoreline into a dense, urban area. Many Hong Kong residents will be aware of operations in this area and the visual impact will be significant. To the sensitive receivers in the area the visual impact will be considerable and unavoidable. There are, however, relatively few sensitive receivers that will be affected by the developments in the long term; the Mount Davis Cottage Area is likely to be relocated and the dominant land use in the area is actually

Green Belt. Within this context of change, the impact of the Public Dump will be minimal. It does, however, represent the beginning of that transformation and the overall visual impact will be greater, because of this.

73. Following the assessment of possible visual impacts of the construction, operation and completion of the Public Dump, recommendations have been made that will assist in minimising visual impacts at the detailed design stage:

- Adopt high visual standards for all operational and cumulative work in this area as a precedence for the future reclamation work and other projects in the area.
- Develop proposals for the construction and dumping operations that will minimise and mitigate any visual impacts.
- Due to its landscape value as a natural backdrop and its role in screening views from the landward side of the public dump, it is important to retain and minimise impact on the vegetation on the lower slopes of Mount Davis, below Victoria Road, during the course of work.
- Locate semi-permanent plant, such as the rock-crusher, as close as possible to the existing shoreline in Area 1 where it will be screened from view from Hong Kong Island. Incorporate hoardings or advance planting along the seawall to screen views from the sea. Particular attention should be given to minimising damage to the Green Island shoreline.
- Careful attention should be given to the detailed design and appearance of the western seawall and its interfaces. If possible, include planting as part of advance works to mitigate views of operations from the west.
- Carry out off-site planting, along Victoria Road and the Kennedy Town waterfront, for permanent and temporary visual mitigation.

74. Should vehicular access to the Public Dump prove essential it would be preferable, on a visual impact basis, to adopt the IWTS Access Road Option to reduce the impact on the visually important lower slopes of Mt. Davis.

Disused Track Access

75. The Disused Track Option is likely to involve major slope work and extensive removal of the existing vegetation. In accordance with the new Works Branch Technical Circular, alternatives that involve less impact to the existing slope should be pursued wherever possible.

76. Care should be taken to minimise the area affected by the work and, in particular, tree felling. It is strongly recommended that construction work is concentrated on one side of the existing track only; thereby preserving any vegetation either above or below the track. Sturdy fences (of non-timber material) should be erected to minimise damage to vegetation to be retained. A tree survey should be undertaken prior to the commencement of construction, to document the trees that will be removed during construction.

77. Construction methods should aim to minimise disturbance to the slopes. Engineers should work closely with landscape architects to devise the optimal alignment and feasible methods to minimise tree removal. It is recommended that, wherever possible, the access road is constructed on a temporary structure to minimise earthworks in the area.

78. Once the final access road alignment and areas of disturbance have been identified detailed landscape proposals for temporary and long-term reinstatement of vegetated areas should be prepared.

Temporary reinstatement

79. Temporary reinstatement should be carried out adjacent to the structure to mitigate operational impacts. These areas are likely to be disturbed once the access is removed following completion. Temporary planting should include fast growing tree species, such as *Eucalyptus sps.* and *Acacia sps.* that will create a short term screen.

Permanent reinstatement

80. Permanent reinstatement should take place following the construction stage on newly formed permanent slopes that will not be affected when the temporary access road is removed. Permanent reinstatement should also take place following completion. Planting shall comprise a mixture of native and fast-growing woodland tree species. The fast growing species will quickly "heal" the slopes with the native species forming a more balanced ecological mix. Plant selection shall be based on those species removed during construction, as documented in the tree survey.

Marine Barging Point

81. In order to delay the significant visual impacts of road construction, the marine access option from the Marine Barging Point is supported on visual grounds in the interim period until the site is re-developed in mid-1997. Construction and operational visual impacts will be limited, where the prior removal of the KTIP structure and chimney stacks will result in an overall visual improvement to the area.

Access Road Options

82. As a result of the Task Force on Land Supply and Property Prices, which has identified two Residential R(B) sites along the proposed alignment of the disused track access option, the CED has undertaken to investigate an alternative alignment of the access road option in terms of feasibility together with an environmental and traffic impact assessment study which will be used for comparison with the IWTS access option. This further study is anticipated to be completed in early 1995.

Monitoring and Audit Requirements

83. The monitoring and audit objectives and responsibilities during the baseline, construction, operational and post-completion phases of development, as relevant to the Public Dump and Marine Barging Point are defined. Monitoring requirements are described with respect to location and frequency, together with a framework for determining environmental performance criteria and remedial Action Plans.

84. An Environmental Monitoring and Audit Manual, prepared separately to this report, augments the monitoring and audit requirements provided in this report and acts as the reference document in each of the development phases for the Public Dump and Marine Barging Point.

1. INTRODUCTION

Introduction

1.1 This Final Environmental Impact Assessment Report (Final Report (EIA)) has been prepared as part of the Green Island Reclamation (Part) Public Dump Environmental and Traffic Impact Assessment, which has been awarded by the Civil Engineering Department (CED) under Consultancy Agreement No. CE7/93. Details of the brief for the Final Report (EIA) are summarised in Sections 1.12 to 1.14 below. The primary objective of the report is to fulfill the recommendations for further work identified in the Final Initial Assessment Report (IAR) (Ref 1.1 - submitted in October 1993) and the Summary of Key Findings Report (EIA) (Ref 1.2 - submitted in November 1993), as approved by Government. The environmental assessment conducted for the study has been based on the sequence of works, as discussed in Chapter 3 of this report.

1.2 The Final Report (EIA) provides a quantitative assessment of impact in relation to the key environmental issues identified in the Final IAR report, and where necessary recommends possible mitigation measures which should be incorporated into the design and implementation of the works in order to reduce the potential impacts on nearby sensitive receivers. Assessment of cumulative impacts is also provided with respect to each of the key environmental issues. Recommendations are given for environmental monitoring and audit requirements during the baseline, construction, operational and post-completion phases of development, which are to be augmented in an Environmental Monitoring & Audit Manual prepared separately to this Study.

1.3 Under the Consultancy Agreement No. CE7/93 a Supplementary Agreement was awarded on 24 January 1994 by CED to undertake an additional environmental assessment for the use of the decommissioned Kennedy Town Incineration Plant (KTIP) site as an alternative access option for the barging of Public Dump materials to the Green Island Public Dump. The assessment of impacts with respect to the environmental key issues identified under the Main Agreement has been conducted for the construction and operation of the Marine Barging Point site, and the findings are incorporated into this report.

1.4 The report is presented in two volumes (Vol. I and Vol. II), where the environmental assessment comprises this report, Vol. I and the traffic impact assessment (land and marine) is Vol. II.

Background

1.5 One of Government's key policy objectives for waste management within Hong Kong is to ensure that proper facilities are available to dispose of all waste in a cost-effective and environmentally acceptable manner. In early 1992, the Fill Management Committee formulated a Public Dumping Strategy which identified those short and long term reclamation sites required to meet the Territorial demand for the disposal of surplus materials suitable for public dumping. The sites identified have been termed "Public Dumps". The Strategy was endorsed by the Land Development Policy Committee on 27 March 1992. In the Strategy it was recommended that part of the proposed Green Island Reclamation should be advanced for the purposes of receiving public dump material from 1995 onwards. Following initial investigations it was concluded that the portion of the Sulphur Channel between Green Island and Kennedy Town, covering an area of some 37 hectares, was suitable for infilling with public dump material and could be designated as a public dump. The location of the proposed dump is shown on Figure 1.1.

1.6 According to the Public Dumping Strategy, barging points are needed for the transportation of suitable public dumping material to public dumps in order to minimise land traffic impact. The former KTIP site has been identified as a suitable site for a barging point for the Green Island Public Dump. It would become available after the existing plant and structure are demolished, and the site decontaminated, currently scheduled at the beginning of 1996. The Marine Barging Point would serve as an interim facility, alleviating the land traffic volume associated with the public dump until approximately mid-1997. The Marine Barging Point site would then be restored to open space/ recreational use, as designated under the Kennedy Town and Mount Davis Outline Zoning Plan (S/H1/4). Besides the use of other barging sites on Hong Kong Island such as Quarry Bay water front and Aldrich Bay Reclamation, will help to improve the traffic flow situation as compared with the case of having only one barging point in operation. It is currently planned to operate the barging point at Aldrich Bay Reclamation from mid-1995 to late 1997 whilst the one at Quarry Bay will be operated after 1997 on a long-term basis.

1.7 The Green Island Public Dump is a key component of the public dumping programme and will provide the only facility for the dumping of suitable public dumping material on Hong Kong Island in the period 1996 to 2002. Its location close to the residential, commercial and business districts of Western and Central dictates that the transportation of suitable public dumping material through this area will be a sensitive issue. To address this issue, and that of marine traffic impacts, a separate Land and Marine Traffic Impact Assessment (TIA - Refs 1.3 and 1.4) has been conducted in parallel with the EIA.

Context of the Environmental Assessment

1.8 It is broadly recognised that the infilling of areas for reclamation using materials suitable for public dumping is a preferred means of disposal for such waste. By putting this material to positive use the need to dredge or quarry materials for fill is reduced, as are the demands placed on disposal to Hong Kong's existing landfills. However, it is also recognised that the development of such public dumps have the potential to cause adverse impacts on the marine environment and the local community as a result of their construction and subsequent operation. As such, Government procedures require that an environmental assessment be conducted to determine the type and severity of the environmental impacts of these works.

1.9 By carrying out an initial assessment, key environmental issues of concern were identified at an early stage so that essential information could be supplied to the design process. Furthermore areas were identified for further detailed assessment in the subsequent EIA, as presented in this report. The incorporation of environmental considerations into the feasibility stage of the project will allow for the inclusion of suitable mitigation measures in the design, construction and operation of the works. By doing so the works can be managed within the restraints of Government regulations and guidelines and to an environmentally acceptable standard.

1.10 Key issues of concern which were identified in the Final IAR and subject to preliminary assessment included the following:

- noise impact;
- air quality impact;
- water quality and dredged sediments;
- sewerage impact;
- marine ecology;
- terrestrial ecology; and
- visual impact

1.11 In conducting the environmental assessment reference has been made to all relevant ordinances and related technical guidance on the environment and to the Hong Kong Planning Standards and Guidelines (Ref 1.5).

Scope of the Final EIA

1.12 The Final Report (EIA) of the public dump proposals has been based on the recommendations for further study as presented in the Final IAR and the Summary of Key Findings Report. These recommendations are presented, as appropriate, at the beginning of each Chapter in this report. In addition the findings of the TIA Working Papers have been considered in an environmental context and relevant information from the reports has been used for the purposes of assessment in the EIA. Under the Supplementary Agreement to the Main Agreement CE 7/93, the construction and operation of the Marine Barging Point has been assessed against the environmental key issues given in Section 1.10.

1.13 This information has been assessed in conjunction with the engineering proposals, as far as these are known. The requirements of the brief with respect to the EIA are summarised as follows:

(a) to identify and describe the elements of the community and environment, including wildlife habitats on Green Island and Hong Kong Island, likely to be affected by the proposed project;

(b) to minimize pollution, nuisance and environmental disturbance arising from the Project;

(c) to identify and evaluate the net environmental impacts and cumulative effects expected to arise during the execution of the Project in relation to the existing and planned community and neighbouring land uses;

(d) to recommend cost-effective methods and measures, and to identify standards, which may be necessary to mitigate these impacts and reduce them to acceptable levels;

(e) to recommend environmental monitoring and audit requirements necessary to ensure the effectiveness of the environmental protection measures adopted; and

(f) to identify and evaluate the net environmental impacts.

1.14 The Final EIA Report is presented in the following chapters :

- *Chapter 2* The Study Area
- *Chapter 3* Sequence of Works
- *Chapter 4* Noise Impact
- *Chapter 5* Air Pollution
- *Chapter 6* Sewerage Impact
- *Chapter 7* Water Quality and Dredged Sediments
- *Chapter 8* Marine Ecology
- *Chapter 9* Terrestrial Ecology
- *Chapter 10* Visual Impact
- *Chapter 11* Monitoring and Audit Requirements
- *Chapter 12* Conclusions and Recommendations

References

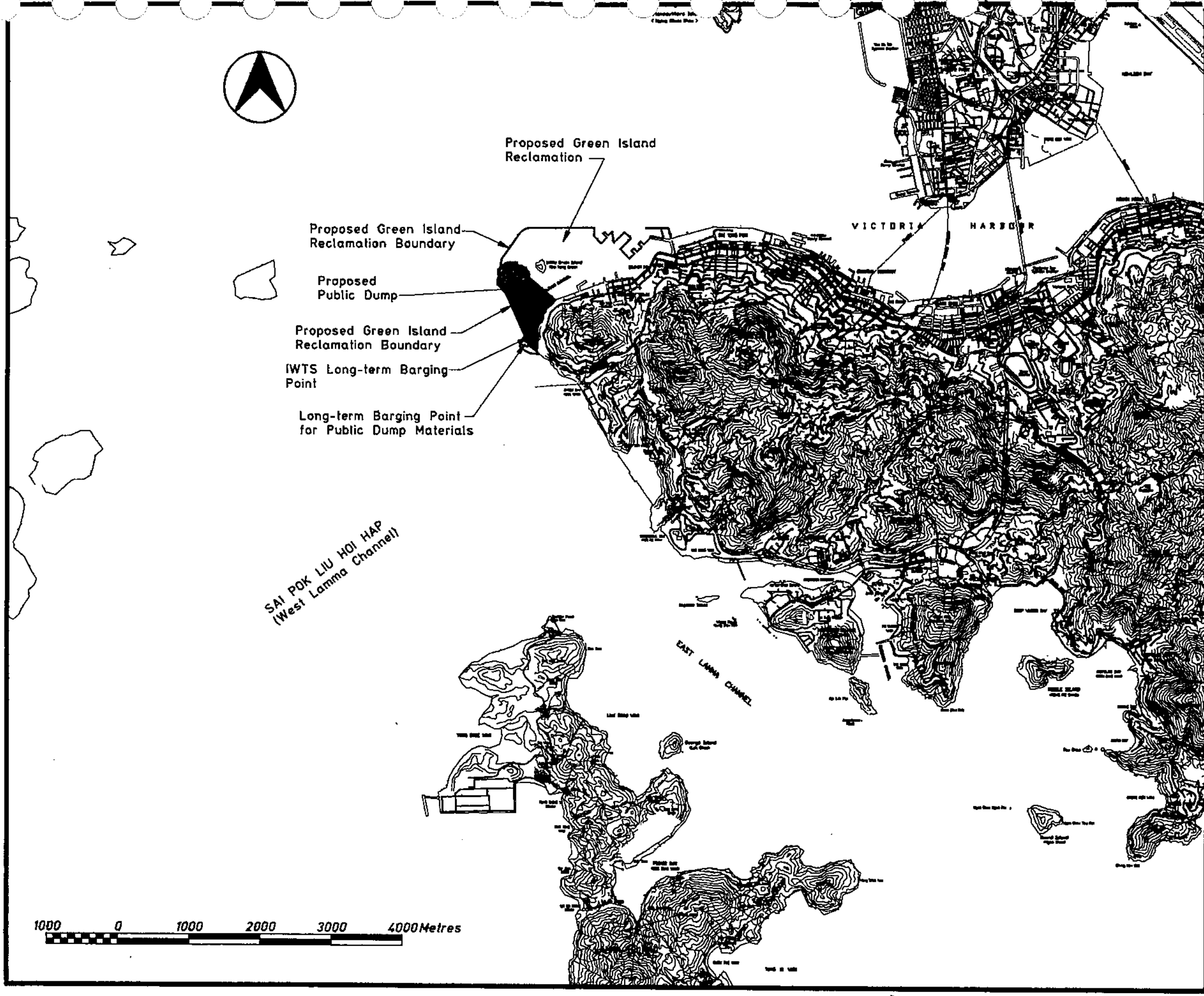
1.1 Green Island Reclamation (Part) Public Dump, Enviornmental & Traffic Impact Assessment Final Initial Assessment Report. Scott Wilson Kirkpatrick (Hong Kong) Ltd. Civil Engineering Department, October 1993.

1.2 Green Island Reclamation (Part) Public Dump, Environmental & Traffic Impact Assessment. Summary of Key Findings (EIA). Scott Wilson Kirkpatrick (Hong Kong) Ltd. Civil Engineering Department, November 1993.

1.3 Green Island Reclamation (Part) Public Dump, Environmental & Traffic Impact Assessment. Traffic Impact Assessment (Land). Scott Wilson Kirkpatrick (Hong Kong) Ltd. Civil Engineering Department, November 1993.

1.4 Green Island Reclamation (Part) Public Dump, Environmental & Traffic Impact Assessment Traffic Impact Assessment (Marine). Scott Wilson Kirkpatrick (Hong Kong) Ltd. Civil Engineering Department, November 1993.

1.5 Environmental Guidelines for Planning in Hong Kong. An extract from the Hong Kong Planning Standards & Guidelines. Hong Kong Government, 1991.



GREEN ISLAND RECLAMATION (PART) - PUBLIC DUMP FINAL REPORT(EIA)

Figure No. 1.1

Location Plan

2. THE STUDY AREA

Introduction

2.1 The study areas for the assessment relate to those for the consideration of marine traffic impacts, road traffic impacts, and water quality impacts. The study areas for the assessment of air quality and noise impacts are also delineated by the road traffic impact study area. Marine and road traffic study areas are shown in Figure 2.1, and the water quality impact study area in Figure 2.2. The study area for visual assessment has no defined boundaries but considers views from the Outlying Islands and West Kowloon.

Site Description

2.2 The proposed public dump will cover an area of 37 hectares. The dump will be located between Green Island and Kennedy Town, and will form part of the larger Green Island Reclamation which will cover a total area of 185 hectares. This area has been selected as a public dump on the basis that the facility would not be in conflict with adjacent development programmes forming the larger Green Island Reclamation, and that there were no specific development programmes for this area when the "Public Dump Strategy" was formulated in 1992.

2.3 At present, the proposed reclamation area is open marine water comprising the deep and fast flowing navigational route of Sulphur Channel. The area is located at the foot of the north-western slope of Mount Davis, the slopes of which are currently used for open space, recreational purposes and low-rise residential development. The reclamation will link the western tip of Hong Kong Island to Green Island located approximately 500 metres offshore. Currently, Green Island is largely undeveloped with a coverage of natural vegetation and a rocky shoreline habitat. Existing buildings on the island include a meterological station, an automatic lighthouse, a disused signal station, and a Detention Centre.

Environmental Setting and Landuses

2.4 The proposed Marine Barging Point site is approximately 80 m in both dimensions, some 0.6 ha in area, and is accessible from Victoria Road. Waste will be delivered to the site by truck and end-tipped to barges for transportation to the Public Dump. A site location plan is shown in Figure 2.3 and a conceptual operation plan in Figure 2.4. Further details on traffic issues and operational arrangements can be found in the Traffic Impact Assessment Revised Draft Final Report to this study (Ref 2.1).

2.5 The existing land uses in the vicinity of the Public Dump and Marine Barging Point range from the industrial, residential and recreational environs of Kennedy Town to the east, to a Green Belt Zone of open space, park and amenity area surrounding Mount Davis to the south and west. The existing Victoria Road runs along the headland abutting Lau Wong Hoi Hap (Sulphur Channel), and connects Kennedy Town with Wah Fu. The existing alignment and geometry of Victoria Road is considered to be sub-standard and proposals have been made for it to be upgraded (Ref 2.2).

2.6 The shoreline of Kennedy Town is marked by a mixed residential, recreational and industrial marine frontage which includes the China Merchants Wharf to the east of the reclamation area, and Urban Services Department Depot to the west. Significant land uses in the immediate vicinity of the reclamation site include a temporary recreation area on Sai Ning Street (football pitches, sitting out area) which is zoned for ultimate use as a Cargo Handling Area, commercial /godown properties, and a bus terminus. The KTIP located on the junction of Sai Ning Street was decommissioned in March 1993. Other Government, institution and community uses in the area include a mortuary at the eastern end of Sai Ning Street, and an abattoir and wholesale fish and vegetable market to the west of Cadogan Street.

2.7 The area to the landward side of the proposed reclamation area falls within a Green Belt Zone, as shown on the draft Kennedy Town and Mount Davis Outline Zoning Plan (OZP) No. S/H1/4 (Ref 2.3). The Metroplan Landscape Strategy for the Urban Fringe and Coastal Areas Report, identifies areas near to the proposed reclamation site as 'Landscape Protection Areas' and 'Development Areas with High Landscape Value' and proposes that Mount Davis be retained as a 'Landscape Protection Area' with potential for future enhancement as an urban fringe park (Ref 2.4). The Green Island Reclamation Feasibility Study has also identified that areas to the west of Mount Davis warrant designation as 'Areas of High Amenity Value' (Ref 2.5).

Sensitive Receivers

2.8 There are numerous sensitive receivers in the vicinity of the proposed Public Dump and Marine Barging Point which have the potential to be adversely affected by the development. The Mount Davis Cottage Area (under the control of Housing Department) at Kung Man Tsuen is a significant existing residential housing area. Its location and proximity to the proposed public dump is considered highly sensitive to all phases of the reclamation. Other sensitive receivers in the vicinity include the residential tower, Serene Court, a recreation area and Old Folks Home on Sai Ning Street, the Lui Ming Choi Memorial School on Ka Wai Man Road, the Kennedy Town Jockey Club Clinic and Welfare Centre on Victoria Road, and the Sam Kindergarten in the Mount Davis area located further west along Victoria Road. It is probable that all of these developments will act as sensitive receivers to all phases of the reclamation.

2.9 Proposed land uses in the vicinity of the proposed reclamation area as shown on the OZP No. S/H1/4 (Ref 2.3) include residential development to the seaward side of Victoria Road, and Government/Institution and Community uses on the landward side of Victoria Road and at the western end of Sai Ning Street. There is no definite development schedule for these landuses and it is unlikely that they will be sensitive receivers during the construction phase of the reclamation.

2.10 Identified sensitive receivers for the purposes of noise and air quality assessment are given in Tables 4.3 and 5.1 (a and b) of this report, respectively.

References

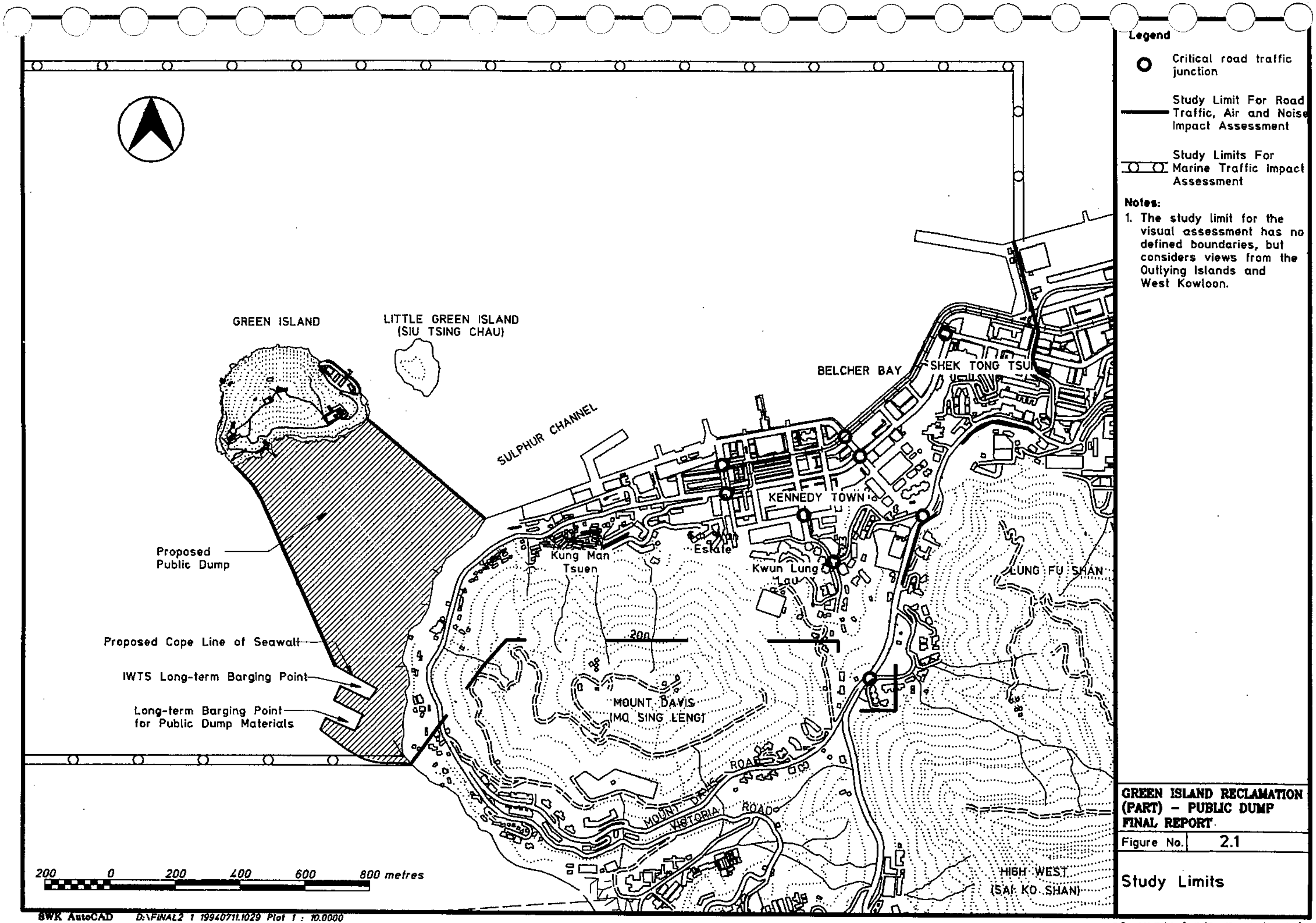
2.1 Green Island Reclamation (Part) Public Dump, Traffic Impact Assessment (Revised Draft Final Report). Scott Wilson Kirkpatrick (Hong Kong), Civil Engineering Department, May 1994.

2.2 Victoria Road Improvements Stage II Final Preliminary Report Volume 1. Rendel Palmer and Tritton International Hong Kong Ltd., in association with BCP Hong Kong, Binnie and Partners (Hong Kong). Highways Department, Hong Kong.

2.3 Kennedy Town and Mount Davis Outline Zoning Plan No S/H1/4, August 1993.

2.4 Metroplan: Landscape Strategy for the Urban and Coastal Areas by Strategic Planning Unit, Land & Works Branch, March 1989.

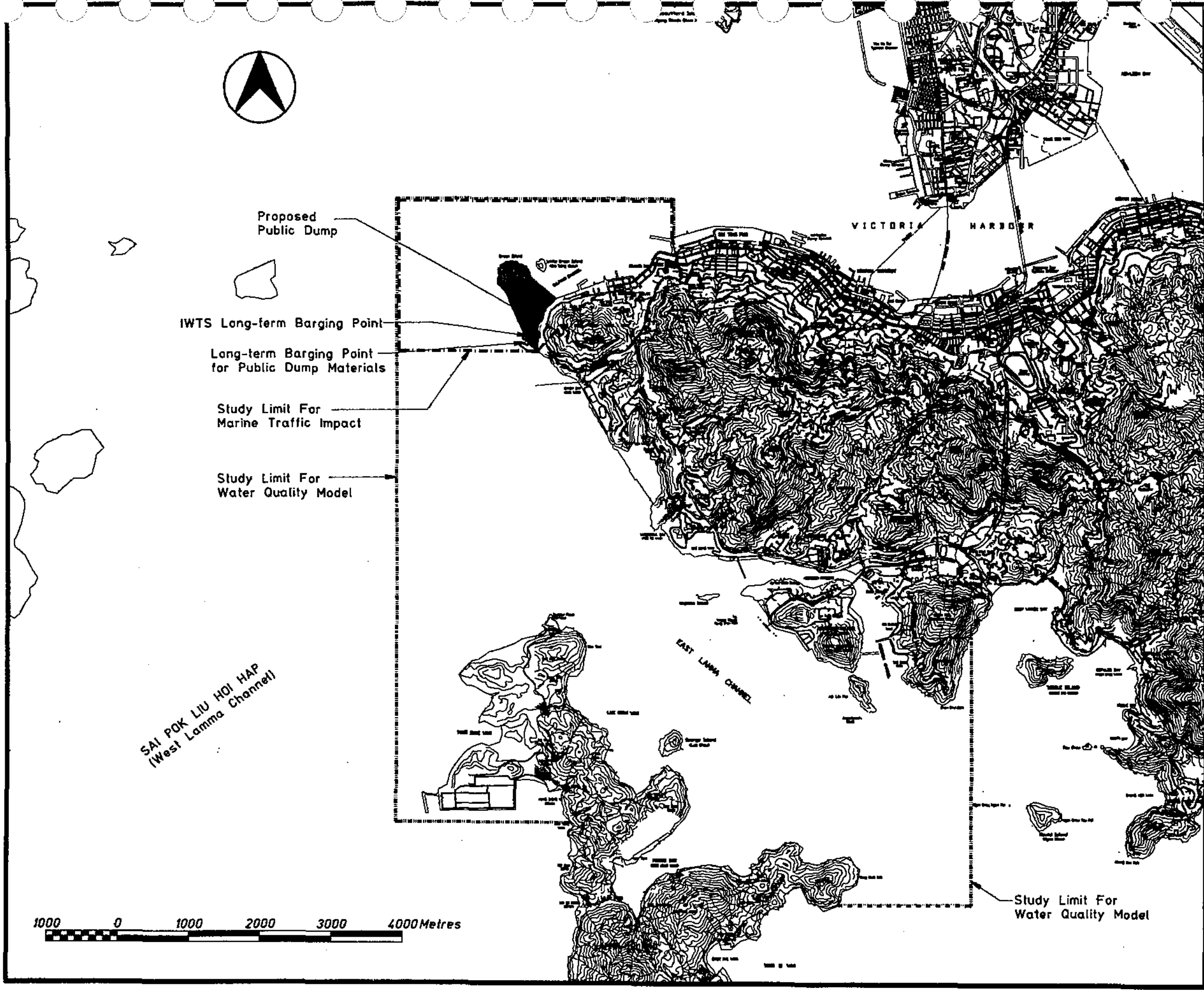
2.5 Green Island Reclamation Feasibility Study (H197) Technical Paper No. 13. Urban Design and Landscape Guidelines. Ove Arup & Partners, Peter Y.S. Pun & Associates. Territory Development Department, Urban Area Development Office, 1989.



GREEN ISLAND RECLAMATION (PART) – PUBLIC DUMP FINAL REPORT

Figure No. 2.1

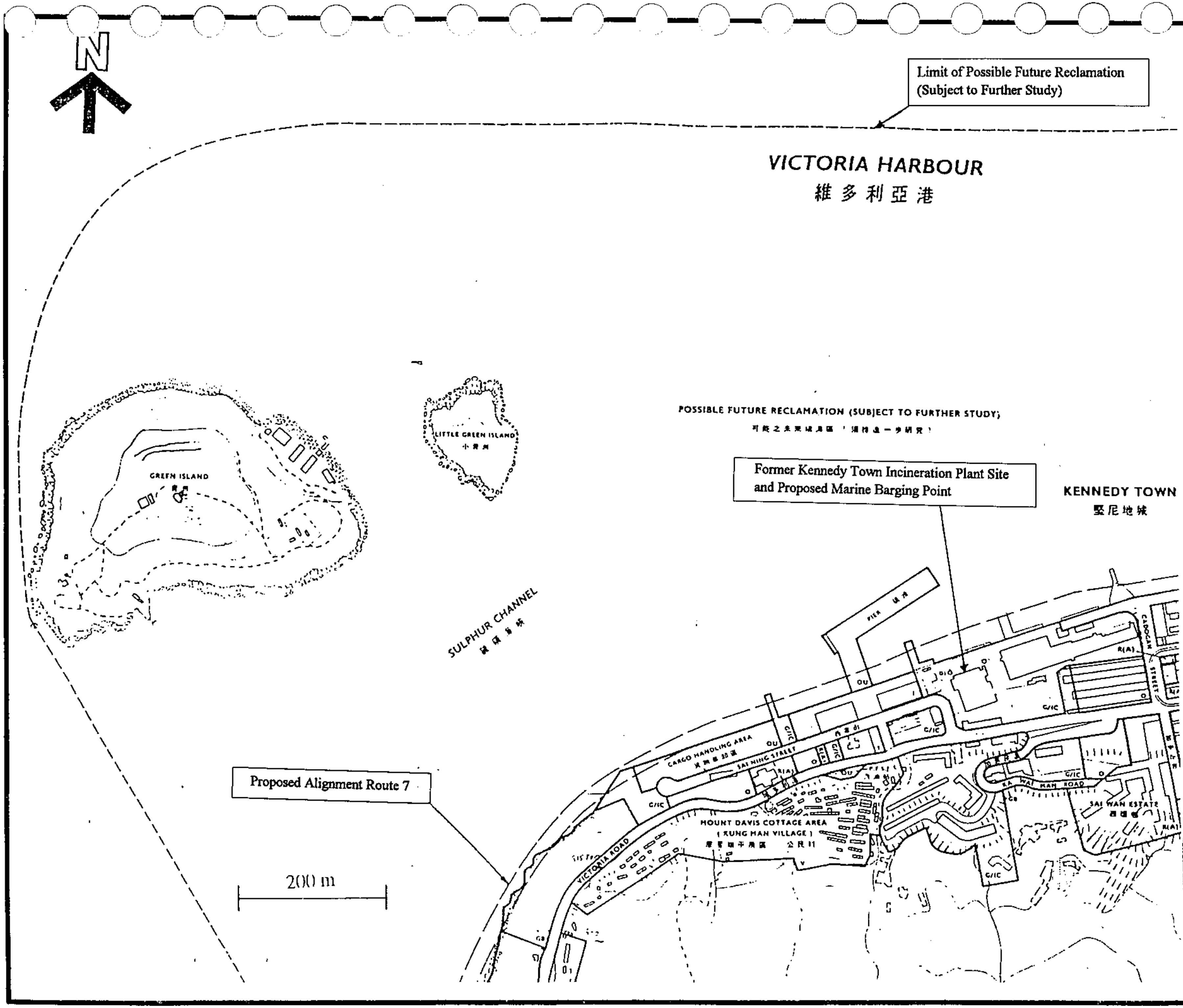
Study Limits



GREEN ISLAND RECLAMATION (PART) – PUBLIC DUMP FINAL REPORT

Figure No.	2.2

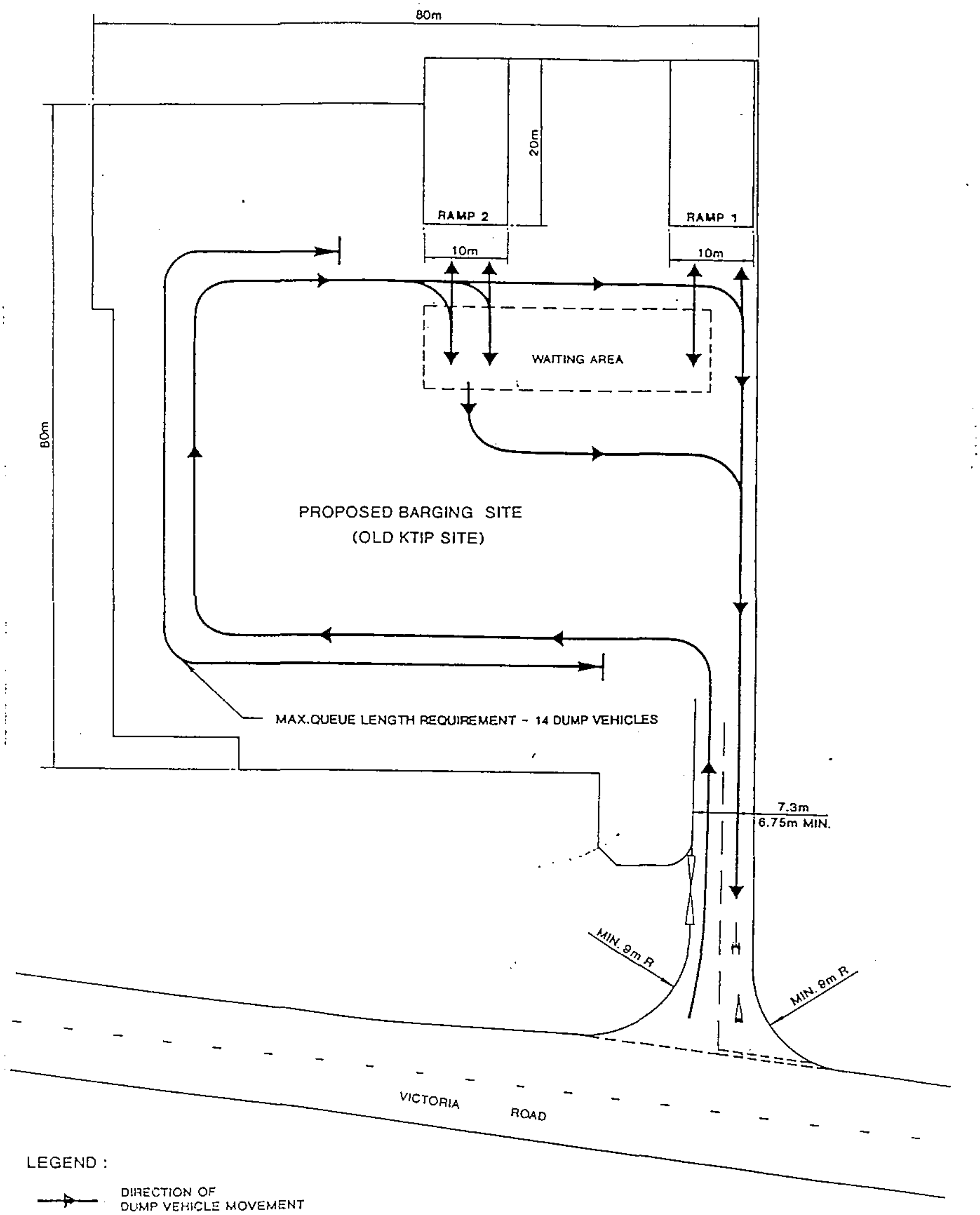
Limits of Water Quality Study



GREEN ISLAND RECLAMATION (PART) - PUBLIC DUMP
FINAL REPORT

Figure No.	2.3

Proposed Location of Marine Barging Point



GREEN ISLAND RECLAMATION (PART) - PUBLIC DUMP FINAL REPORT

Figure No. 2.4

Operational Layout Plan of Marine Barging Point

3. SEQUENCE OF WORKS

Introduction

3.1 This chapter of the report provides an update on the construction and commissioning dates for major projects in the area of the Green Island Reclamation and a description of the works and activities which will be required in order to construct and operate that part of the reclamation which will form the proposed public dump.

3.2 During the study information has been made available by CED who are carrying out the design and sequencing of the proposed reclamation for the public dump. The Consultants have therefore carried out a critical examination and review of the assumptions and constraints used in deriving the sequence of works sketch given in Appendix I of the Consultancy Brief (shown in Figure 3.1) and have used this as a basis for further work during the study.

3.3 The CED has provided guidance on the implementation programme and sequence of work to be adopted. These, and a construction works programme are given in this chapter.

3.4 A detailed sequence of works assessment has been made which considers the requirements for importation of rockfill and sand blanket, phasing of seawall construction and the potential for stockpiling public dump material. Details of the sequence of works required to achieve the general approach given in the consultancy brief are also described.

Other Projects and Related Access Arrangements

3.5 Table 3.1 shows the construction and commissioning dates which have been given or assumed for each of the committed or proposed projects in the study area affecting public dump activities from 1996 to 2002. Relevant projects are shown on Figure 3.2.

3.6 The layouts considered for the proposed Green Island Reclamation and Route 7 Expressway are those given in the Green Island Reclamation Feasibility Study (GIRFS) Draft Final Report (Ref 3.1). Although Route 7 (Kennedy Town to Aberdeen) and the part of Green Island Reclamation required for it will not affect the public dump, they will affect the long-term transport arrangements for the Island West Transfer Station (IWTS) and the Mount Davis Sewage Treatment Works (MDSTW). By landlocking the area available for the interim IWTS marine reception area, an alternative long-term marine reception area will be required for the transfer of bulk waste to the WENT Landfill. It is planned to locate this at the south-west corner of the Area 1 reclamation on the western seawall which would be accessed along part of the adjacent Route 7 distributor road. In addition, a long term barging berth for public dump materials is proposed next to the IWTS marine reception area. However, the end user of these berthing facilities will have to undertake a separate environmental impact assessment study.

3.7 In the Consultancy Brief, the temporary eastern seawall is proposed to be aligned between the south-eastern shore of Green Island and the corner of the seawall for the proposed IWTS barging point. If this alignment is necessary then extensive liaison with the IWTS contractor will be required for the tie-in section to be constructed. Furthermore, the tie-in section would reduce the effective marine frontage for IWTS barging operations. Therefore, the alignment should be moved westwards.

3.8 Reluctance to interfere with the IWTS project stems from two points. The first is that the existing Urban Services Department (USD) depot (see Figure 3.2) will be required as a works area for the construction of the cavern facility. The second is that under current arrangements the IWTS contractor will be responsible for the design, construction and maintenance of the

IWTS access road from Victoria Road to suit the cavern layout and orientation, and subject to being able to connect into Route 7.

3.9 Other nearby proposed developments affecting the public dump include the Drainage Services Department's (DSD) underground MDSTW as considered under the SSDS study and the Water Supplies Department's (WSD) service reservoir on the surface above IWTS. Details of MDSTW requirements are contained in SSDS Working Paper No. UG6 (Ref 3.2) and essentially involve the timely formation of reclamation between the USD depot and the MDSTW cavern for a works area and access. The MDSTW access road would later be incorporated into Route 7. It is possible that 20 to 30ha of land on Green Island Reclamation may be required for secondary level sewage treatment. This would be an addition to the currently proposed MDSTW if the SSDS Stage II oceanic outfall proposal is not retained.

Table 3.1 - Commissioning Dates for Other Relevant Projects

Other Relevant Projects	Construction Date	Commissioning Date
Island West Transfer Station	Late 1994	Late 1996
Rock Hill Street Extension	June 1994	June 1996
Extension to Smithfield Road	Late 1994	January 1997
Cadagon Street Building Development	Mid 1993	Early 1997
Route 7 (Sai Ying Pun to Kennedy Town including Belcher Bay Link)	1993	1997
Route 7 (Kennedy Town to Aberdeen)	2008 [4]	2011 [1]
Green Island Reclamation (Remainder)	2005 [4]	2008 [6]
SSDS Mount Davis Sewage Treatment Works	1999 [4]	2002 [2]
WSD Service Reservoir	Early 1997 [3]	End 1999 [3]
Marine Borrow Area	Mid 1994 [5]	Early 1997
Central, Western and Wan Chai West Sewage	1996	2000

NB:

1 - Transport Department, Highways Department CTS2 Update
2 - Advised by AB_2H letter to SWK (ref C/11/REB/JB/at/2230L) dated 16.3.92
3 - Advised by WSD memo to CED (Ref (5) in WWO 3071/87V dated 17.1.94
4 - Assumed three year construction period
5 - Refer to SWK letter (ref 93837/211/2921) dated 1.11.93
6 - Assumed from 1

Sources of Fill

3.10 The Technical Note on sources of materials and traffic routes issued earlier in this study presented findings on a search of the database prepared by the Fill Management Committee on annual fill requirements and surpluses from Government projects. It was concluded that during 1996, 1999, 2001 and 2002 the majority of public dump material would arise on Hong Kong Island from private sector projects and during 1997, 1998 and 2000 on Kowloon from

Government projects. These findings, which have attracted no adverse Government comment have been considered in the following section rather than the assumed scenario given in the Brief, which is based on all public dump material being delivered by road.

Preliminary Implementation Programme

3.11 A preliminary implementation programme, based on the sequence of works sketch shown in Figure 3.1, is given in Figure 3.3. Assumptions for the preliminary implementation programme are as follows:

- a contaminated mud disposal area is available (otherwise should add 3 to 4 months for identification and approval of disposal destination);

- one contractor will be appointed for the advance works (ie Stage I Area 1 work) and the following Stage I Area 2 work to avoid re-mobilisation of plant and equipment;

- because of the strong currents expected in the 100 m wide fairway, there will be a 50% reduction in the productivity rate of adjacent seawall construction and the laying of the sand blanket during Stages II and III;

- to reduce the impact of sediment plumes arising from public dump filling, the western seawall will be completed as soon as possible;

- production rates
  - dredging 500,000 m^3/month
  - permanent seawall construction 800 m p.a. } if constructed separately
  - temporary seawall construction 1,000 m p.a. }
  - permanent seawall construction 600 m p.a. } if constructed together
  - temporary seawall construction 800 m p.a. }
  - public dump filling rate of 1.0 million m^3 p.a.

- public dump filling will be limited to rising tides; and

- there is sufficient capacity in the dump, excluding Area 1, for over 7.0 million m^3 of public dumping material. Whenever the situation is considered appropriate, silt curtains will be provided along the alignment of the seawalls to avoid the dispersion of suspended solids in the water column. Moreover, either sealed closed-grab with silt curtains or cutter-suction dredger for the dredging of seawalls, shall be used where possible.

Access to the Dump

3.12 Two road access arrangements to the public dump have been considered although it is considered unrealistic for access to be achieved in time for filling in early 1996. These options are known as the IWTS and Disused Track options and involve considerable interface with both IWTS and MDSTW projects respectively. This could effectively rule out road access altogether leaving marine access as the only viable option. The two road options are shown on Figure 3.4. The IWTS option involves the widening of the proposed IWTS access road for shared use by both projects. Other options considered include the use of Sai Ning Street which accesses the USD depot and the use of a conveyor belt from a reception area built off Victoria Road. The former was effectively ruled out during both the Cavern Project (CAPRO) (Ref 3.3) and IWTS studies (Ref 3.4) in order to avoid disruption to warehouse activities by China merchants who make extensive use of Sai Ning Street. The latter would involve building an elevated structure to serve as a loading platform for the conveyor belt. This is considered to be operationally unsound both environmentally and from a traffic management viewpoint.

3.13 It is proposed that the selected road access arrangement would be utilised following the interim use of the barging point on the former KTIP site. The use of the barging point is expected to continue until mid-1997, at which time the site will be developed for open space/recreational use according to Kennedy Town and Mount Davis OZP S/H1/4. The barging point and road access arrangement would not therefore be used concurrently for transportation of material to the dump site. Following completion of the public dump, the selected road access arrangement would be decomissioned and the land reinstated. This particularly applies to the Disused Track option where extensive re-vegetation would be required in those sections not required by other projects.

Stage I (Advance Works)

3.14 In order to receive public dumping materials as soon after contract award in July 1995, advance works will be required to allow receipt of the required volumes at the expected rates of fill. This will be achieved by constructing Stage I Area 1 as advance works along with any works required for marine access arrangements. To accept public dump material from April 1996 it is necessary to complete by then, as an absolute minimum, most of Area 1 and the adjacent sections of the western seawall and the Area 2 sand blanket.

3.15 Depending on the sources of rockfill for the advance works seawall construction, it may be necessary to construct a part of the advance works reclamation to accommodate rock crushing plant. An area of maximum 100 m x 50 m could cope with the full range of crushing processes and stock-piling required. In the event that suitably-sized rockfill were directly available, no rock crushing plant would be necessary for the advance works. Therefore, the rock crushing plant required for processing over-sized material during public dump filling would be located on the completed advance works reclamation (Area 1).

3.16 It is estimated that part of the rockfill which is required for the advance works seawall construction could be available from the IWTS project between early 1995 and late 1996. There is no suitable holding area for the storage and sorting of the IWTS excavated rock spoil within the IWTS site, so arrangements would have to be made for this in the Green Island site. A suitable area might be the foreshore adjacent to Area 1. Table 3.1 shows that there are other projects, such as MDSTW and the WSD service reservoir which might provide sources of rockfill for seawall construction provided that the fill is made available to suit the public dumping programme.

Stage I (remainder)

3.17 The remaining work required for public dump filling in Area 2 includes dredging and seawall construction of the additional sections for the permanent and temporary seawalls and the placing of a nominal 1 m thick sand blanket and wick drains over the remainder of Area 2.

Scope of Construction Work

3.18 The maximum scope of the construction works, from a dredging and filling point of view comprises:

- $3,600,000m^3$ of full trench dredging given that this is the preferred construction method in water depths of zero to 22 m, and maximum dredging depths of up to 36 m; and
- $3,200,000m^3$ of sand or cdg filling to trenches (based on the assumption that $500,000m^3$ of rock is required to be placed from the seabed level upwards).

Construction Programme

3.19 A possible construction programme is shown in Figure 3.5. The anticipated dredging rate for the trench dredging is 500,000m^3/month and would take some 9 months to accomplish. Areas 1 & 2 in Stage I are shown to be completed 24 months from the end of the mobilisation period, which makes efficient use of the marine construction plant.

Dredging Methods

Shallow Waters

3.20 In shallow waters it will not be possible to use trailer dredgers, since their laden drafts tend to be around 9 m or greater and they would not wish to navigate in such close proximity to the shore. Therefore, grab dredgers are preferred for this work. They have a number of advantages. They are relatively shallow draft, can dredge themselves into shallow areas, and it would be possible to use silt curtains around them if it was demonstrated that the mud was contaminated.

3.21 Grab dredgers are affected by currents. However, the maximum current in the centre of the Sulphur Channel seems to be less than 0.4m/s for most of the tidal cycle and it is assumed that the currents along the coast will be even slower. An efficient 6 m^3 grab dredger working in, say, 5 m of water would probably achieve a production rate of between 30,000 and 40,000 m^3/wk. Production rates will drop rapidly as the water depths increase and the currents become stronger further out into the channel. Grab dredgers should thus only be considered for the inshore work. Outputs will not be affected by disposal distance since this is only a matter of supplying more barges.

Deep Waters

3.22 In view of the relatively weak tidal currents and the fact that the trench dredging is to be carried out in one operation it is considered that the use of a trailer dredger is feasible. The production rates which might be achieved in the two trenches by a 5,000 m^3 trailer are as follows:

	Disposal distance (km)	Output (m^3/wk)
Western Trench		
Upper layers:	15	190,000
	25	97,500
	40	65,700
Lower layers:	15	73,900
	25	50,000
	40	33,700
Trench B		
Upper layers:	15	134,000
	25	93,000
	40	64,000
Lower layers:	15	69,000
	25	48,000
	40	33,000

3.23 The lower production rates in Trench B are due to the shorter length and the necessity for the dredger to turn more frequently. A range of disposal distances have been given as, at the present time, it is not known where the contaminated dredged mud will be placed. Clearly, these productions, together with the productions from one of two grab dredgers, are likely to be high enough to satisfy the stated rate of 500,000 m^3/month.

Filling Methods

3.24 There are two types of filling operation to be carried out; placing sand in trenches up to the original sea level and placing a 1 metre thick sand blanket over the fill area.

Trench Filling

3.25 Trench filling, except in shallow areas, would be carried out by another trailer dredger. Sand has been assumed in preference to cdg due to the past-track requirement for Stage 1, Area 1 and 2 works which have a tight programme. Sand would be won from a marine borrow area (location not yet identified) and deposited in the dredged trench. Bottom dumping of sand is not recommended from both the operational and environmental viewpoint. A potentially more material-efficient method of deposition is to pump the hopper out through the suction pipe, thereby ensuring by careful positioning of the pipe that the sand remains in the trench. Production rates for this type of operation for a 5,000 m^3 capacity trailer have been estimated and are given below.

Transport distance (km)	Weekly output (m^3/wk)
15	106,700
25	90,200
40	73,200

3.26 These rates assume that the sand is being won at a depth of 25 metres in a borrow area which has overburden removed by other plant, and that the sand has a relatively low fines content (similar to the marine sand in the East Lamma Channel). The pumping out process is assumed to take 120 minutes on the basis that it is passed through one of the suction arms of a twin pipe vessel.

Placing of Sand Blanket

3.27 Sand for the sand blanket would be dredged as for the trench filling. To form the blanket the trailer could be operated in a number of ways, depending on its discharge arrangements. If it is assumed that the bottom discharge arrangements do not lend themselves to careful placing of sand, then a bow spraying method could be adopted. In this mode the dredger would sail slowly down a series of parallel lines in the filling area, spraying a sand/water mixture out of a bow pipe in a fan shaped trajectory ahead of the vessel. This would ensure that the sand was well distributed over the sea floor and would reduce the possibility of failure of the mud underlayers.

3.28 With some trailers, controlled bottom-dumping may be feasible. The bow spraying method could take as long as the trench filling method described above and therefore it would be prudent to assume the same rates of production for the same sized vessel.

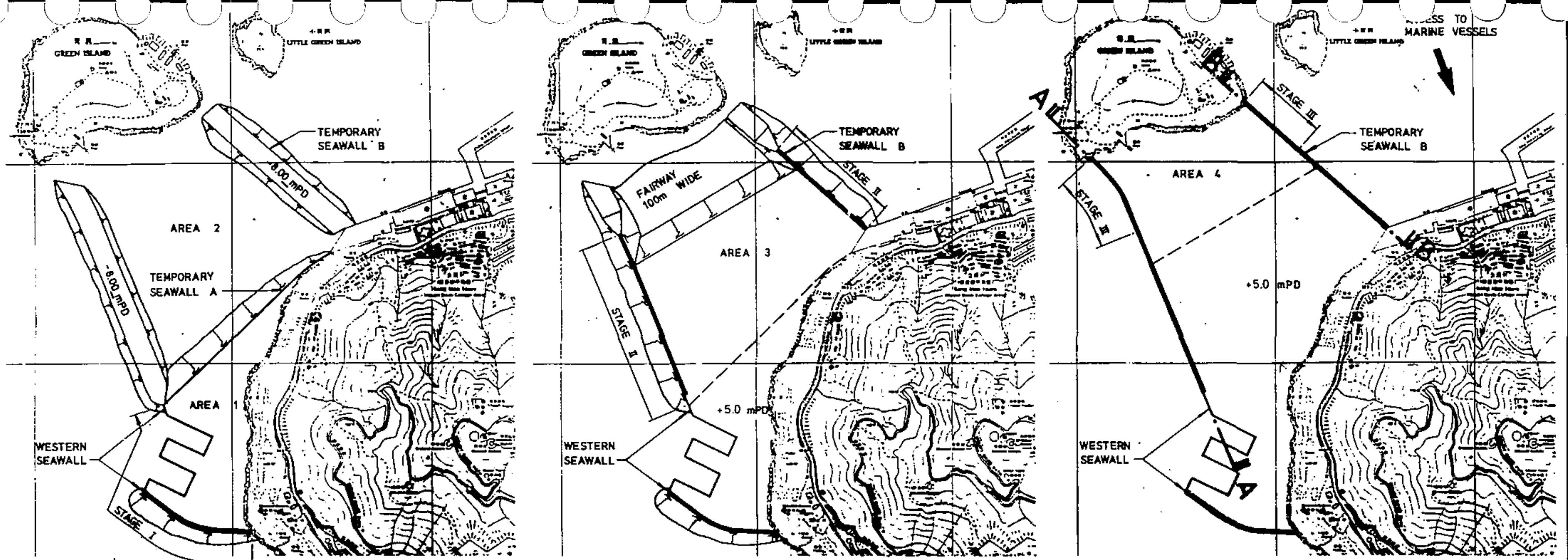
References

3.1 Green Island Reclamation Feasibility Study, Draft Final Report. Ove Arup & Partners. Territory Development Department, 1992.

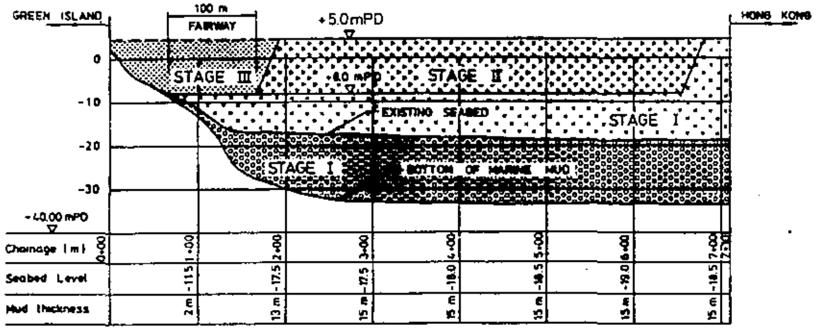
3.2 Strategic Sewage Disposal Scheme, Working Paper UG6 on Mount Davis Works. AB_2H Consultants. Drainage Services Department, May 1992.

3.3 Cavern Project Studies, Final Report on Refuse Transfer Station. Ove Arup & Partners. Civil Engineering Department, May 1991.

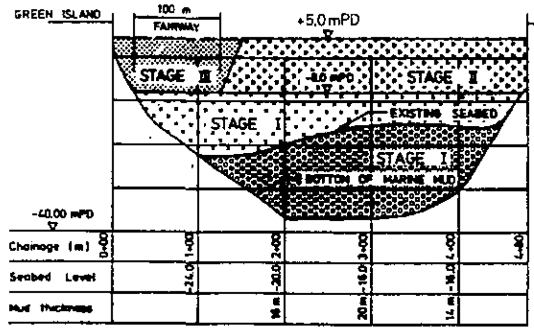
3.4 Island West Transfer Station Study, Final Report. Scott Wilson Kirkpatrick (Hong Kong). Environmental Protection Department, January 1993.



STAGE I	STAGE II	STAGE III
1. Dredge mud for all Seawall foundation starting from H.K. Island.	1. Build next stage of Western Seawall & Temporary Seawall B to +6.0 & 5.0mPD respectively.	1. Divert marine traffic to North Green Island Fairway.
2. Build Western Seawall & Temporary Seawall A to +6.0 & 5.0mPD respectively.	2. Maintain Fairway (reduced to 100m width).	2. Build remainder of the Seawall to +5.0mPD.
3. Place sand blanket in Area 1 & fill to form platform with public dump material by barge.	3. Public dumping by barge & end tipping to Area 3.	3. End tipping of public dumping material in Area 4.
4. Build remainder of Western Seawall & Temporary Seawall B to -8.00 mPD.	4. Drainage works.	4. Drainage works.
5. Place sand blanket & wick drains in Area 2.		



LONGITUDINAL SECTION A-A



LONGITUDINAL SECTION B-B

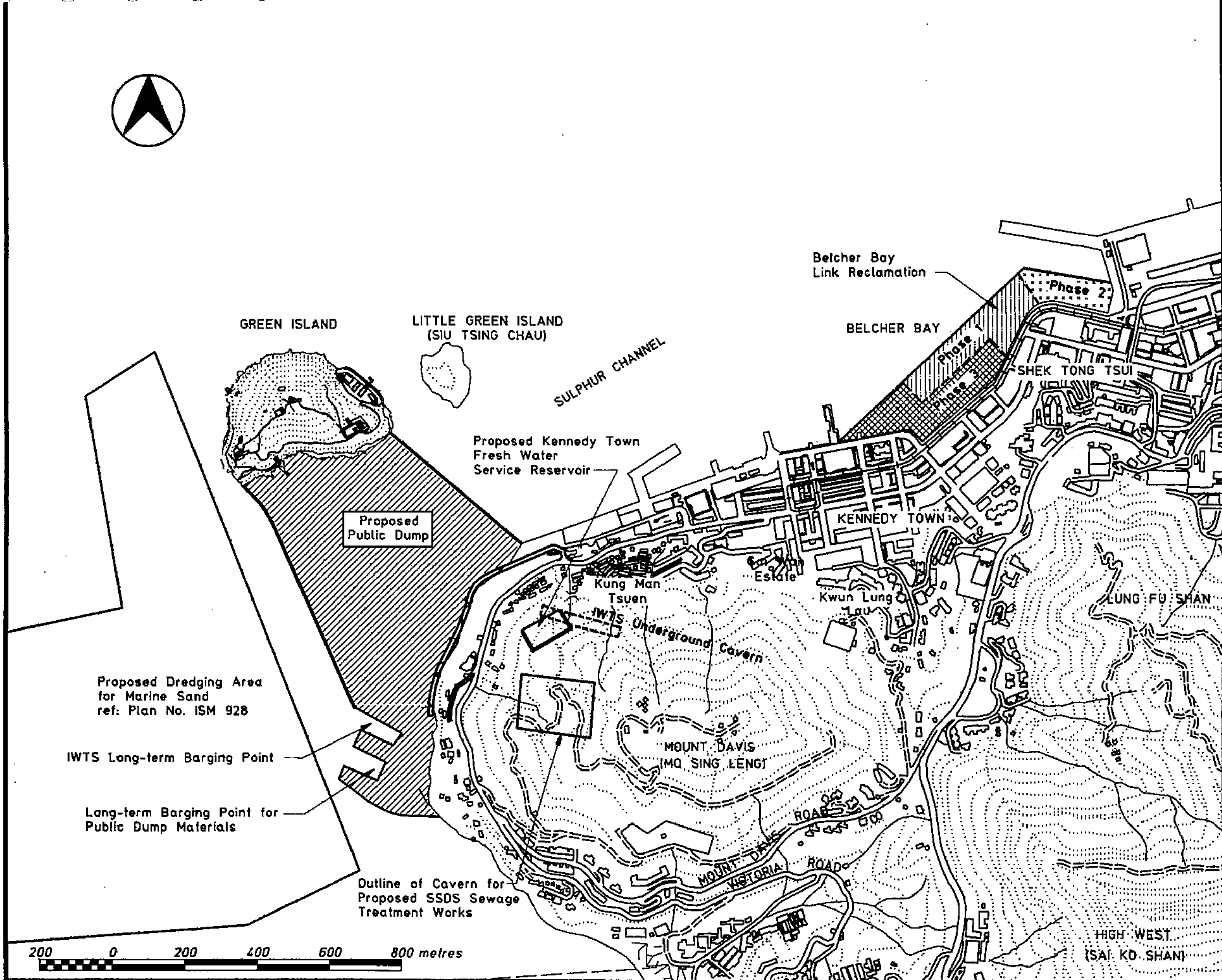
LEGEND :

- STAGE I DREDGING
- STAGE I SEAWALL
- STAGE II SEAWALL
- STAGE III SEAWALL

GREEN ISLAND RECLAMATION (PART) – PUBLIC DUMP FINAL REPORT

Figure No. 3.1

Sequence of Works



GREEN ISLAND RECLAMATION (PART) – PUBLIC DUMP FINAL REPORT

Figure No. 3.2

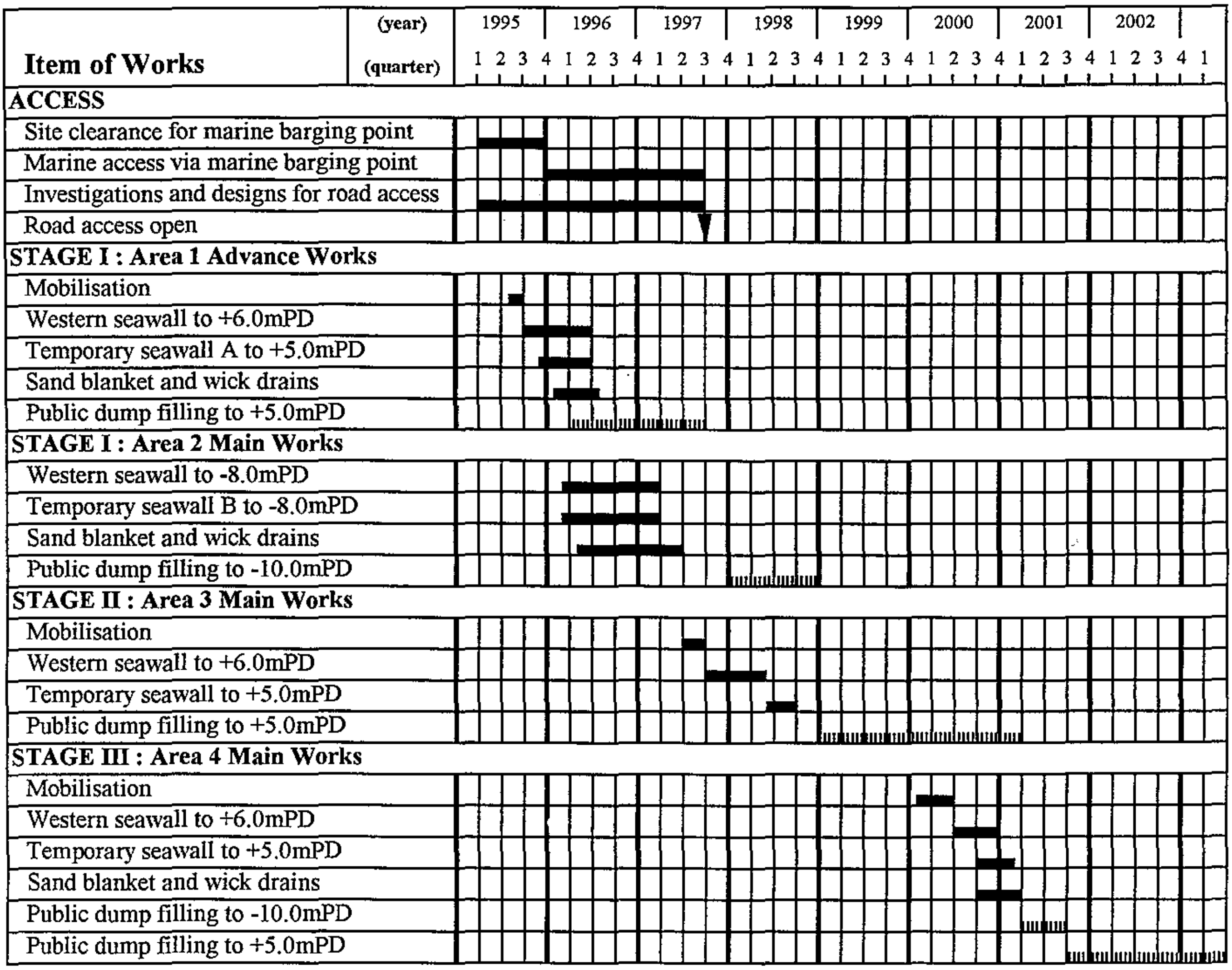
Other Projects

SWR AutoCAD D:\FINAL3 2 19940711.1348 Plot 1 : 10.0000

Green Island Reclamation (Part) - Public Dump

Environmental & Traffic Impact Assessment

Figure No. 3.3 : Preliminary Implementation Programme

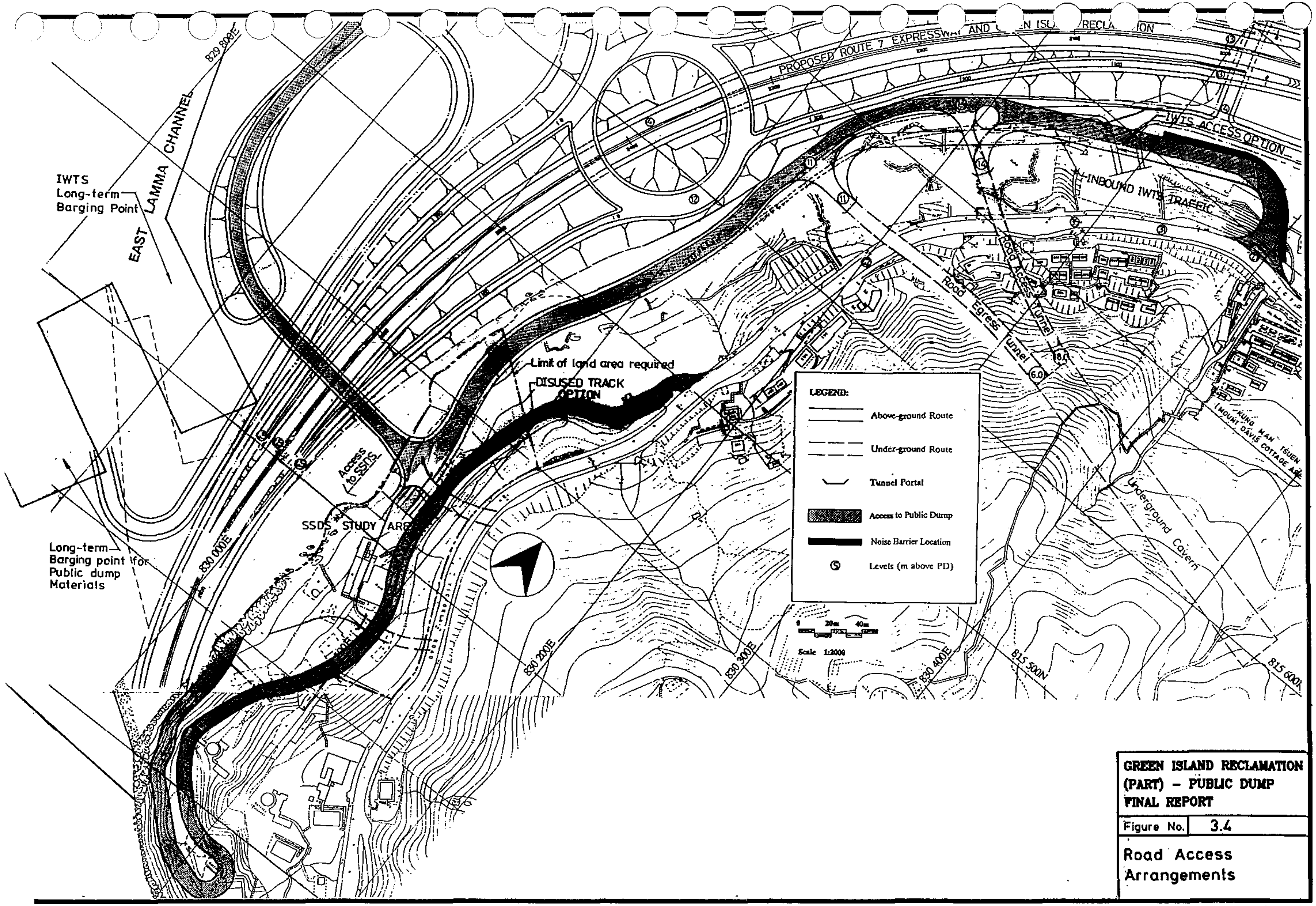


Legend:

Construction activity ▬▬▬

Public dump filling ||||||||||||||||

1. Estimated public dump capacity 7,000,000 cu m over 7 years.
2. Assumed rate of filling is 1,000,000 cu m p.a. which is consistent with the Public Dumping Programme for 1992 - 1999 revised in October 1993.



GREEN ISLAND RECLAMATION (PART) - PUBLIC DUMP FINAL REPORT

Figure No. 3.4

Road Access Arrangements

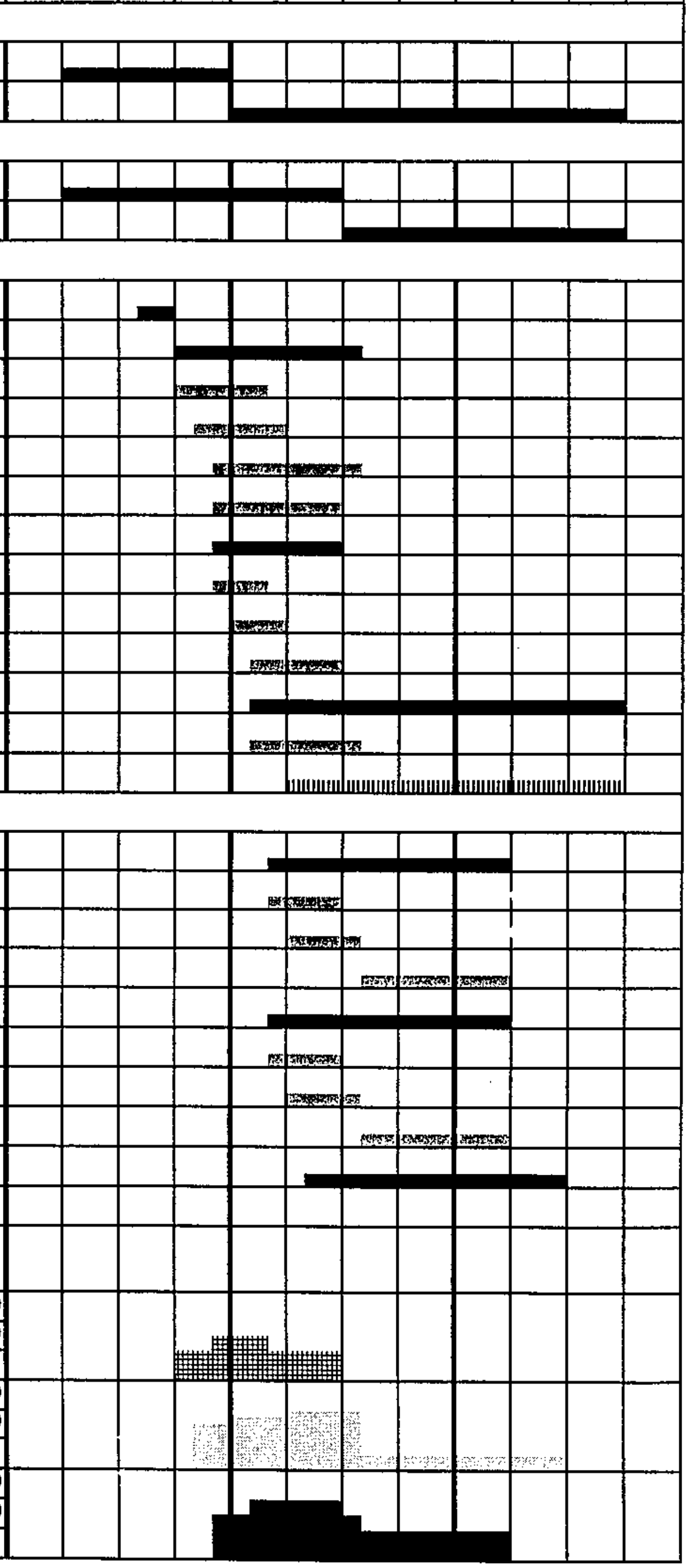
Green Island Reclamation (Part) - Public Dump

Environmental & Traffic Impact Assessment

Figure No. 3.5 : Proposed Construction Programme (Stage I only)

Item of Works		(year) / (quarter)	1995: 1 2 3 4	1996: 1 2 3 4	1997: 1 2 3 4
Marine Access Works					
Site clearance for marine barging point					
Construction and operation of marine barging point					
Road Access Works					
Surveys, investigations and designs					
Construction					
STAGE I : Area 1 Advance Works					
Mobilisation					
Western seawall to +6.0mPD					
Dredging	1,959,000	cu m			
Trench filling (sand)	1,607,000	cu m			
Sloping seawall (rock)	1,452,000	cu m			
Vertical seawall for IWTS	included above				
Temporary seawall A to +5.0mPD					
Dredging	168,000	cu m			
Trench filling (sand)	180,000	cu m			
Sloping seawall (rock)	113,000	cu m			
Platform filled to +5.0mPD					
Sand blanket and wick drains	20,000	cu m			
Public dump filling	2,000,000	cu m			
STAGE I : Area 2 Main Works					
Western seawall to -8.0mPD					
Dredging	864,000	cu m			
Trench filling (sand)	709,000	cu m			
Sloping seawall (rock)	524,000	cu m			
Temporary seawall B to -8.0mPD					
Dredging	578,000	cu m			
Trench filling (sand)	474,000	cu m			
Sloping seawall (rock)	350,000	cu m			
Sand blanket	250,000	cu m			
Public dump filling to -10.0mPD					

Activity	Total (in cu m)	Scale (in cu m)
Dredging	3,569,000	700,000 350,000
Sand filling	3,240,000	400,000 200,000
Rock filling (seawall)	2,439,000	200,000 100,000



Legend:

Construction activity

- Summary task
- Detailed task

Public dump filling

p:\home\wastemgt\..\93837P05.XLS

4. NOISE IMPACT

Introduction

4.1 Construction of the access road and seawall, the dump operations (particularly crushing of material), and road traffic and barges associated with the dump are likely to impact directly on the noise environment of the Mount Davis area. The noise environment of the Kennedy Town area adjacent to the public dump will also be indirectly affected. The construction and operation of the Marine Barging Point on the former KTIP site will also have the potential to generate noise impacts from on-site and associated traffic activities. These impacts are also assessed in this chapter.

4.2 This chapter provides a quantitative assessment of noise impact, based on a schedule of powered mechanical plant during the construction and operational phases of development. Impacts from a rock crushing plant and dump related traffic have also been assessed.

Environmental Standards and Guidelines

Construction Phase

4.3 The Noise Control Ordinance (NCO) provides for the control of construction noise. Assessment procedures and standards are set out in two Technical Memoranda associated with the Ordinance: the Technical Memorandum on Noise from Construction Work other than Percussive Piling (Ref 4.1) and the Technical Memorandum on Noise from Percussive Piling (Ref 4.2).

4.4 Under the existing provisions, there is no control of noise from powered mechanical equipment (PME) other than percussive piling equipment between the hours of 07.00 and 19.00 on normal weekdays. However, it has become industry practice (particularly for government contracts) to set a daytime construction noise criteria of 75 dB(A) L_{eq} (30 min) at the facades of noise sensitive receivers (NSRs) in urban areas such as Kennedy Town. Outside the hours of 07.00 to 19.00, contractors are required to obtain a Construction Noise Permit. The applicable noise limits for the Mount Davis and Kennedy Town areas are given in the Table 4.1.

Table 4.1 : Acceptable Noise Limits

Time Period	Acceptable Noise Level dB(A)	
	Mount Davis*	Kennedy Town
All days during the evening (19.00-23.00), and general holidays during the daytime and evening (07.00-23.00)	60/65	65
All days during the night-time (23.00-07.00)	45/50	50

NB: * The lower noise limits apply to NSRs not directly affected by traffic noise

4.5 Percussive piling is subject to noise control in the daytime, and is prohibited between 19.00 and 07.00 on normal weekdays and all day on public holidays (including Sunday). Permitted hours of piling depend on the noise levels as received at the worst-affected NSRs. A Construction Noise Permit is required for percussive piling.

4.6 The Acceptable Noise Levels (ANLs) for piling at dwellings is 85 dB(A), based on the assumption that the NSRs have windows and no central air conditioning. For schools, clinics and places of worship in the Study Area, the ANL is 75 dB(A) under similar window conditions. The permitted hours of piling are shown in Table 4.2.

Table 4.2 : Permitted Hours of Operation for Piling

Amount by which noise from piling exceeds the ANL	Permitted hours of operation on any day not being a general holiday
More than 10 dB(A)	08.00 - 09.00 and 12.30 - 13.30 and 17.00 - 18.00
1 to 10 dB(A)	08.00 - 09.30 and 12.00 - 14.00 and 16.30 - 18.00
No exceedance	07.00 - 19.00

Operation Phase

4.7 The operation of the public dump constitutes the formation of reclamation, and as such is considered under the NCO to be construction works. Thus, the construction assessment criteria provided above continue to apply during operation of the dump.

Road Traffic Noise

4.8 The Hong Kong Planning Standards and Guidelines (HKPSG) stipulate that the road traffic noise level, L_{10} (1 hour) should not exceed 70 dB(A) at the sensitive facades of dwellings, and 65 dB(A) at the sensitive facades of schools, but otherwise, there is no specific guideline for the assessment of noise from dump-related traffic which is expected to constitute a small percentage of the traffic on public roads. As such, it is proposed that the impact from this traffic should be assessed on the basis that an increase of 1.0 dB(A) or more, when comparing the traffic flows without and with dump-related traffic, is considered to represent a significant deterioration in the traffic noise environment requiring mitigation.

Identification of Representative NSRs

4.9 Mount Davis Cottage Area (Kung Man Tsuen), adjacent to the proposed public dump, is a low-density village area overlooking Sulphur Channel. In addition to single family and cottage dwellings, it houses a school. North of this village area, also overlooking the dump site, are several highrise residential towers of 20 to 30 storeys. Most of these village and highrise receivers are currently exposed directly or indirectly to traffic noise from Victoria Road (one of two access routes between Western and Mount Davis/Pokfulam) and noise from waterfront activity. Residences and the school will be subject to noise impacts from construction of the dump facilities, the dump operations, and traffic associated with the dump.

4.10 Sensitive receivers further from the dump site itself include those in nearby Kennedy Town, including highrise, midrise, and lowrise residential receivers, schools, and places of worship. These receivers are already exposed to high noise levels from road traffic, marine traffic, waterfront activities, and the Kennedy Town Abattoir and Wholesale Market.

4.11 From these sensitive areas, 14 representative NSRs have been chosen to provide an indication of the impacts of the dump during its construction and operation. These representative NSRs are described in Table 4.3, and their locations are shown in Figure 4.1.

Table 4.3 : Noise Sensitive Receivers

Representative NSR: Name and Number of Storeys			Grid Reference		Comments
1	Sam Kindergarten	1-2	815500N	830135E	Kindergarten School*
2	302-304 Victoria Road	1-2	815645N	830230E	Village house
3	269-270 Victoria Road	1-2	815750N	830345E	Village house
4	Serene Court	22	815825N	830475E	Residential atop multi-storey podium carpark
5	8-9 Victoria Road	1-2	815800N	830520E	Village house in Kung Man Tsuen
6	Chung Sing Benevolent Society School	3	815600N	830715E	Primary school
7	Centenary Mansions	25	815885N	831100E	Residential atop 4 storey podium carpark
8	Grand Fortune Mansions	23	816080N	831105E	Residential atop 1-storey podium
9	New Fortune House	21	816100N	831285E	Residential atop podium carpark
10	56 C-D Belchers Street	9	815970N	831320E	Residential with commercial at ground level
11	Lung Hong Apartments	22	815930N	831180E	Residential with commercial at ground level
12	Kennedy Town Jockey Club Clinic	3	815885N	830815E	Public clinic (air-conditioned)
13	Lui Ming Choi Memorial School	6	815845N	830835E	Primary School
14	Sai Wan Estate North Terrace	5	815835N	830990E	HKHA Residential

NB: * to be re-developed into Social Centre for the Aged (no air conditioning)

4.12 NSRs that have been assessed in relation to construction, operation and traffic flow associated with the Marine Barging Point located at the former KTIP site, are those used in the air quality assessment specified in Table 5.1B.

Assessment Methodology

4.13 The noise from construction and operation of the public dump has been obtained using the procedures outlined in the Technical Memorandum on Noise from Construction Work other than Percussive Piling (Ref 4.1).

4.14 In order to best determine the noise levels associated with land-based dump operation, current operations at the existing Ma On Shan Public Dump were monitored on 24 November 1993. In addition, noise monitoring was performed at a local quarry in October 1993 to determine the noise levels associated with operation of a rock crusher. Assuming point sources of noise, the following approximate sound power levels (SWLs) associated with specific operations were obtained, and are used in the present study in place of the equipment SWLs listed in Table 4.4 of the Technical Memorandum.

Table 4.4 : Monitored Sound Power Levels of Dump Operations

Activity and Sound Power Levels		Comments
Task	dB(A)	
Rock crushing	120.2	Kawasaki 70x60 Jaw Crusher
Sorting of fill	114.8	20-HT tracked backhoe sorting fill
Loading of fill	109.9	Sumitomo S340 tracked backhoe and idling Mitsubishi Hi-Lux 24-tonne dumptruck: dirt/rubble collected and loaded
Transport of fill along reclamation to tip site	113.2	Isuzu CXZ 24-tonne dumptruck (full) in drive-by test on level reclamation. Conveyor belt SWL from Technical Memorandum.
Spreading and compaction of fill	118.6	Tracked Caterpillar bulldozer operating with steel-cylinder rubber-tyre roller

4.15 In the absence of any frequency spectra for the dump equipment, no air absorption correction has been made in the following predictions. Over long distances, this correction would be significant. Thus, the results reported below overestimate the noise at distant receivers (eg Receivers 8 and 9). This overestimation presents little difficulty, however, since distance attenuation alone results in dump noise levels that are not expected to exceed the desired maximum at distant NSRs.

4.16 Haul road traffic noise has been assessed with reference to the BS5228:Part I:1984 (Ref 4.4).

Background Noise Level and Monitoring Data

4.17 The impact of the dump's construction and operational noise depends on the prevailing background noise level and the sensitivity of receivers to the intruding noise. Information obtained from monitoring will enable an assessment of the acceptability of the dump-related noise (and therefore the need for mitigation measures) to be made.

4.18 The existing noise environment in the Mount Davis area is dominated by traffic noise from Victoria Road. The noise environment in the Kennedy Town area is dominated by noise from traffic, the abattoir, and the wholesale market. A noise survey has been conducted as part of the study, and is discussed below.

4.19 Monitoring data for the Mount Davis Cottage Area and Kennedy Town area were obtained for the Green Island Reclamation Feasibility Study (Ref 4.5) and the IWTS Study (Ref 4.6). In addition, background noise measurements were obtained in December 1993 at three locations in Kennedy Town and Mount Davis Cottage Area (see Figure 4.2 for locations). These background noise measurements were taken between 07.00 and 19.00 at the roof levels of three residential buildings. Results of these monitoring programmes are shown in Table 4.5.

Table 4.5 : Background Noise Levels in the Kennedy Town and Mount Davis Areas

Location	Noise Levels		Major Noise Sources
	parameter*	dB(A)	
Singapore International School	L_{eq} (30 min)	69.3	Road and marine traffic Abattoir Wholesale market
Kennedy Town Jockey Club Clinic (NSR12)	L_{eq} (30 min)	73.5	Road and marine traffic Abattoir Wholesale market
Centenary Mansions (NSR7)	L_{eq} (30 min)	74.0	Road and marine traffic Abattoir Wholesale market
Mount Davis Cottage Area	L_{eq} (15 min)	67.0 to 75.3	Road traffic
	L_{90} (15 min)	57.2 to 68.7	Road traffic
Serene Court (roof) (NSR4)	L_{90} (1 hr)	54.0 to 60.5	Activities at waterfront Helicopters
51 Kennedy Town Praya (roof)	L_{90} (1 hr)	61.8 to 65.8	Activities at waterfront Construction activity Air conditioning Traffic Market activities Helicopters
Lung Hong Apartments (roof) (NSR11)	L_{90} (1 hr)	63.5 to 65.5	Activities at waterfront Construction activity Traffic Helicopters

NB * Noise descriptors are dependent on those used under the various monitoring programmes.

4.20 Existing background noise level data, including those given in Table 4.5, are typical of those of an urban Hong Kong environment. Dominant noise sources in the area include marine and road traffic, construction works, and activities related to the wholesale market and abattoir adjacent to Victoria Road.

Impact of Construction Activities

Public Dump

Construction of Seawall

4.21 The construction of the dump will commence with Stage 1 Area 1 Advance Works, comprising construction of the southern part of the western seawall and a small barging platform. The tasks and equipment anticipated, are given in Table 4.6.

Table 4.6 : Stage 1 Area 1 Advance Works: Construction Tasks and Equipment

Mobilisation	
Western Seawall to +6.0mPD	
Dredging	□ Grab dredger (1) within 50 m of shore □ Trailer dredger (1) at distance greater than 50 m from shoreline
Trench filling (sand)	□ Trailer dredger (1)
Sloping seawall (rock)	□ Derrick barge (1) □ Tugboat (1)
Temporary Seawall A to +4.5mPD	
Dredging	□ Grab dredger (1) within 50 m of shore □ Trailer dredger (1) at distance greater than 50 m from shoreline
Trench filling (sand)	□ Trailer dredger (1)
Sloping seawall (rock)	□ Derrick barge (1) □ Tugboat (1)
Platform for barging	
Wick drains	□ Derrick barge (5) □ Tugboats (2)
Platform filling (sand)	□ Trailer dredger (1)

4.22 Stage 1 Area 2 Main Works follow, during which the seawalls are extended, and much of the reclamation is infilled, leaving a narrow passage near Green Island for marine access. The tasks and equipment anticipated are given in Table 4.7.

4.23 Expansion of the seawalls and infilling of the reclamation occur under the Stage 2 period in Area 3. Main Works are anticipated to involve tasks and equipment given in Table 4.8. Dredging activities are restricted to daytime hours (0700 to 1900 hours) and therefore no exceedance of noise standards during restricted hours (1900 to 0700 hours) are expected.

Table 4.7 : Stage 1 Area 2 Main Works: Construction Tasks and Equipment

Western Seawall to -8.0 mPD	
Dredging	□ Trailer dredger (1) only
Trench filling (sand)	□ Trailer dredger (1)
Sloping seawall (rock)	□ Derrick barge (1) □ Tugboat (1)
Temporary Seawall B to -8.0 mPD	
Dredging	□ Trailer dredger (1) only
Trench filling (sand)	□ Trailer dredger (1)
Sloping seawall (rock)	□ Derrick barge (1) □ Tugboat (1)
Wick drains	□ Derrick barge (5) □ Tugboats (2)
Area 2	
Sand blanket	□ Trailer dredger (1)
Wick drains (in 1996 to 1997)	□ Derrick barges (5) □ Tugboats (2)

Table 4.8 : Stage 2 Area 3 Main Works: Construction Tasks and Equipment

Mobilisation	No PME
Western Seawall (remainder) to +6.0 mPD	
Sloping seawall (rock)	□ Derrick barge (1) □ Tugboat (1)
Temporary Seawall B to +4.5 mPD	
Sloping seawall (rock)	□ Derrick barge (1) □ Tugboat (1)
Operation and drainage	
Filling by barge (1998 to 2001)	□ Unmotorised barges (3) □ Tugboats (3)

4.24 The final stage of the project occurs when the seawalls are extended to Green Island, and the remaining reclamation is infilled. Tasks and equipment anticipated are given in Table 4.9.

Table 4.9 : Stage 3 Area 4 Main Works - Construction Tasks and Equipment

Mobilisation	No PME
Western Seawall (remainder) to +6.0mPD	
Sloping seawall (rock)	□ Derrick barge (1) □ Tugboat (1)
Temporary Seawall B (remainder) to +4.5mPD	
Sloping seawall (rock)	□ Derrick barge (1) □ Tugboat (1)
Operation and drainage	
Filling by barge (2001 to 2003)	□ Unmotorised barges (3) □ Tugboats (3)
Wick drains (2000 to 2001)	□ Derrick barges (5) □ Tugboats (2)

Operation of the Dump

4.25 During operation of the dump, tipping will occur both by sea and by land in all four reclamation areas. Materials will be transported to the site predominately by road, entailing a peak-hour flow of 72 vehicles. Two or three loads per day can be expected by sea barge. Lorries delivering materials to the dump will use Victoria Road to access the haul road leading to the dump itself.

4.26 Oversized materials are expected to constitute about 10 percent of the total quantity of material in the dump. This material will be stockpiled and broken down to a smaller size before disposal in the reclamation. In addition to this task, handling, dumping, and processing of the material will entail the equipment given in Table 4.10.

Identification of Construction/Operation Scenarios

4.27 A preliminary implementation programme is provided in the Final Initial Assessment Report, and indicates that the following activities are expected to proceed concurrently, presenting worst-case activity levels:

- 3-4 quarters 1995: <u>Stage 1 Area 1 Advance Works</u>
  □ western seawall to +6mPD
  □ temporary seawall "A" to +5.0mPD

- 1-2 quarter 1996: <u>Stage 1 Area 2 Main Works</u>
  □ western seawall to -8mPD
  □ temporary seawall "B" to -8mPD
  <u>Public dumping</u> at Area 1 (by sea)

- 2-3 quarters 2000: <u>Stage 3 Area 4 Main Works</u>
  □ western seawall to +6mPD
  □ temporary seawall to +5.0mPD
  <u>Public dumping</u> in Area 3 (by land)

Table 4.10 : Land-based Filling - Tasks and Equipment

Operation	Equipment Requirements	
	Equipment Type	Number
Crushing of oversized materials	Rock crusher	1
Sorting of fill by size	Tracked excavator Wheeled loader	3 3
Loading of fill for transport to tip site	Loaders	3
Transport of fill to tip site	Dumptrucks Conveyor/Stacker	20 3
Spreading of fill	Bulldozers	5
Compaction of fill	Rollers	2

Access Road Traffic

4.28 Two access road options are under consideration, and have been separately described and assessed in an earlier study, Traffic Impact Assessment (Land) (Ref 4.7). Briefly, these two options are described below:

- Disused Track Access Road Option: Vehicles would approach the dump via an upgraded and extended track which branches off Victoria Road in the Mount Davis area, immediately across from NSR1 (the school at 410 Victoria Road). This proposed road is 400 m long with a maximum gradient of 10 percent, and requires extensive earthworks and structures.

- IWTS Access Road Option: Vehicles would approach the dump via an access road running parallel to and north of the Island West Transfer Station access road. The access road intersects Victoria Road adjacent to Serene Court (NSR4). Compared to the Disused Track Option, fewer earthworks are involved in the construction, and the gradients are gentler.

Marine Barging Point

4.29 Details of the items of powered mechanical equipment (PME) have not been specified, but have been estimated to include the following:

- lorry (x1)
- petrol concrete mixer (x1)
- petrol concrete saw groover (x1)
- silenced generator (x1)
- hand held vibratory poker (x1)

4.30 Based on the sound power levels for PME given in the Technical Memorandum on 'Noise from Contruction Work other than Percussive Piling', the combined sound power level is 118 dB (A). It is assumed that all construction related activities will be restricted to daytime operation only (0700-1900 hours, Monday to Saturday).

4.31 Noise sensitive receivers (NSRs) in the vicinity of the construction site include Kennedy Town Jockey Club Clinic and Lui Ming Choi Memorial School. Assuming that percussive piling will take place separately from other construction work, then noise impacts on the NSRs from the PME based on a notional noise source midway between the centre of the site and the nearest boundary to the NSR can be calculated using the combined sound power level (118 dB(A)), the distance correction factor (44 and 48 dB (A) respectively) and the facade effect factor (3 dB (A)):

- Kennedy Town Jockey Club Clinic (65 m distant) = 77 dB(A)

- Lui Ming Choi Memorial School (100 m distant) = 73 dB(A)

4.32 Target noise criteria for the NSRs during daytime hours (i.e. 0700 to 1900 hours) are 75 dB (A) for Kennedy Town Jockey Club Clinic and 70 dB (A) for Lui Ming Choi Memorial School (65 dB (A) during examinations). Therefore, target noise criteria are exceeded for both NSRs. However, existing buildings and additional mitigation measures can be expected to reduce noise impacts to levels below the target noise criteria. For example, the presence of bus maintenance workshops to the forefront of Kennedy Town Jockey Club Clinic, which remove the line of sight to the construction site, will reduce noise levels by between 5 to 10 dB (A) thereby resulting in noise compliance. Other measures including a reduction in the number of PME items in use at any single time, and the erection of suitable temporary screening structures (see Section 4.51) will serve to protect Lui Ming Choi Memorial School. It is recommended that construction works be scheduled to avoid examination times at the school to avoid exceedance of the relevant target noise criteria.

4.33 The above prediction for noise impacts on NSRs are dependent on the exact requirements of PME for construction of the Marine Barging Point which have yet to be specified.

4.34 It is expected that the dominant noise source associated with the redevelopment of the site will be associated with the demolition of the former Kennedy Town Incineration Plant, which is outside the scope of this assessment. It is recommended that any noise barriers used to achieve satisfactory noise level at NSRs during demolition work should be maintained for the duration of the construction works.

Impact of Operational Activities

Public Dump

Noise from Site Activities and Access Road

4.35 Using the worst-case construction and operation scenarios outlined above, and including noise from haul road traffic, the anticipated noise levels due to the public dump in 1995, 1996 and 2001 are given in Tables 4.11 - 4.13.

4.36 Tables 4.11 - 4.13 indicate that noise from the dump construction and operation exclusive of the noise from haul road traffic lies within acceptable limits during the periods examined. In part, this is due to topographical barriers and to the presence of highrise residences and go-downs along Sai Ning Street and from No. 60 to No. 84 Victoria Road. The topography and buildings shield several receivers in Kennedy Town and in the Mount Davis area.

4.37 For the purpose of this assessment, the rock crushing plant was assumed to be located at the barging platform. Placing the plant near the shoreline will ensure that the topographic barrier formed by the steep hillside slope is utilized. This measure should be sufficient to mitigate noise from the plant, but additional mitigation in the form of a shed enclosed on the landward side may serve further to reduce noise, as well as dust emissions.

4.38 However, the presence of haul road traffic causes a significant deterioration in the noise environment of NSRs in close proximity to it, notably those represented by NSRs 1 and 2 (assuming Disused Track Access Road option) and by Receivers 2, 3, and 4 (assuming IWTS Access option). Specifically, these sensitive receivers are those near the haul road junction with Victoria Road, and comprise both village receivers and highrise receivers. There is a need for noise reduction measures along the haul road, though construction and operational traffic noise at the reclamation is expected to remain below the daytime construction noise criteria given in the Hong Kong Planning Standards and Guidelines.

Noise from Public Roads

4.39 The impact of increased traffic flows on public roads due to the presence of dump-related traffic has been constrained by the prevailing traffic flows. Dump traffic is expected to utilize roads given in Table 4.14 and 4.15, which also show the incremental increases in L_{10} peak hour traffic noise levels for 1996 and 2001. An increase of 1.6 dB(A) in peak hour traffic noise may arise in Victoria Road. Certain mitigation measures have been considered but found impacticable and ineffective:

- laying of porous asphalt is not acceptable to Highways Department due to maintenance difficulty on a local road with a steep gradient and a high percentage of heavy vehicles;
- erection of an enclosure is expensive and impracticable due to site restraints such as inadequate space for foundations and the requirement of providing access at the concerned road junctions (gaps in the enclosure for access will reduce its acoustic effectiveness); and
- erection of noise barrier is ineffective as most NSRs overlook Victoria Road, thus render the barrier ineffective.

However, the extent of impact due to these predicted traffic flows may be reduced significantly under the latest proposal of operating two marine barging points concurrently on Hong Kong Island leading to diversion of the expected construction traffic flow. Besides traffic management schemes to redistribute the dump-related traffic on the use of the public roads during non-peak hours may be more effective to reduce the noise impacts on those concerned sensitive receivers.

Table 4.11 : Facade Noise Levels due to Construction and Operation* : 1995

	Representative NSR	Facade Noise Level dB(A)				
		Access Road: Options 1/2	Area 1: Construction	Area 1: Operation	Area 2	Total
1	Sam Kindergarten	78.4 69.8	66.7	71.5	61.9	79.5/ 74.7
2	302-304 Victoria Rd	71.6 73.8	63.1	68.0	63.3	74.0/ 75.4
3	269-270 Victoria Rd	69.1 76.4	58.6	55.5	65.5	71.1/ 76.8
4	Serene Court	68.1 79.8	58.8	63.9	64.7	71.0/ 80.1
5	8-9 Victoria Rd	67.5 73.4	52.9	53.2	62.1	68.8/ 73.8
6	Chung Sing Benevolent Society School	--	45.8	51.0	48.6	53.7
7	Centenary Mansions	--	43.5	47.5	45.5	50.5
8	Grand Fortune Mansions	--	42.2	47.4	54.3	55.3
9	New Fortune House	--	40.5	46.5	52.9	54.0
10	56 C-D Belchers Street	--	41.4	46.7	42.8	49.0
11	Lung Hong Apartments	--	42.4	47.5	44.1	49.9
12	Jockey Club Clinic	--	44.9	50.1	47.5	52.7
13	Lui Ming Choi Memorial School	--	44.9	50.1	47.1	52.6
14	Sai Wan Estate N Terrace	--	44.0	49.2	45.5	51.6

NB: * refers to the rock crushing plant in Area 1.
1: Disused Track Option
2: IWTS Option

Table 4.12 : Facade Noise Levels due to Construction and Operation* : 1996

Representative NSR		Facade Noise Level dB(A)			
		Access Road: Options 1/2	Area 2: Construction	Area 2: Operation	Total
1	Sam Kindergarten	78.4/ 69.8	63.8	73.0	79.6/ 75.0
2	302-304 Victoria Rd	71.6/ 73.8	65.1	71.9	75.7/ 76.7
3	269-270 Victoria Rd	69.1/ 76.4	66.0	67.1	72.7/ 77.3
4	Serene Court	68.1/ 79.8	65.1	66.3	71.7/ 80.2
5	8-9 Victoria Rd	67.5/ 73.4	62.4	62.6	69.9/ 74.2
6	Chung Sing Benevolent Society School	--	49.0	51.8	54.1
7	Centenary Mansions	--	45.9	48.3	50.8
8	Grand Fortune Mansions	--	54.6	55.1	58.5
9	New Fortune House	--	53.3	46.6	55.2
10	56 C-D Belchers Street	--	43.2	46.5	48.6
11	Lung Hong Apartments	--	44.4	47.5	49.7
12	Jockey Club Clinic	--	47.8	50.6	52.9
13	Lui Ming Choi Memorial School	--	47.5	50.4	52.7
14	Sai Wan Estate N Terrace	--	46.0	49.3	51.4

NB: * refers to rock crushing plant in Area 1.
1: Disused Track Option
2: IWTS Option

Table 4.13 : Facade Noise Levels due to Construction and Operation* : 2001

Representative NSR		Facade Noise Level dB(A)			
		Access Road: Options 1/2	Area 4: Construction	Area 3: Operation	Total
1	Sam Kindergarten	78.4/ 69.8	54.0	72.4	79.4/ 74.3
2	302-304 Victoria Rd	71.6/ 73.8	55.1	72.0	74.9/ 76.0
3	269-270 Victoria Rd	69.1/ 76.4	55.0	67.3	71.4/ 76.9
4	Serene Court	68.1/ 79.8	54.4	66.5	70.5/ 80.0
5	8-9 Victoria Rd	67.5/ 73.4	53.0	63.1	69.0/ 73.8
6	Chung Sing Benevolent Society School	--	41.0	52.2	52.5
7	Centenary Mansions	--	46.8	51.7	52.9
8	Grand Fortune Mansions	--	47.5	56.0	56.5
9	New Fortune House	--	42.6	47.0	48.4
10	56 C-D Belchers Street	--	36.1	47.0	47.3
11	Lung Hong Apartments	--	37.1	48.0	48.3
12	Jockey Club Clinic	--	40.0	51.0	51.3
13	Lui Ming Choi Memorial School	--	39.7	50.8	51.2
14	Sai Wan Estate N Terrace	--	38.5	49.7	50.0

NB: * refers to rock crushing plant in Area 1.
1: Disused Track Option
2: IWTS Option

Table 4.14 : 1996 Peak Hour Traffic Flows in Kennedy Town and Mount Davis Area

Road	Peak Hour Flow without dump		Peak Hour Flow with dump		Resulting increase in L_{10} Facade Noise Level dB(A)
	Veh	% Heavy	Veh	% Heavy	
Victoria Road E/b Victoria Road W/b	333 524	30% 30%	402 593	42% 38%	1.6
Belchers St W/b	690	70%	737	72%	0.4
Catchick St E/b	275	30%	293	34%	0.7
K Town Praya E/b K Town Praya W/b	355 560	30% 30%	373 579	33% 32%	0.4
Queens Rd W E/b Queens Rd W W/b	646 724	30% 30%	664 742	32% 32%	0.3
Pokfulam Rd S/b Pokfulam Rd N/b	964 1651	30% 30%	971 1659	30% 30%	--
Mt Davis Rd W/b Mt Davis Rd E/b	76 261	30% 30%	83 268	30% 30%	0.2

Table 4.15 : 2001 Peak Hour Traffic Flows in Kennedy Town and Mount Davis Area

Road	Peak Hour Flow without dump		Peak Hour Flow with dump		Resulting increase in L_{10} Facade Noise Level
	Veh	% Heavy	Veh	% Heavy	
Victoria Road E/b Victoria Road W/b	374 504	30% 30%	441 573	50% 45%	2.2
Rock Hill St W/b	668	30%	737	37%	1.2
Catchick St E/b	310	30%	328	34%	0.7
K Town Praya E/b K Town Praya W/b	423 513	30% 30%	431 531	31% 32%	0.3
Queens Rd W W/b	1157	30%	1168	31%	0.2
Pokfulam Rd S/b Pokfulam Rd N/b	1035 1711	35% 35%	1042 1718	35% 35%	--
Mt Davis Rd W/b Mt Davis Rd E/b	279 369	30% 30%	286 376	30% 30%	0.1

NB: The need for mitigation measures to reduce the noise from road traffic is not anticipated.

Marine Barging Point

4.40 Operational noise data from an existing marine barging point for the transfer of construction waste materials located at Aldrich Bay, Shau Kei Wan, have been used for the purposes of assessment. These data are shown in Table 4.16, and are representative of noise emissions from a normal truck-to-barge transfer of construction waste from a tipping jetty.

Table 4.16: Result of Noise Monitoring of Construction Waste Barging Point at Aldrich Bay, Shau Kei Wan

Distance from source (m)	$L_{Aeq\ (1\text{-}hr)}$ dB		Average (dB)
14	75.0	76.5	75.8
23.5	72.3	74.5	73.5

NB: Correcting to 100 metres distance, 75.8dB is equivalent to 58.7dB, whilst 73.5dB is equivalent to 60.9dB. hence a source level of 59.9dB $L_{Aeq\ (1\text{-}hr)}$ at 100 metres has been used in calculating the impact at KTIP.

4.41 Predicted operational noise levels at sensitive receivers adjacent to the proposed barging point, based on data given in Table 4.16, are given in Table 4.17.

Table 4.17: Predicted Noise Level Arising from the Proposed Barging Point

Sensitive Location	Distance (metres)	Unmitigated Noise Level (dB)
Jockey Club Clinic	121	58
Centenary Mansion	230	53
Lui Ming Choi Memorial School	175	55
St Lukes Settlement	137	57
Chung Sing Benevolent Society School	158	56
Kennedy Town Government School	186	55
Grand Fortune Mansions	247	52

NB: Assumed a source noise level of 59.9dB $L_{Aeq\ (1\text{-}hr)}$ at 100 metres.

4.42 The figures in Table 4.17 are based on a measured operational noise corrected for distance from the source. However considerable attenuation against noise will be provided by existing buildings between sensitive receivers and the barging point source. For example St. Lukes Settlement and the Kennedy Town Jockey Club Clinic on Victoria Road are shielded by the bus service workshops on the opposite side of the road. Similarly, NSRs further away up the hill from Kennedy Town are shielded by intervening structures, including the NSRs mentioned on Victoria Road.

4.43 Noise predictions in Table 4.17take no account of screening provided by the natural topography on intervening structures between sensitive receivers and the barging point. Any intervening structure which removes line of sight of the source from the receiver can be considered to provide at least 10 dB(A) attenuation of noise from that source. Thus most or all of the unmitigated noise levels quoted would be reduced still further by existing screening and are not expected to exceed relevant noise criteria.

Barging Point Traffic Noise

4.44 The route taken by traffic to the barging point will vary according to the point of waste arising. However, all traffic will use Victoria Road with access to the barging point adjacent to the current site of the KTIP. As site vehicles travel further from the site the relative increase in traffic on local roads which they represent will reduce. Hence, the impact of site traffic has been considered only on Victoria Road, where it is potentially greatest.

4.45 In calculating the noise impact due to site traffic four situations have been considered, using available traffic data.

- 1995 without site traffic;
- 1995 with site traffic;
- 2001 without site traffic; and

- 2001 with site traffic;

4.46 1995 and 2001 traffic data has been used, even though barging point operations are expected to commence at the beginning of 1996, and to cease in mid-1997. This is to provide information should development dates be re-scheduled for any reason. Due to a general increase in expected traffic flow on Victoria Road between 1995 and 2001, the relative impact of Marine Barging Point traffic is expected to decrease and hence 1995 predictions represent the worst case scenario. The calculation method for deriving any changes in noise level is given in the UK Department of Transport's Calculation of Road Traffic Noise memorandum. Traffic assumptions and forecasts, together with predicted noise impacts, are given in Table 4.18.

Table 4.18: Barging Point Traffic Assumptions, Forecasts and Predicted Noise Impacts

Parameter	1995		2001	
	Without Site	**With Site**	**Without Site**	**With Site**
Victoria Road flow pcu/hr	1561	1771	2154	2514
Conversion to veh/hr	1156	1312	1576	1862
Vehicle speed km/hr	50	50	50	50
% Heavy vehicle	30%	33%	30%	30%
Corrected noise levels dB $L_{A10(1\text{-hr})}$ at 10 metres from kerb	76.1	76.9	77.4	78.1

NB: All flows are AM peak hour flows. The corrected noise level does not consider road gradients or road surface corrections, which would cancel out in any comparative calculations.

The With Site Figures contain a 50% increase to represent 600 vehicle trips per day.

4.47 The extent of the impact associated with the barging point traffic will be determined by two factors: firstly, whether 400 or 600 vehicle trips per day occur; and secondly, the traffic flows prevailing on Victoria Road at the time the barging point is in operation. The effect of the general increase in traffic in this area is to reduce the impact attributable to the Marine Barging Point. Using 1995 flows the increase in peak hour traffic noise will be between 0.7 - 2.3 dB(A). The exact vehicle movements are not known at this stage but it can be seen that as the flows increase beyond 400 per day then the increase in traffic noise is likely to exceed 1 dB(A), and hence would need attention. Monitoring of flows during operation will allow this impact to be quantified and the extent of any mitigation required to be established.

Impacts Following Completion (Public Dump)

4.48 No impacts in breach of relevant noise criteria, are expected during the standing period following the completion of reclamation. Construction of residential and other land uses according to the Recommended Outline Development Plan (Ref 4.8) for the reclamation will, however, be associated with noise impacts and these should be addressed accordingly upon finalization of the design. Once constructed, the land uses in the area are not anticipated to result in noise impacts in breach of relevant noise criteria on adjacent sensitive receivers.

Cumulative Noise Effect

Public Dump

4.49 Other major infrastructure projects are planned in the Study Area, including the Green Island Link and works associated with the SSDS (Stages 2-4). No quantitative information on noise levels associated with the Green Island Link are currently available. However, some preliminary estimates of unmitigated noise associated with the SSDS are available from the Draft Environmental Assessment Report of the Strategic Sewage (Ref 4.8). At Receiver 1, the following facade noise levels are expected:

- 77 dB(A) due to construction works,
- 62 dB(A) due to operation of the MDSTW.

4.50 Cumulative noise impacts at NSR1 from SSDS development and Public Dump have been estimated using a worst case scenario, and results are presented in Table 4.19. Worst case assumes a development programme of 1995 to 2001, although it is likely that construction dates are between 1999-2002 (see Table 3.1). Figures presented in Table 4.19 represent maximum predicted noise levels and are not expected to be exceeded should relative development programmes be altered.

4.51 The dates of construction and operation of the SSDS are not known. However, assuming concurrent operations for the SSDS and the Green Island Public Dump, cumulative noise levels given in Table 4.19 may occur at Receiver 1.

4.52 These results show that the cumulative effects of local construction and infrastructure projects could lead to high noise levels at exposed facades around NSR1. Further cumulative assessment is difficult in the absence of site specific data for adjacent development. Provided concurrent developments are subject to individual noise control measures it is likely that relevant noise standards can be maintained in the area.

Marine Barging Point

4.53 The extent to which cumulative impacts associated with the Marine Barging Point may be in breach of relevant noise criteria will depend upon the timing of other developments in the area. However, the impact from this site during construction and operation alone is not expected to be in exceedance of respective noise criteria in terms of some of the major redevelopment and infrastructure schemes in this area. The relative spatial displacement of the Marine Barging Point and Public Dump will prevent any cumulative impact from these two sites arising which is in breach of relevant noise criteria, particularly if mitigation measures recommended in this assessment are implemented.

Table 4.19 : Cumulative Noise Impacts at NSR1 from Strategic Sewage Disposal Scheme and Green Island Public Dump

SSDS	Facade Noise Level dB(A)	
	Disused Track Access Road Option	IWTS Access Road Option
2nd-4th Quarters, 1995		
SSDS Construction	81.4	79.0
Mt Davis Sewage Treatment Works	79.6	74.9
1st Quarter, 1996		
SSDS Construction	81.5	79.1
Mt Davis Sewage Treatment Works	79.7	75.2
2nd-3rd Quarters, 2001		
SSDS Construction	81.4	78.9
Mt Davis Sewage Treatment Works	79.5	74.5

Conclusions and Recommendations

4.54 Traffic on the access road is expected to generate facade noise levels in excess of 75 dB(A) (L_{eq}) at NSRs near its alignment. If the Disused Track Access Road option is chosen, excessive noise levels are experienced at the Sam Kindergarten and a number of village houses represented by NSRs 1 and 2. If the IWTS Access Road option is chosen, a greater number of village houses are affected. In addition, the highrise Serene Court (NSR4) is affected. The need for mitigation measures is therefore anticipated.

4.55 Given the expected 8-year lifespan of the fill, the installation of a partial enclosure over the access road is recommended. An inwardly curved noise barrier along the access road will mitigate the noise impacts on the nearby NSR. The barrier material should have a mass per unit of surface area of at least 7 kg/m^2, and should have acoustic lining. This mass per unit area conforms with British Standards (Ref 4.9) and is deemed sufficient to block the transmission of most construction related noise through the barrier.

4.56 The barrier will be subject to a detailed design that will consider the effectiveness of topography in providing barrier attenuation. However, the following preliminary information gives some indication of its anticipated height and length. The proposed barriers are shown in Figure 3.4.

4.57 In order to provide effective protection to high-level receivers (either highrise facades or NSRs on elevated ground), the barrier should be curved inward over the access road. Its height will be constrained by the need to provide adequate clearance for dump-related vehicles. The width of the overhang should generally be limited to a single lane on the landward side. However, if the IWTS Access Road option is chosen, a short section of the haul road (approximately 20 m) adjacent to Serene Court may be totally enclosed.

4.58 The length of barrier required depends on the access road option chosen. If the IWTS Access road option is chosen, the length of barrier would extend about 200 m from the junction with Victoria Road; this would take it approximately to the IWTS inbound road access tunnel turnoff. This length of barrier would protect Serene Court and Regent Heights. A preliminary assessment of the site indicates that the lowrise village receivers in Kung Man Tsuen would be adequately protected by topography.

4.59 If the Disused Track Access Road option is chosen, approximately 80 m of barrier would be required, starting at the junction with Victoria Road. It should be noted that vehicles exiting onto the public road should have adequate sight-lines along that road. For this reason, a full-height barrier cannot extend right up to the edge of Victoria Road. This safety requirement has implications for the effectiveness of the barrier especially in relation to its ability to adequately mitigate noise levels at the school and the two residences immediately across the junction. At this stage the exact sight lines required are not known and hence the constraints on the barrier dimensions cannot be assessed. It may be that further mitigation will be required at these receptors.

4.60 The Technical Memorandum on Noise from Construction Work other than Percussive Piling (Ref 4.1) indicates that an effective barrier (ie, one that is of sufficient size and weight, and without gaps) reduces noise at the receivers by about 10 dB(A). This would be sufficient to bring noise levels at NSRs near the access roads to levels within the noise standards given in the Hong Kong Planning Standards and Guidelines.

4.61 If the land use permits, an alternative to the purpose-built barrier is an earth embankment. Like the purpose-built barrier, an embankment would have to be of adequate height to screen noise sensitive facades from direct line of sight to the access road. A barrier or embankment has the added benefit of helping to reduce the transmission of dust.

4.62 In addition to the partial access road enclosure, good site practices to minimise noise are recommended. Good site practices during construction and operation can be encouraged through the inclusion of noise control clauses as shown in Appendix 1 of this report.

4.63 The extent of the impact associated with increases in traffic on local roads will be determined by two factors: firstly, the number of vehicle trips per day; and secondly the traffic flows prevailing on Victoria Road at the time the site is in operation. The effect of the general increase in traffic in this area is to reduce the impact attributable to the public dump. Monitoring of flows during operation will be necessary in order for this impact to be quantified and the extent of any mitigation required to be established.

Marine Barging Point

4.64 Target noise criteria for Kenndy Town Jockey Club Clinic and for Lui Ming Choi Memorial School are exceeded for both NSRs during the construction period of the Marine Barging Point. However, existing buildings and additional mitigation measures can be expected to reduce noise impacts to levels below the daytime target noise criteria. For example, the presence of bus maintenance workshops to the forefront of Kennedy Town Jockey Club Clinic, which remove the line of sight to the construction site, will reduce noise levels by between 5 to 10 dB (A) thereby resulting in noise compliance. Other measures including a reduction in the number of PME items in use at any single time, and the erection of suitable temporary screening structures will serve to protect Lui Ming Choi Memorial School. It is recommended that construction works be scheduled to avoid examination times at the school to avoid exceedance of the relevant daytime target noise criteria.

4.65 The predictions for construction noise impacts on NSRs are dependent on the exact requirements of PME for construction of the barging point which have yet to be specified.

4.66 It is expected that the dominant noise source associated with the redevelopment of the site will be associated with the demolition of the former Kennedy Town Incineration Plant, which is outside the scope of this assessment. It is recommended that any noise barriers used to achieve satisfactory noise level at NSRs during demolition work should therefore be maintained for the duration of the construction works.

4.67 Noise impacts in exceedance of the relevant noise criteria during the operation of the barging point are not envisaged, provided that operations are restricted to day time working hours. Noise impacts associated with traffic serving the barging point are minor given existing and future traffic flows on Victoria Road and would only increase noise levels under a worst case scenario by approximately 1.5 dB (A).

References

4.1 Technical Memorandum on Noise from Construction Work other than Percussive Piling. Environmental Protection Department, Hong Kong Government, June 1990.

4.2 Technical Memorandum on Noise from Percussive Piling. Environmental Protection Department, Hong Kong Government, July 1990.

4.3 Exco Directive, Equitable Redness for Persons Exposed to Increased Noise Resulting from the Use of New Road, November 1989.

4.4 BS5228:Part 1 : Noise Control on Construction and Open Sites (Code of Practice for Basic Information and Procedures for Noise Control. British Standards Institution, 1984.

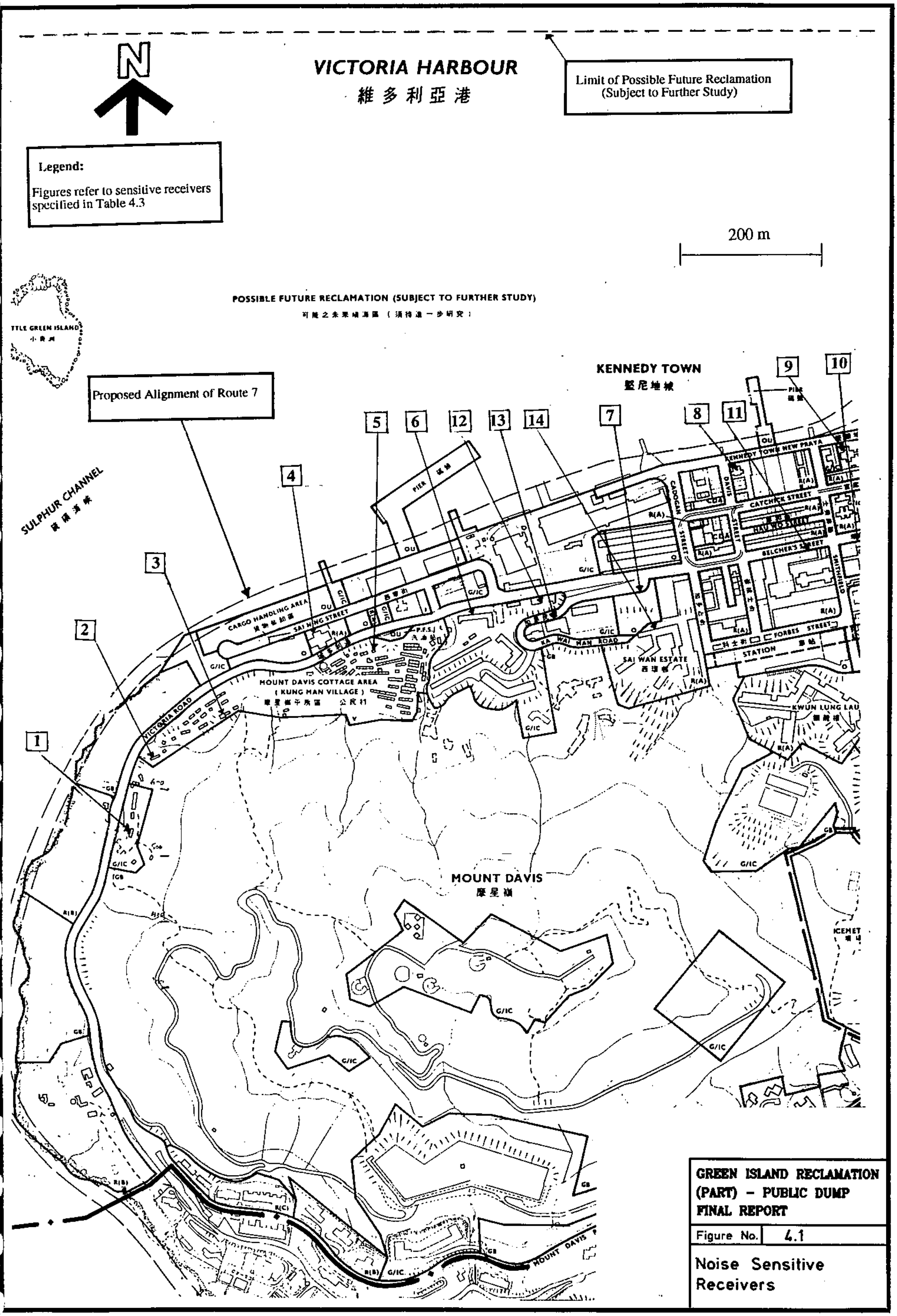
4.5 Green Island Reclamation Feasibility Study. Ove Arup and Partners. Hong Kong Government, 1989.

4.6 Study for Island West Transfer Station. Scott Wilson Kirkpatrick (Hong Kong). EPD Hong Kong Government, 1992.

4.7 Green Island Reclamation (Part) Public Dump, Traffic Impact Assessment (Land). Scott Wilson Kirkpatrick (Hong Kong), Civil Engineering Department, November 1993.

4.8 Green Island Feasibility Study, Recommended Outline Development Plan, June 1993. Ove Arup and Partners, Territory Development Department, Urban Area Development Office, 1989.

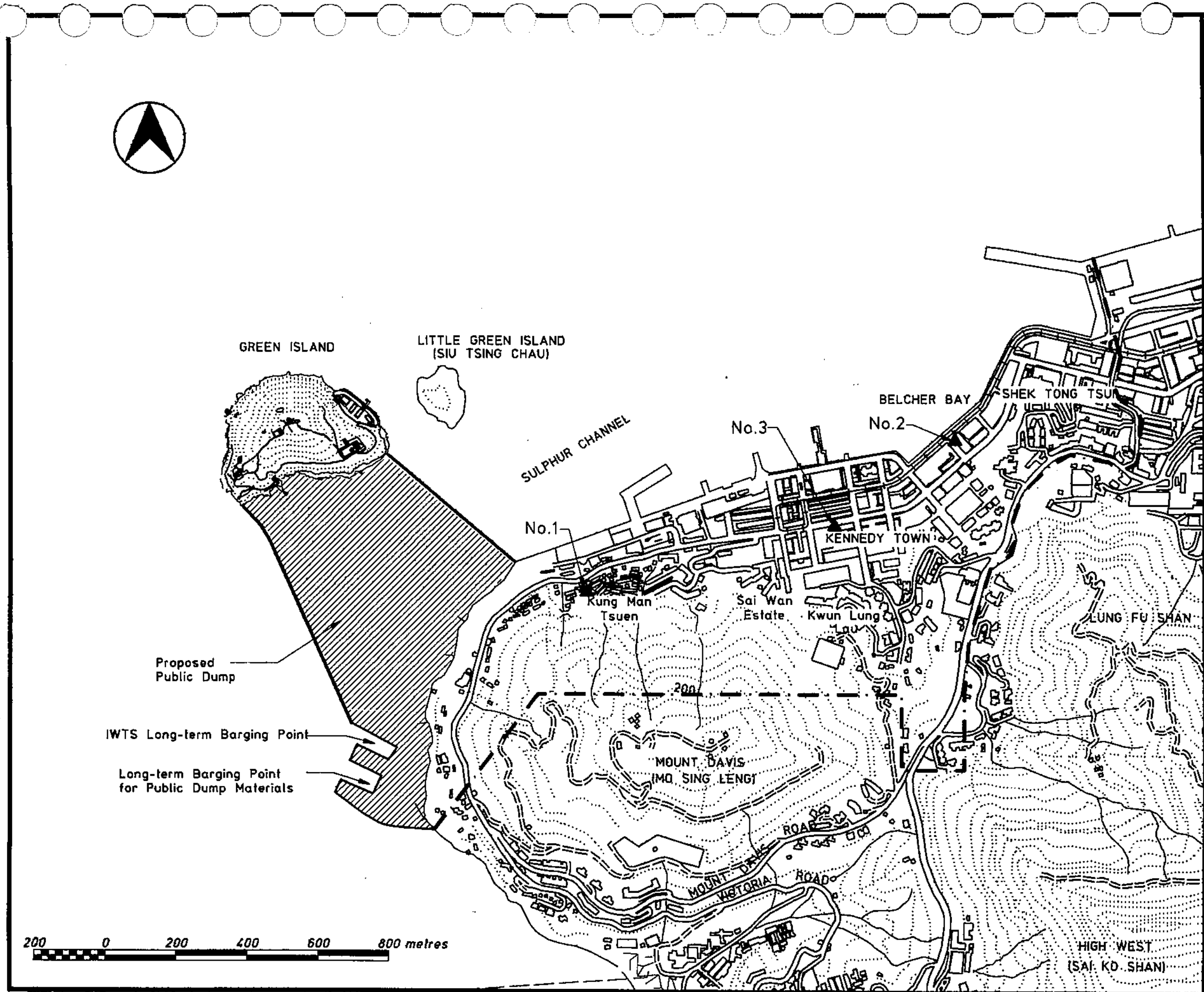
4.9 UK Department of Transport, Calculation of Road Traffic Noise HMSO Publications, 1988.



GREEN ISLAND RECLAMATION (PART) - PUBLIC DUMP FINAL REPORT

Figure No. 4.1

Noise Sensitive Receivers



GREEN ISLAND RECLAMATION (PART) - PUBLIC DUMP FINAL REPORT

Figure No. 4.2

Noise Monitoring Locations

SWK AutoCAD D:\RDFR4 2 19940713.1158 Plot 1 : 10.0000

5. AIR POLLUTION

Introduction

5.1 The chapter details the environmental standards and guidelines for air quality in the Green Island and Kennedy Town area of Hong Kong and provides an assessment of current air quality and monitoring protocols. Impacts of construction activities associated with Public Dump reclamation activities are considered with particular reference to dust. In addition impacts of operational activities are also considered with particular emphasis being given to motor vehicle emissions and odour generation from water stagnation. Consideration is given to impacts following completion and cumulative impacts.

5.2 The Initial Assessment Report recommended that further assessments be undertaken on the following :

- the impact of dust emissions on sensitive receivers for construction and operational phases of the project;
- the impact of motor vehicle emissions;
- consideration of the cumulative impacts on ambient air quality of developments phased to be built at the same time as the Public Dump; and
- an assessment of odour nuisance from the embayment of stormwater and foul drainage outfalls.

5.3 The construction and operation of the barging point on the former KTIP site will also have the potential to generate air quality impacts from on-site and associated traffic activities. These impacts are also assessed in this chapter.

Sensitive Receivers

5.4 Sensitive receivers identified for the purposes of air quality assessment for the public dump are given in Table 5.1A, and shown in Figure 5.1A. Sensitive receivers associated with the barging point are shown in Table 5.1B and Figure 5.1B. All receivers have been subject to EPD approval for assessment purposes.

Environmental Standards and Guidelines

Statutory Limits

5.5 The Air Pollution Control Ordinance (APCO), Cap. 311, is the principal legislation which provides powers for controlling air pollutants from a variety of stationary sources, including fugitive dust emissions, from construction sites, and encompasses a number of Air Quality Objectives (AQOs). These are reproduced in Table 5.2.

5.6 The Harbour Air Control Zone (ACZ), which includes the study area, was instituted in January 1987. The overall objectives of the ordinance are the protection of public health. Future developments should ensure that the AQOs identified in Table 5.2are complied with. The most important airborne pollutant arising from construction work and reclamation is dust, therefore total suspended particulates (TSP) and total respirable suspended particulate (RSP) are included in Table 5.2.

Table 5.1A: Sensitive Receivers - Green Island Reclamation (Part) Public Dump

	Sensitive Receiver	Coordinates		Distance from Reclamation Boundary (metres)	Heights above Principle Datum (metres)
1.	Mount Davis Cottage Area	815500N	830230E	85	55
2.	Residential Block (Sai Ning Street)	815825N	830475E	190	20
3.	Chung Sing Benevolent Society School	815860N	830690E	400	12
4.	Kennedy Town Jockey Club Clinic	815885N	830815E	450	6
5.	Kindergarten	815710N	830275E	80	35
6.	Sai Ning Recreation Area (Temporary)	815875N	830425E	145	5
7.	Residential development (potential)	815635N	830120E	10	5
8.	Government/Institution/Community	815885N	830395E	110	5
9.	Government/Institution/Community	815625N	830205E	80	5
10.	Old Folks Home	815835N	830410E	120	5
11.	Welfare Centre	815780N	830485E	206	25
12.	Green Island	816065N	829615E	10-150	5-45
13.	Police Buildings	815142N	830144E	150	40

Table 5.1B: Sensitive Receivers - Marine Barging Point

	Sensitive Receiver	Coordinates		Distance from Marine Barging Point Boundary (metres)	Heights above Principle Datum (metres)
1.	Kennedy Town Jockey Club Clinic	830815N	815885E	135	6
2.	Centenary Mansion	815915N	830982E	232	6
3.	St Lukes Church & Lui Ming Choi Memorial School	881850N	830819E	157	25
4.	St Lukes Settlement	815882N	830783E	140	6
5.	Chung Sing Benevolent Society School	815864N	830742E	157	7
6.	Kennedy Town Government School	815834N	830755E	187	25
7.	Grand Fortune Mansions	816072N	831017E	242	4

NB: The receivers closest to the construction site are St Lukes Settlement and the Kennedy Town Jockey Club Clinic. These are approximately 50 metres from the south of the construction site and 135-140 m from the proposed Marine Barging Point.

Table 5.2 : Hong Kong Air Quality Objectives

Pollutant	Average Time				
	1 Hour	8 Hour	24 Hour	3 Months	1 Year
Sulphur Dioxide	800	--	350	--	80
Total Suspended Particulates	--	--	260	--	80
Respirable Suspended Particulates*	--	--	180	--	55
Nitrogen Dioxide	300	--	150	--	80
Carbon Monoxide	30000	10000	--	--	--
Photochemical Oxidants (as ozone)	240	--	--	--	--
Lead	--	--	--	1.5	--

NB: All concentrations in micrograms per cubic metre ($\mu g/m^3$), measured at 298°K (25°C) and 101.325kPa (one atmosphere).
1 hour concentrations not to be exceeded more than three times per year.
8 and 24 hour concentrations not to be exceeded more than once per year.
3 month and 1 year concentrations are arithmetic means.
*Respirable suspended particulates (RSP) means suspended particles in air with a nominal aerodynamic diameter of 10 microns (μm) or less.

5.7 Emissions from motor vehicles are controlled by the Road Traffic (Construction and Use) Regulations in which motor vehicles must be designed to meet specified emission standards as detailed in the regulations. Vehicles should also be constructed and maintained so as not to emit excessive smoke levels. The APCO allows for the specification of fuel quality which may be used for motor vehicles. The current lead in ordinary petrol level in Hong Kong is 0.15 g/l.

Specified Processes

5.8 A rock crushing plant with a capacity exceeding 5,000 tonnes per annum and concrete batching plants with a silo capacity exceeding 50 tonnes are classified as Specified Processes (SP) under the APCO. There will be a requirement for these plants to operate under Best Practicable Means (BPM).

Guidelines

5.9 Where impacts are of short duration, for example dust generation during construction activity, it is more appropriate to use guidelines in the assessment of impacts.

5.10 An hourly average of TSP of 500 $\mu g/m^3$ is not a statutory limit, but has been applied in Hong Kong where a dust problem is likely. This limit typically applies to the site boundary and/or the nearest receiver.

5.11 A limit of 2 odour units is recommended by the Environmental Protection Department (EPD) for particular offensive installations. A limit of 2 odour units at the site boundary corresponds to a concentration of twice the odour detection threshold of odorous compounds.

Background Information and Monitoring Data

Meteorology

5.12 This section reviews the general climate of Hong Kong and the prevailing meteorological conditions in the Kennedy Town and Green Island area.

5.13 The typical wind regime of Hong Kong is dominated by the northeast monsoon in winter and the southwest monsoon in summer. Wind regimes are further complicated by the topography of Hong Kong, surface winds may vary in speed and direction over quite short distances. In addition to the normal variations in wind speed and direction, the vertical distortion caused by roughness effects may also be modified by the diurnal thermal effects of daytime anabatic winds enhanced by sea-breeze effects, and the night-time katabatic winds enhanced by land breezes.

5.14 A summary of climatological data for Hong Kong for 1961 - 1990 (Ref 5.1) shows the persistence of an easterly prevailing wind (70° - 90°) with an average windspeed of 6.3 metres per second (m/sec). The annual rainfall is 2214.3 mm and (millimetres) total evaporation is 1528.8 mm. The mean air temperature is 23°C and relative humidity averages 77%. Mean monthly measurements of evaporation compared to mean monthly rainfalls indicate a water deficit during the period October to March. These conditions may be conducive to the entrainment of dust from surfaces.

5.15 Meteorological data for the Kennedy Town locality is limited. Green Island has an anemometer measuring wind data (Ref 5.2). Figure 5.2 shows the annual wind rose for Green Island for 1974 - 1983 and for January 1990 to December 1992 (Ref. 5.2). Prevailing winds are east - north east and south. The wind regime is dominated by the northeast monsoon in winter and the south west monsoon in summer. The sensitive receivers identified in Table 5.1 would be affected by west to north-westerly winds (270° - 360°). On average these occur approximately 12% of the time (see Figure 5.2). Analysis of daily meterological data for October 1989 to July 1993 shows that directional winds in the sector 270 - 360° occurred only 7.2% of the time. Average wind speeds were 17.7kilometres per hour (km/hr) (4.9 m/sec). Maximum mean daily wind speeds for this sector were 39.3 km/hr (10.9 m/sec).

5.16 The longest unbroken period when wind was blowing from an unfavourable direction was 6 days. The average of daily mean wind speeds was 17.1 km/hr (4.75 m/sec). The adverse directional winds were 280 - 320°.

Air Quality

5.17 A network of fixed monitoring stations measuring ambient air quality have been established systematically over the past decade in Hong Kong. In 1992, there were 11 stations in the network each measuring continuously gaseous and particulate pollutants and meteorological parameters. At a number of locations the level of TSP concentrations exceeded the AQO. In addition, breaches of the AQO for nitrogen dioxide (NO_2) and RSP occurred at several locations in 1992.

5.18 The nearest EPD continuous air monitoring station to the Green Island/Kennedy Town area is located at upper level of Central and Western Police Station between High Street and Hospital Road. Air pollution levels are measured 18m above ground level. Table 5.3 shows that the air quality in the district is adversely affected by fugitive dust emissions. This may be due to the many construction site activities taking place in the vicinity. The air quality in Central and Western area is comparable with average Hong Kong air quality levels (Refs 5.3 and 5.4). Air quality data for this location between 1986 and 1992 is presented in Table 5.4.

Table 5.3 : Breaches of the Air Quality Objectives from 1987 to 1992

Year	Annual TSP	Annual RSP	Daily TSP	Daily RSP	Daily NO_2
1987	+	+	-	-	+
1988	+	+	+	+	+
1989	+	-	+	+	-
1990	-	-	-	-	+
1991	-	+	-	-	-
1992	+	+	-	-	-

NB: + = Exceedance of the Air Quality Objectives

Table 5.4 : Ambient Air Quality Levels for Western & Central ($\mu g/m^3$) 1986-1992 (Ref. 5.4)

Sulphur dioxide (SO_2)

	50% ile*	98% ile**	Mean	Maximum 1-hour	Maximum 24-hour
1986	8	35	17	545	127
1987	10	67	15	269	75
1988	13	72	19	196	73
1989	9	66	16	236	77
1990	11	99	19	402	142
1991	13	75	18	409	62
1992	15	113	23	727	135

Nitrogen dioxide (NO_2)

	50% ile*	98% ile**	Mean	Maximum 1-hour	Maximum 2-hour
1986	54	208	67	743	280
1987	55	184	63	452	227
1988	26	102	32	782	235
1989	51	177	60	573	329
1990	47	120	50	218	152
1991	44	112	46	209	112
1992	47	119	50	206	115

Table 5.4 : Ambient Air Quality Levels for Western and Central ($\mu g/m^3$) 1986-1992(Ref. 5.4) (Cont'd)

Total suspended particulates (TSP)

	50% ile*	98% ile**	Mean	Maximum 1-hour	Maximum 24-hour
1986	81	196	89		215
1987	85	184	90		187
1988	95	188	102		362
1989	81	174	84		192
1990	73	150	75		229
1991			75		200
1992*					153

Respirable suspended particulates (RSP)

	50% ile*	98% ile**	Mean	Maximum 1-hour	Maximum 24-hour
1986	53	134	57		169
1987	68	162	68		172
1988	66	156	71		328
1989	48	126	53		144
1990	51	100	54		139
1991			56		131
1992*					142

NB: * 50 percentile ** 98 percentile

5.19 Table 5.5 summarises the results of a TSP and RSP monitoring undertaken between the 22 March 1993 and 5 April 1993 on the roof of Kennedy Town Jockey Club Clinic. Measured concentrations of both TSP and RSP were well within the AQOs of 260 and 180 $\mu g/m^3$ respectively. Also given in the table is data from an earlier particulate survey relating to the Island West Transfer Station (IWTS) study (Ref 5.5).

5.20 Additional air quality data for the immediate Kennedy Town locality is limited. Previous air monitoring survey results relate to Kennedy Town Incinerator and are for six toxic metals, benzo-alpha-pyrene (BaP), polychlorinated biphenyls (PCBs) and nine other volatile organic compounds (Ref 5.6).

5.21 Other studies have found that ethylene dichloride (EDC) levels were above guidelines recommended in the USA (Ref 5.7). The main sources of EDC are believed to be motor vehicles and petrol filling stations. A maximum concentration of BaP, an indicator of polycyclic aromatic hydrocarbons (PAHs) emitted from inefficient combustion of fossil fuel, had a maximum concentration of 2.6 $\mu g/m^3$ (Ref 5.8).

Table 5.5 : TSP and RSP Levels in the Kennedy Town Area ($\mu g/m^3$) (Ref 5.5)

	TSP		RSP	
	Mean	Range	Mean	Range
Kennedy Town Jockey Club Clinic	84.5	52-149	36.1	20-58
Sai Ning Street*	35.4	19.3-58.7	24.1	14.3-35.2

NB: * Data from Island West Transfer Station EIA (Ref 5.5)

5.22 A mobile laboratory monitoring survey used in 1989 (Ref 5.9) to determine background air quality levels in the vicinity of the Kennedy Town Incinerator observed marginal exceedances of the AQO for NO_2.

5.23 No other air quality data for the locality is presently available. Nevertheless, a kerbside study undertaken from November 1991 to February 1992 at the junction of Yee Wo Street, East Point Road and Great George Street in Causeway Bay is particular relevance to the motor vehicle emissions modelling study (Ref 5.10) (see Section 5.41). The results from this monitoring study are indicative of the likely kerbside air pollution levels that would be encountered in Kennedy Town and therefore may be used as baseline data in these studies in the absence of site specific data. Concentrations are summarised in Table 5.6.

Table 5.6 : Air Quality Levels for Yee Wo Street Roadside Monitoring Study November 1991 - February 1992 ($\mu g/m^3$) (Ref 5.3)

	98% ile	Maximum
NO_2	177 (149)	241 (154)
CO	391 (256)	637 (291)
TSP	(583)	(586)

NB: 99 (99) - hourly (daily)

Existing Pollution Sources

Kennedy Town Incinerator

5.24 The incinerator is located on the water front adjacent to the abattoir and was operated by EMSD with an average daily waste throughput of 500 tonnes prior to its decommissioning in March 1993. The incinerator had previously caused air pollution problems in the locality since no gaseous emission control had been installed except for an electrostatic precipitator. Post-closure measurement of TSP and RSP at the Kennedy Town Jockey Club Clinic, opposite the incinerator, indicated that 24-hour TSP and RSP concentrations were within respective AQO standards (Ref 5.5). It is expected that the closure of the incinerator has given rise to an improvement in air quality in the locality.

Kennedy Town Abattoir

5.25 Odour emissions from the abattoir have been a source of complaint. These are generated by animal lairages and slaughtering activities, together with odorous emissions from the animal by-product plant and the crematory facilities inside the abattoir compound. The installation of an odour removal system on the by-product plant proved ineffective in reducing the emission to an acceptable level and the residents of Kennedy Town have continued to suffer from unpleasant odours emanating from the abattoir (Ref 5.3). EPD have carried out a review of odour nuisance problems in the locality created by the abattoir, the by-products plant and the crematory (Ref 5.11). The review indicated that odour problems were likely to occur within a 300 m radius of the existing facilities. For the existing abattoir alone the distance for which odour nuisances would be likely to occur would be 200 m.

Green Island Cement

5.26 Green Island Cement has a large cement storage depot and a concrete batching plant at Catchick Street. Although cement and aggregates are imported by sea, some particulates are deposited on road surfaces by motor vehicles and then re-entrained by both wind or motor vehicular turbulence.

Motor Vehicle Emissions

5.27 Motor vehicle exhausts emit a wide range of compounds. Those which are of general concern include carbon monoxide (CO), oxides of nitrogen (NO_x), hydrocarbons (HC), particulates and lead (Pb).

5.28 Vehicular emissions are principally dependent on traffic volume and speed, age of vehicle, type of combustion engine (petrol or diesel), driving mode, etc. In addition the pollutant concentration at the sensitive receiver will be determined by distance of the receiver location from the highway, topography and prevailing meteorological conditions.

5.29 In peak traffic hours, the centre of Kennedy Town exhibits traffic congestion and low vehicle speeds, although traffic is not high. There is, however, a large amount of pedestrian, hand-trolley and roadside activity in the area, associated with nearby markets.

Other Sources

5.30 Other smaller pollution sources in the locality include restaurants, pig-roasting and lard boiling factories. The air pollution from these sources relates mainly to odour nuisance.

Predictive Modelling Approach

Public Dump

Dust Emissions

5.31 The quantity of dust emissions generated on-site, and hence the level of dust nuisance from reclamation activities, will be effectively governed by the size of the area being reclaimed, the level of reclamation activity, particle size distribution and specific site operations at any one time. Many of these criteria are not precisely known and therefore have in some instances been assumed.

5.32 At the request of EPD the Fugitive Dust Model (FDM) was used to predict dust concentrations from the reclamation area. Previous studies in Hong Kong have used both Industrial Source Complex-Short-Term (ISCST) and CALINE-4 air pollution models.

5.33 Table 5.7 summarises the assumed modelling parameters used to assess the impact of dust emissions from the proposed reclamation area.

Table 5.7 : Assumed Modelling Parameters for Dust - Green Island Reclamation (Part) Public Dump

(a) Emission rates

(i)	Vehicle movements on unpaved road	- 2644g/veh-km*
(ii)	Emission from construction activity	- 0.00012g/m^2/sec
(iii)	Aggregate handling**	
(iv)	Concrete batching plant	- uncontrolled 0.12kg/m^3 (0.0022g/m^2/sec)*** - controlled 0.012 kg/m^3 (0.00022g/m^2/sec)***
(vi)	Rock crushing	- 0.14 kg/Mg (30 tons - 0.00132 g/m^2/sec)**** (60 tons - 0.00263 g/m^2/sec)****

NB: * Assumed
- silt content of 14.1%
- particle size multiplier of 0.8
- mean vehicle speed - 15 km/hr
- mean vehicle weight (loaded) 26.6 tonnes
- mean number of vehicle wheels 10

** Calculated from :

$$kg/Mg = k\,(0.0016)(u/2.2)^{1.3}/(M/2)^{1.4}$$

u = wind speed
M = material moisture content (0.7%)
K = particle size multiplier (0.74)

*** Based on plant capacity of 60m^3/hr and a plant area of 0.09 ha

**** Based on a plant area of 0.09 ha

Emission rates have been assumed to be worst case. By allowing for the number of wet days (118.6) (except for emissions predicted for vehicle movements which are already allowed for in the emission rate) emissions may be reduced by up to 32.5%. Similarly, an effective watering programme (twice daily watering with complete covering) is estimated to reduce emissions by up to 50% (Ref. 5.12).

(b) Model Parameters

Particle size density - concrete (crushed) - sand	1.85 g/cm^3 2.5 g/cm^3
Particle size fraction (See Figures 5.2 and 5.3)	
Surface roughness height Hong Kong International Airport Meteorological Data.	0.375 m

5.34 Emission values given in Table 5.7 are based on AP-42 (Ref 5.12). A dust emission value for on-site activities of 0.00012 $g/m^2/sec$ was used in the modelling study, it is believed that this value is still likely to be representative in the absence of other detailed site-specific source emission data. The impacts of dust emissions relative to sensitive receivers is at present difficult to appraise due to the exact location of operations and their precise phasing being unknown. Nevertheless, predicted concentrations are given for TSP from an arbitrary point at incremental intervals downwind of an assumed operational area of 0.5hectares (ha). For the purpose of this study, uniform dimensions have been assumed. Due to the constraints outlined above being imposed on the modelling assumptions, the predictions should be viewed with care.

5.35 Dust emissions from motor vehicle movements on unpaved areas are a function of vehicle speed, vehicle weight, number of wheels per vehicle, surface texture and moisture. Particles are lifted and deposited from rolling wheels and the road surface and exposed to strong air currents in turbulent shear with the surface. The turbulent wake behind the vehicle continues to act on the road surface after the vehicle has passed. Calculated emission rates based on AP-42 were used in the modelling study.

5.36 It was assumed that the particle size distribution of the material from filling operations was based on the particle size curve given in Figure 5.3. A typical particle size distribution for marine sand for marine sediments found in Hong Kong, given in Figure 5.4, was used for the modelling of emissions from the sand blanket during construction activities.

5.37 Emission rates for the concrete batching plant were modelled based on both a controlled and uncontrolled process. It was assumed that the particle size distribution of the material was cumulatively spread across the silt particle size fraction of 1 - 63 μm.

5.38 Emission rates for the rock crushing plant assumed a peak rate of 60 tonnes per hour of material being processed and a normal rate of 30 tonnes per hour.

5.39 For aggregate handling the emission rate is wind speed dependant. Therefore, the emission rate was adjusted accordingly for varying wind speeds in the modelling study and concentrations were predicted for set distances downwind of the source.

5.40 Predicted pollution concentrations from the modelling studies for sensitive receivers are given in tabular form (see relevant sections on construction and operational impacts). Where the format of the data allowed dust dispersion patterns from emission sources are given in the form of contour maps (see relevant sections on construction and operational impacts).

Motor Vehicle Emissions

5.41 Motor vehicle emissions were modelled using CALINE 4. Assumed modelling conditions were:

* wind speed	:	2m/sec
* wind direction	:	worst case wind direction
* stability class	:	D
* mixing height	:	500m
* temperature	:	25 degrees Celsius (°C)
* horizontal wind direction fluctuations	:	10 degrees

5.42 Nitrogen dioxide (NO_2), particulates and CO were modelled using vehicle emission data supplied by the Vehicle Emission Control Section of EPD. Nitrogen oxide (NO_x) values were modelled, it was assumed that 20% equates to NO_2 levels.

Odour Emissions

5.43 The quantification of odours from a stagnant water body is difficult due to the uncertainty in the areas exact location and variable size. Discharge outfalls in the locality discharge to the channel and therefore the impact of odour emissions will be diminished.

5.44 Odour emissions consist of complex mixtures of compounds which are odorous both individually and collectively. There is no simple relationship between the odorous characteristics of the individual compounds and the characteristics of the mixture. The method used to quantity odour impact is that developed by Warren Springs Laboratory (WSL), UK. The method adopted the principle of dynamic dilution for the sensory measurement of odours. This method determines the number of times a sample of odorous air has to be diluted with clean odour free air such that 50% of a group of panellists just cannot detect an odour. This number of dilutions is called the dilution factor, D, which is a measurement of the strength of odour. The nuisance potential of an odorous emission is a function of strength of the odour, the wind speed, the surface area of the source, the distance from the odour source to the receiver, the atmospheric conditions and the gas flow rate F (m^3/sec).

5.45 The odour emission rate E (m^3/sec) is given as :

$$E = DF$$

The maximum distance from the source at which complaints are likely to occur therefore may be estimated by using the following expression :

$$d_{max} = (2.2E)^{0.6}$$

Where d_{max} is the maximum distance from the source within which complaints are likely to occur. The empirical expression was derived by Warren Spring Laboratory, UK. They noted that the distance from the source at which complaints were likely to occur was a function of odour emission rate (E) hence the relationship $d_{max}=(2.2E)^{0.6}$. Therefore, the greater the emission rate the greater the maximum distance (or buffer zone) required from the source to a sensitive receiver to prevent the likelyhood of odour complaints. The purpose of the equation is to delineate the maximum distance from the source which complaints are likely to occur. Therefore receivers within this zone will be subject to odour nuisance and the limit of 2 odour units will be exceeded. Conversely, beyond the maximum distance no odour will be detected and therefore the odour limit will be complied with. Therefore, the assumption is that no detection of odour is a reasonable compliance objective.

Where odorous air simply escapes from a fugitive source, such as in the given study, quantification of D and especially F, is virtually impossible. A more important related phenomena, which further complicates the quantification of odours is the absence, in most cases, as in this example, of any positive flow of odorous air upwards from a stagnant water source. Emissions from a stagnant water source are essentially due to evaporation being dependent upon temperature and wind speed. This is further complicated by the emission being from an air/water interface.

5.46 Effective vertical velocities for activated - sludge tanks have previously been estimated to be no more than 1-2 mm/sec although velocities of 10 times this value have been observed. (Ref 5.13 and 5.14)

5.47 Following consultations with WSL (Ref 5.15) it was revealed that a maximum likely D value for a primary treatment sewage discharge to a water course would be in the region of 200. This value is considered as conservative.

Marine Barging Point

Dust Emissions

5.48 At the request of EPD the Fugitive Dust Model (FDM) was used to predict dust emission concentrations from vehicular movements and operations relating to the construction site and barging point activities at the proposed Marine Barging Point. Summarised in Table 5.8 are the assumed modelling parameters used to assess the impact of dust emissions from the proposed developments. Emission values are based on AP-42 (Ref 5.12).

Table 5.8: Assumed Modelling Parameters for Dust

(i)	Vehicle movements on paved roads	0.73g/veh-km*
(ii)	Emissions from construction activity	0.00012g/m^2/sec
(iii)	Aggregate handling**	
(iv)	Stockpiling***	7.0 x 10^{-5}g/m^2/sec

NB: * Assumed silt content of 5.5%
Number of traffic lanes 2
Surface dust loading 1.7 kg/km
Industrial augmentation factor 1
Average vehicle weight 26.6 Mg

** Calculated from:
kg/Mg = k (0.0016) ((u/2.2)$^{1.3}$) ((M/2)$^{1.4}$)
u = wind speed (m/sec)
M = moisture content (0.7%)
k = particle size multiplier (0.74)

*** Assumed silt content of 14.1%
Number of wet days with $\geq$ 0.25 mm rainfall (118.6 days)
Percentage of time that the unobstructed windspeed exceeds 5.4 m/sec at pile height (48.5%)

NB: Hong Kong International Airport meteorological data used
Surface roughness height 0.375m
Particle size density 1.85

5.49 Dust emissions were input to the FDM model for a paved road running along both the eastern side of the construction site and the northern side of the site to the barging point positions. The model was run for peak hour traffic which was taken as 14% of the total daily traffic. Two scenarios were examined for comparison, one with a total daily traffic flow of 400 vehicles and the other with a total daily traffic flow of 600 vehicles. Dust emissions from two stockpiles were modelled using FDM, the stockpiles were positioned adjacent to the barging point and were 5 m by 5 m in size. Aggregate handling dust emissions were used in the FDM model to represent batch drops. Batch drop areas of 30 m by 16 m were modelled (representing the size of a barge-opening) and down wind concentrations calculated. The emissions from construction activities are spread over the entire Marine Barging Point site and are associated with earth-moving and site formation activity.

Motor Vehicle Emissions

5.50 At the request of EPD the motor vehicle emissions were modelled using CALINE 4, using the same assumptions as for modelling conducted for the Public Dump. Exhaust emissions were modelled for the paved road using the same traffic scenarios, as for dust emission modelling.

Impact of Construction Activities

Public Dump

5.51 For the purposes of this assessment construction impacts are considered in relation to dust emissions from the site formation and construction of the seawalls.

Impact of Dust Emissions

5.52 The recommendations of the report titled "Reclamation Methods and Phasing of Green Island Reclamation Feasibility Study" (Ref 5.16) were for the use of marine fill as a primary fill material and filling by three phases to mitigate against possible dust nuisance. The use of a trailing suction hopper dredger will further reduce the likelihood of dust generation. During the final stage of filling the emplacement of a metre thickness of covering over the landform may give rise to more significant dust nuisance concerns.

5.53 The nuisance potential of any dust produced will be determined by the degree of effort placed upon dust control. Therefore dust control and mitigation measures should be adopted and enforced, through the use of statutory powers and contractual requirements. The nuisance from dust emissions will be reduced by the distance of the reclamation work from principal centres of commercial or residential activity and sensitive receivers.

5.54 The main cause for concern relating to dust may occur once the surface has arisen above the water level and has the opportunity to dry out. Fugitive dust emissions will be more serious in the Winter (October to March) during the months of water deficit. The predominantly north-easterly wind in the Winter months (i.e. blowing dust-away from Hong Kong Island) will significantly reduce the potential for dust nuisance. Emissions and a reduction in emissions can be achieved by:

- employing methods of working to minimise dust generation or impact;
- dampening down surfaces;
- providing and using water spray, bowsers, mobile sweeping plant and vehicle wheel and body cleaning facilities;
- control of vehicle speeds and movement;
- dust control on specific operations;
- use of side enclosures and coverings where practicable for storage piles;
- covering vehicle loads with tarpaulin; and
- routing of vehicles and positioning of plant at the maximum distance form sensitive receivers.

5.55 Although the detailed development programme has yet to be determined, it is anticipated that different development stages of the project may give rise to problems associated with dust impacts on sensitive receivers. Dust control and mitigation measures should therefore be rigidly applied by the contractor to minimise potential impacts.

5.56 The principal sources of dust that will require special consideration in the project will be:

- site preparation - large areas of the reclamation are likely to be worked concurrently;
- material handling and processing;
- wind erosion from stockpile and working areas;
- vehicle and plant movement on unpaved surfaces; and
- possibly concrete batching plant facilities

5.57 "The Green Island Reclamation (Part) - Public Dump. Review of Sequence of Works" Report (Ref 5.17)details the proposed programme. Dust emissions from dredging activities are likely to be minimal due to the high moisture content of the material. Placing of sand in trenches up to the original seabed level will result in minimal emission. Sand will be won from a marine borrow area and pumped from a hopper through a suction pipe, thereby ensuring careful positioning of the pipe that the sand remains in the trench.

5.58 In order to receive public dumping materials as soon as possible after contract award in March 1995 advance works will be required to allow receipt of the required volumes at the expected rates of fill. This will be achieved by constructing a triangular area, at the south-west corner of the reclamation site. It is envisaged that this area will accommodate the rock crush plant and initially the concrete batching planting. The exact positions of these potential dust emission sources are presenting unknown other than there approximate general location in the aforementioned area.

5.59 Figures 5.5 to 5.7 shows the predicted concentrations in $\mu g/m^3$ from the concrete batching plant for uncontrolled emissions in the triangular area to the south-west of the reclamation area. It was assumed that the particle size distribution of the material was cumulatively spread across the silt particle fraction of 1-63μm. Table 5.9 shows the impact of emissions on identified sensitive receivers.

5.60 Assuming that the plant will be operated efficiently then the values given in Table 5.9 should be divided through by 10 (see emission values in Table 5.7) to provide concentrations occurring from a controlled plant (controlled values are given in parenthesis). Emissions may further reduced by 50% if watering is carried out twice daily (Ref 5.12).

5.61 The impacts from the concrete batching plant should also be considered with operation impacts as the construction of sea walls will continue during the planned operational phases of the development.

Table 5.9 Predicted Dust (TSP) Concentrations Concrete Batching Plant on Sensitive Receivers ($\mu g/m^3$) (Uncontrolled and Controlled)

Sensitive Receiver*	Maximum 1-hour	Maximum 24-hour	Annual
1	335 (34)	34 (3)	2.0 (0.2)
2	86 (9)	11 (1)	<1 (0.1)
3	63 (6)	4 (0.5)	<1 (0.1)
4	55 (6)	3 (0.3)	<1 (0.1)
5	156 (16)	21 (2)	<1 (0.1)
6	88 (9)	12 (1)	<1 (0.1)
7	247 (25)	21 (2)	1.4 (0.1)
8	86 (9)	12 (1)	<1 (0.1)
9	229 (23)	27 (3)	1.2 (0.1)
10	97 (10)	13 (1)	<1 (0.1)
11	97 (10)	8 (1)	<1 (0.1)
12	70 (7)	8 (1)	<1 (0.1)
13	1330 (133)	127 (13)	88 (0.8)

NB: * Refer to Table 5.1A

5.62 The principal dust impact concerns relate to the concrete batching plant. Table 5.9 shows that provided the plant is properly controlled only one sensitive Receiver (Receiver 13, see Table 5.1A) is likely to be adversely affected by emissions. The receiver, a Police building, is within 150 m of the reclamation site and close to the proposed site for the plant. The dust emission concerns are compounded by the fine nature of the material. Due to the close proximity of this receiver to the reclamation site it should be ensured that the concrete batching plant is situated as far as possible in the initial development area from this receiver. Maximum 1-hour concentrations at Receiver 13 for the concrete batching plant (133 $\mu g/m^3$) and sand blanket construction (47.7 $\mu g/m^3$) under worst case assumptions are, however, below the recommended 1-hour guideline of 500 $\mu g/m^3$.

5.63 The maximum TSP level recorded in Kennedy Town is 149 $\mu g/m^3$ (see Table 5.5). The maximum 24-hour level predicted at the receiver site (Receiver 13) (controlled) is 13 $\mu g/m^3$. It is therefore unlikely that the AQO for 24-hour TSP (260 $\mu g/m^3$) will be exceeded at this receiver. Maximum long-term levels (controlled) of $< 1 \mu g/m^3$ are insignificant.

Marine Barging Point

5.64 For the purposes of this assessment construction impacts are considered in relation to dust emissions from the site formation and associated earth-moving activities.

5.65 Maximum dust (TSP) concentration predictions at the identified sensitive receivers over the 1-hour, 24-hour and annual periods are given in Table 5.10. These concentrations represent a worst case scenario, whereby it is assumed that the entire site area (0.6 ha) is being worked simultaneously, and meteorological conditions are the most unfavourable.

5.66 From Table 5.10,it is noted that the worst maximum predicted 1-hour average concentration occurs at the Kennedy Town Jockey Club Clinic at 402.2 $\mu g/m^3$. The worst maximum predicted 24-hour average (165.9 $\mu g/m^3$) and annual average TSP concentrations (25.5 $\mu g/m^3$) occur at St Lukes Settlement and the Kennedy Town Jockey Club, respectively. Guideline and AQO permissible TSP concentrations over the 1-hour, 24-hour and annual periods are 500 $\mu g/m^3$, 260 $\mu g/m^3$ and 80 $\mu g/m^3$ respectively.

5.67 Therefore, predicted dust impacts associated with the construction of the barging point, under worst case conditions, are not expected to exceed respective guidelines and AQOs. In reality, predicted dust concentrations are envisaged to be substantially less than figures presented in Table 5.10 as site formation and earth-moving activities during construction are likely to be limited. This is because associated impacts with these activities will largely be restricted to the prior demolition of KTIP structures, and the degree of construction required to develop the Marine Barging Point site is not substantial.

5.68 Further, mitigation measures can be effectively deployed to ensure that dust impacts are maintained well within acceptable levels. These measures included restricting the work surface area to less than 0.6 ha, and implementing the measures specified in Section 5.54.

Table 5.10: Predicted Dust (TSP) Concentrations from Barging Point Construction Activity ($\mu g/m^3$)

Sensitive Receiver*	Maximum 1-hour	Maximum 24-hour	Annual
1	402.2	139.4	25.5
2	83.3	12.6	22.4
3	211.3	47.4	15.4
4	394.7	165.9	12.0
5	287.1	106.4	7.7
6	224.1	87.7	1.2
7	53.7	9.1	1.1

NB:* Refer to Table 5.1B

Impact of Operational Activities

Public Dump

5.69 Operational practices will principally be concerned with the phased filling of the reclamation site and associated activities. The potential sources of pollution will include:

- dust emissions from filling activities and site activities,
- odour emissions from stagnant water; and
- motor vehicle emissions.

Impact of Dust Emissions

5.70 Dust suppression methods and techniques outlined above should be employed and these will help to reduce dust emissions. In addition, the confinement of filling operations to limited sized phases will also reduce impacts. Approximately 10% of material delivered to the site will be oversized.

5.71 Tables 5.11 and 5.12 show the predicted concentrations at sensitive receivers from dust emissions. In Table 5.12 it has been assumed that the vehicles are moving from the access road exit towards Green Island over the reclamation area (the predicted concentration for Receiver 12 will be approximately the same as 13). Figures 5.8 to 5.10 show the dispersion patterns of the dust for the rock crusher plant.

Table 5.11: Predicted Concentrations from Filling and Site Activities for Dust ($\mu g/m^3$)(Rock Crusher and Concrete Batching Plant)

Sensitive Receiver	Concrete Batching Plant (Controlled)			Rock Crusher 60-tons			Rock Crusher 30 tons		
	1-hr	24-hr	Annual	1-hr	24-hr	Annual	1-hr	24-hr	Annual
1	34	3	0.2	105.3	16.2	1.2	52.9	8.1	0.6
2	9	1	0.1	21.8	3.3	0.2	10.9	1.6	0.1
3	6	0.5	0.1	13.2	1.8	0.2	6.6	0.9	0.1
4	6	0.3	0.1	11.5	1.6	0.2	5.8	0.8	< 0.1
5	17	2	0.1	41.7	7.2	0.4	20.9	3.6	0.2
6	9	1	0.1	19.6	3.4	0.2	9.9	1.7	0.1
7	25	2	0.1	74.5	10.4	0.7	37.4	5.2	0.4
8	9	1	0.1	21.4	3.6	0.2	10.8	1.8	0.1
9	23	3	0.1	66.6	11.2	0.7	33.4	5.6	0.4
10	10	1	0.1	22.4	3.8	0.3	11.3	1.9	0.1
11	10	1	001	23.4	3.4	0.3	11.1	1.7	0.1
12	7	1	0.1	15.2	2.7	0.4	7.6	1.3	0.2
13	133	12.7	0.8	720.5	84.2	7.7	360.2	42.0	3.9

5.72 Whilst the positions of the rock crusher and the concrete batching plant are tentatively known with respect to dust emissions, the activities associated with vehicle movements, aggregate handling and active work areas and their associated emissions will be variable and therefore their impact on sensitive receivers will be variable and may not necessarily coincide.

5.73 Figures 5.11 - 5.13 show the impact of these sources at incremental distances downwind of the source. No adjustment is made for height above Principal Datum. Figures 5.14 - 5.16 show the contour plots for an active 0.5 ha work area. No correction factors are given for dust suppression.

5.74 Comparing Tables 5.11 and 5.12 and Figures 5.11 to 5.13 allows for the direct impact on sensitive receivers to be assessed as well as the cumulative impact of dust emissions on sensitive receivers assuming that all coincide. As detailed above, the exact impact from vehicle movements, aggregate handling and emissions from active work areas is tentative as their exact positioning in relation to sensitive receivers is presently unknown. Table 5.11 shows that the emissions of dust from the concrete batching plant do not exceed the recommended dust 1-hour guideline of 500 $\mu g/m^3$ for any of the sensitive receivers, and for the rock crusher this guideline is only exceeded at Receiver 13 when operating at 60 tonnes/hr (720.5 $\mu g/m^3$). The combined predicted dust concentrations are also below the 24-hour AQO of 260 $\mu g/m^3$. However, the additional impact of emissions from road vehicles, operational work areas and batch/aggregate dropping activities may increase levels further, particularly at receivers close to the site boundary (i.e. Receivers 7, 12 and 13).

Table 5.12: Predicted Concentrations from Vehicular Movements for Dust ($\mu g/m^3$)

Sensitive	Uncontrolled		Controlled	
Receiver	1-hr	24-hr	1-hr	24-hr
1	408	144	123	44
2	174	58	53	18
3	124	38	38	12
4	108	32	33	9
5	278	96	84	29
6	178	60	54	18
7	478	176	14	53
8	186	62	56	18
9	366	132	110	39
10	190	64	57	20
11	174	58	53	18
12				
13	1508	335	453	101

NB: - For Receiver 12 refer to paragraph 5.71. For assumptions refer to paragraph 5.78.

5.75 Figure 5.11 shows the predicted concentrations from batch/aggregate drop operations assuming a 0.5 ha operational area for a 12-hour and extended operational day (24-hour). The latter is given for comparative purposes. This is a very conservative estimate. For actual operations the batch drop area may be considerably smaller and the volumes of waste will vary. In addition Figure 5.11 shows the impact of emissions for windspeeds from 1 m/sec to 10 m/sec. Section 5.15 shows that during westerly winds although maximum windspeeds were 10.9 m/sec average speeds were 4.9 m/sec. Therefore assuming the more dominant windspeed the impact of batch drop operations will be considerably reduced. By applying wetting procedures (see Table 5.7) maximum concentrations at the NSRs will be reduced to approximately 135.9 $\mu g/m^3$. No consideration is given to the height of the receiver above Principal Datum which will further help to reduce emissions. The height of the receivers with respect to the location of the variable emission source is unknown. Batch drop operations close to sensitive receivers should be minimised where possible. No consideration is given either to the number of wet days which will also reduce emissions by approximately 32.5%.

5.76 Figure 5.13 shows the predicted dust concentrations of emissions from active work areas. No consideration is given to the number of wet days and watering activities in the predictions. A more realistic prediction is to apply the correction factor given in Table 5.7. Therefore maximum concentrations will be approximately 100 $\mu g/m^3$ at sensitive receivers.

5.77 Figure 5.12 and Table 5.12 show that dust emissions from vehicles moving on-site on the unpaved (uncontrolled) areas are likely to be elevated. The values given in Table 5.12 are for a hypothetical route from the access road towards Green Island. Figure 5.12 shows the predictions for set distances away from an assumed road. In both situations predicted concentrations are likely to be worst case. It is not presently known which routes the vehicles will take on-site and the number of vehicles which will use each route. Figure 5.12 and Table 5.12 assume peak hour flows. By reducing vehicle speeds to 8 kph (by the use of speed ramps) dust emissions will be reduced by at least 40%. It is also recommended that all unpaved road ways are frequently watered to reduce emissions. A twice daily watering with complete covering will reduce emissions by up to 50% (Ref 5.12). Predicted dust concentrations under these controlled conditions are also given in Table 5.12.

5.78 The maximum recorded TSP level for Kennedy town is 149$\mu g/m^3$ (Table 5.5). This level has been adopted as a background level for comparison with the AQOs given in Table 5.2. No annual average background level for TSP is available for the study. Therefore, for the purposes of this study, the annual level of 75 $\mu g/m^3$ for the EPD Western and Central air pollution monitoring station has been adopted as a baseline level. The TSP AQO for 24-hours and 1-year are 260 $\mu g/m^3$ and 80 $\mu g/m^3$ respectively. The cumulative impacts of values given in Tables 5.11 and 5.12 for each receiver are unlikely to cause either the 24-hour or annual TSP AQO to be exceeded (provided restricted vehicle speed limits are applied and wetting of surfaces are carried out).

5.79 Nevertheless, it is clear that Receiver 13, the Police Buildings, would be at risk of being exposed to high dust levels in some circumstances. Based on this assessment it has been decided not to place any concrete batching plant or rock crushing plant on the site. As can be seen from Table 5.11 the removal of these plant will greatly reduce the potential impacts at Receiver 13. A further benefit is that the vehicle movements in the vicinity of Receiver 13 will also be greatly reduced and the predicted dust impacts from this source will be correspondingly lower.

5.80 The results from the dispersion modelling studies therefore demonstrate that the sensitive receivers are unlikely to be adversely affected by particulate levels, and TSP concentrations will be below the recommended 1-hour guideline of 500 $\mu g/m^3$ at all the sensitive receivers.

Impact of Odour Emissions

5.81 An analysis of hydrodynamic data from a 50mm grid tidal model for the purposes of determining whether stagnation of sewage laden seawater will adversely affect air quality in the vicinity of the development was undertaken. Modelling of marine waters was undertaken by HWR Ltd, and is reported upon in Chapter 7. The modelling considered only the use of water velocity data from the upper layer of the water column as air quality will be most affected by stagnant surface water. Predicted results showed low current speeds occurring in the area east of Green Island and along the shoreline south of Green Island. As the construction of the sea wall proceeds the area of low velocity east of Green Island will increase in size, with the areas along the coastline remaining similar in location and size. A study of velocity vectors showed that on the flood tide low velocities occur in the area east of Green Island but that during the ebb tide there will be flushing and dispersion of this stagnant water. This effect was also demonstrated for the areas of low velocity along the coastline south of Green Island.

5.82 The modelling results showed that the water is likely to become stagnant for part of the tidal cycle but will not remain so for more than a few hours due to the flushing on the subsequent portion of the tide. However, there may be areas along the coast where water will become stagnant and floating debris may become trapped but these will be very small and the debris should disperse within the duration of a few tidal cycles.

5.83 Quantification of odours from the stagnant water area is difficult to evaluate due to the uncertainty in its exact location and its variable size. The outfalls in the area will discharge direct to water and, therefore, the impact of odour emissions is likely to be considerably diminished.

5.84 Hydrodynamic modelling undertaken in this study, indicate that the size of the stagnant water area will increase in size to approximately 80000m^3 once the sea wall is extended to Green Island. The areas of stagnant water were found to be close to the coastline, not more than 150m from the shore. As mentioned previously, low current speeds occur along the coastline south of Green Island.

5.85 Any areas of stagnation which form at this location will be extremely small and localised. It is not possible to determine the extent of the areas as the water model grid is too large. Therefore, the size of the predicted area is only accurate to within 15%.

5.86 As given in Section 5.46 the effective vertical velocities for activated sludge tanks have been estimated to be no more than 1-2 mm/sec (0.001 - 0.002 m/sec). Therefore, assuming that the effective vertical velocity is uniform then the gas flow rate F (m^3/sec) is approximately equivalent to 80m^3 for an effective velocity of 1 mm/sec. Assuming an odour dilution factor D of 200, the odour emission rate E (m^3/sec) = DF = 16000. Therefore the maximum distance from the source at which complaints are likely to occur may be estimated as:

$$d_{max} = (2.2E)^{0.6} = 0.535\ \text{km}$$

Therefore, using the above assumptions, it is apparent that an odour may be noticed from the embayment of stagnant water. The above calculation is very conservative and the limitations in application are detailed elsewhere (Ref 5.14 and 5.15).

5.87 The value given above is likely to be an extreme over estimation of the distance of impact. The vertical emission velocity is unlikely to be uniform and the D value of 200 is also probably an over estimation for this scenario. Warren Spring Laboratory stated that the D value of 200 is likely to be a absolute maximum as it was taken close to a sewage outfall. HWR Ltd in their water modelling studies have observed that the stagnant water direct to marine waters over will not be within 150m of the coast. The sewage pipes at present discharge at depth to marine waters, and the effluent waste will therefore be diluted and the residual odour will be diminished. If the gas flow emission rate was assumed to be uniform, as in the likely scenario, then a revised gas flow rate may be assumed of 44.9 m^3 (derived from segregating unit areas of 10,000 m^2 linearly against effective velocities of 0 to 1 m/sec). Allowing for a 15% error in the calculation, then the revised d_{max} value is 343 m. Conversely, it is not inconceivable that the D factor may be erroneous by a factor which is unknown. Should the error be a factor of 10 then a calculation of d_{max} is therefore 86m. In this situation the maximum distance from the source that an odour is detectable will therefore be reduced. Sensitive receivers likely to be affected by stagnant water odours are those to the north of Victoria Road (Receivers 2, 6, 8 and 10 - Table 5.1A). Predictions show that the stagnant water areas may persist for about 2 hours. The difficulty in obtaining reliable and accurate modelling data prohibits a more detailed study.

Impact of Vehicular Emissions

5.88 The Traffic Impact Assessment (Ref 5.18) identifies that the peak hour flow vehicles will be 72 veh/hr which is equivalent to 126 pcu/hr. Access routes to the site are given for 1996, prior to the introduction of Kennedy Town Traffic Management Scheme, and for 1997 to 2002 which reflects the local circulation proposed under the Kennedy Town Traffic Management Scheme.

5.89 The study concluded that junction performance indicates that the road junctions within the Study Area can operate within capacity. This is the case even with the inclusion of the dump vehicles in the traffic stream, when recommend routes are followed.

5.90 The report shows that the majority of dump vehicles will flow along Victoria Road (93 pcu/hr) with a minority entering and leaving the site from the route south of Mount Davies.

5.91 Dispersion modelling studies using CALINE 4 observed that the incremental increase due to CO emissions from Public Dump Vehicles at sensitive receivers would be 0.1 ppm 115 $\mu g/m^3$, nitrogen dioxide (NO_2) 2 ppb 4 $\mu g/m^3$ and particulates 30.2 μg traffic/m^3). The principal sensitive receivers affected are those closest to the proposed routes (Receivers 2, 3, 4, 5 and 9).

5.92 Emissions from background peak-hour road traffic volumes given in the Traffic Impact Assessment Report are marginally greater than the values given above assuming 10% traffic component value for HGVs, buses etc. Maximum values recorded at sensitive receivers were approximately CO 280 $\mu g/m^3$, particulates 94 $\mu g/m^3$ and NO_2 14 $\mu g/m^3$.

5.93 Incremental increases in CO and NO_2 levels from Public Dump vehicular movements are unlikely to cause the AQOs to be exceeded when added to the maximum hourly levels of 637 $\mu g/m^3$ (Table 5.6) and 206 $\mu g/m^3$ (Table 5.4) respectively. The 1-hour AQOs for CO and NO_2, are 30000 and 300 $\mu g/m^3$ respectively.

5.94 The maximum TSP levels were predicted for Receiver 9 (see Table 5.1A), which is a potential development site for Government/Institution/Community use. Table 5.11 and 5.12 and Figures 5.14 to 5.16 show that the maximum cumulative predicted 1-hour levels from the concrete batching plant (23 $\mu g/m^3$), rock crusher (3.3 $\mu g/m^3$) vehicle movement (80 $\mu g/m^3$), aggregate handling (20 $\mu g/m^3$) and general construction (7.5 $\mu g/m^3$) in addition to Public Dump vehicle emissions are below the TSP 1-hour guideline of 500 $\mu g/m^3$.

Marine Barging Point

Impact of Dust Emissions

5.95 Emission sources associated with the operation of the barging point will include vehicles on paved roads and site activities including construction waste handling/tipping activities and the limited stockpiling of materials. Predicted dust (TSP) concentrations at identified sensitive receivers form stockpiling and vehicle movements (at 400 and 600 visits to site per day) for 1-hour, 24-hour and annual periods are shown in Table 5.13A-C.

5.96 Predicted 1-hour dust (TSP) concentrations from construction waste handling/tipping activities at increasing distances from the emission source as a function of wind speed are given in Figure 5.17. Predicted 1-hour dust (TSP) concentrations from this emission source at identified sensitive receivers are included in Table 5.13A.

5.97 The worst case predicted 1-hour dust (TSP) concentration arising from operational activities occurs at Kennedy Town Jockey Club Clinic (135 m distance) of 196.1 $\mu g/m^3$. This is significantly below the guideline value of 500 $\mu g/m^3$, and it is also likely that 24-hour and annual dust (TSP) concentrations will be below their AQOs of 260 and 80 $\mu g/m^3$ respectively. The worst case predicted concentration could be effectively reduced by the enclosure of the tipping jetty to reduce wind exposure. As this enclosure would also mitigate noise and visual impacts associated with operation of the barging point, it is recommended that enclosure is provided in the site design.

Impacts of Vehicle Emissions

5.98 Predicted vehicle exhaust concentrations from vehicles associated with the barging point alone are below the minimum levels that the CALINE 4 model will predict. Minimum levels are 115 $\mu g/m^3$ (0.1 ppm) for CO and 18.8 $\mu g/m^3$ (0.01 ppm) for NO_x (assuming all NO_x equates to NO_2). If 20% of NO_x is taken to be NO_2, the level is therefore calculated to be below 3.8 $\mu g/m^3$ (0.002 ppm). Predicted vehicle exhaust concentrations from total traffic flows (ie barging point and non-barging point traffic) at the sensitive junction between the barging point and Victoria Road are given in Table 5.14.

5.99 Combining worst total traffic flows in case predicted 1-hour particulate concentrations from Table 5.14 with total dust (TSP) concentrations in Table 5.13A, maximum concentrations occur at Kennedy Town Jockey Club Clinic of 302.2 $\mu g/m^3$. This figure is below the guideline value of 500 $\mu g/m^3$ and could be reduced substantially by the enclosure of the tipping jetty and other dust suppression measures previously described.

Table 5.13A: Maximum 1-Hour Average Dust Concentrations ($\mu g/m^3$)

Sensitive Receivers	Paved Road Vehicle Nos		Stockpile	Construction Waste Handling/ Tipping	Total
	400	600			
Kennedy Town Jockey Club Clinic	2.1	2.9	1.1	190	**196.1**
Centenary Mansion	0.5	0.7	0.4	90	91.6
St Lukes Church & Lui Ming Choi Memorial School	1.9	2.7	0.7	150	155.3
St Lukes Settlement	1.3	1.8	0.1	175	172.2
Chung Sing Benevolent Society School	0.7	0.9	0.1	150	151.7
Kennedy Town Government School .	0.6	0.9	0.1	105	106.6
Grand Fortune Mansions	0.3	0.4	0.3	85	87.7

Table 5.13B: Maximum 24-Hour Average Dust Concentrations ($\mu g/m^3$)

Sensitive Receivers	**Paved Road Vehicle Nos**		**Stockpile**
	400	**600**	
Kennedy Town Jockey Club Clinic	0.8	1.1	0.2
Centenary Mansion	0.8	0.1	0.1
St Lukes Church & Lui Ming Choi Memorial School	0.7	1.0	0.1
St Lukes Settlement	0.4	0.6	0.3
Chung Sing Benevolent Society School	0.2	0.3	0.4
Kennedy Town Government School	0.2	0.2	0.3
Grand Fortune Mansions	0.1	0.1	0.0

Table 5.13C: Annual Average Dust Concentrations ($\mu g/m^3$)

Sensitive Receivers	Paved Road Vehicle Nos		Stockpile
	400	600	
Kennedy Town Jockey Club Clinic	0.1	0.2	0.0
Centenary Mansion	0.1	0.1	0.0
St Lukes Church & Lui Ming Choi Memorial School	0.1	0.1	0.0
St Lukes Settlement	0.0	0.0	0.0
Chung Sing Benevolent Society School	0.0	0.0	0.0
Kennedy Town Government School	0.0	0.0	0.0
Grand Fortune Mansions	0.0	0.0	0.0

Table 5.14: Exhaust Gases Concentrations Obtained from Modelling the Total Traffic Flows at the Junction between the Barging Point Access Road and Victoria Road

	CO ($\mu g/m^3$)	Particulate ($\mu g/m^3$)	NO_x ($\mu g/m^3$)	NO_2 ($\mu g/m^3$)
Kennedy Town Jockey Club Clinic	343	106.1	38	7.6
Centenary Mansion	458	118.8	38	7.6
St Lukes Church & Lui Ming Choi Memorial Sc.	114	32.8	19	3.8
St Lukes Settlement	343	103.6	38	7.6
Chung Sing Benevolent Society School	229	68.2	19	3.8
Kennedy Town Government School	114	30.3	19	3.8
Grand Fortune Mansions	0	15.8	0	0

5.100 Predicted worst case 1-hour concentrations of CO and NO_x from total traffic flows at the junction between the Marine Barging Point and Victoria Road occur at Centenary Mansions at 458 $\mu g/m^3$ (0.4 ppm) and 56.4 $\mu g/m^3$ (0.03 ppm) respectively. If 20% of NO_x is taken to be NO_2, the predicted NO_2 concentration at this location will be 7.5 $\mu g/m^3$ (4ppb). The AQOs for CO over a 1-hour and 8-hour time period are 30,000 $\mu g/m^3$ and 10,000 $\mu g/m^3$ respectively. The AQOs for NO_2 over a 1-hour, 24-hour and annual period are 300, 150 and 80 $\mu g/m^3$ respectively. The results from predictive modelling therefore indicate that air quality impacts arising from vehicle emissions associated with the operation of the Marine Barging Point should not exceed respective AQOs by a significant margin.

Impact Following Completion (Public Dump)

5.101 The precise use of the reclamation area after completion is presently unknown but it is believed to comprise mainly residential areas and open space according to the Recommended Outline Development Plan (Ref 5.19). Future usage therefore is expected to comply with all Hong Kong AQOs. Initial construction activity may cause the upper layers of the reclamation surface to be disturbed, thus causing dust emissions. Strict adherence to dust emission prevention methods detailed in Section 5.54 will however reduce the potential impact to acceptable levels. Future on-site development should be subject to a detailed air quality impact assessment and be a requirement in the tender specification.

Cumulative Impacts

5.102 It is proposed that the Green Island Public Dump will be operational from 1996 to 2002. The commissioning times of other developments in the locality were given in Table 3.1. The Table shows that the developments at Island West Transfer Station (IWTS), Route 7, Strategic Sewage Disposal Scheme (SSDS) Sewage Works, the Cadogan Street Building Development, and Water Services Department (WSD) Service Reservoir will coincide with the Public Dump filling operations. The Belcher Bay development is of sufficient distance from the reclamation area not to have a significant cumulative impact. IWTS, SSDS and WSD developments are situated in elevated positions overlooking the Public Dump site and are located east of operations.

5.103 The environmental assessment study for IWTS concluded that the construction of the cavern will significantly reduce the potential for dust emissions and the most significant effect would be during the initial construction of the cavern and access route. These activities are programmed to occur during late 1994 and early 1995 and thus predate the Public Dump development, which is due to start in 1996.

5.104 The IWTS completion date is just after the Public Dump development commissioning date. Therefore, it is envisaged that the impact from construction activities will not have a significant cumulative effect. Nevertheless, the operation of the waste transfer station will coincide with the operational phase of the Public Dump. The IWTS Initial Environmental Assessment concluded that the air quality impact from peak hourly refuse collection vehicle flows is likely to be insignificant. Predicted maximum 1-hour CO levels based on peak hourly traffic flow for the nearest sensitive receivers in Sai Ning Street, Mount Davis Cottages and the playground and residences at the junction of the IWTS access road and Victoria Road were 0.7 mg/m^3, 0.3 mg/m^3, 0.8 mg/m^3 and 0.60 mg/m^3 respectively. The corresponding maximum increase in NO_2 levels above background levels would be less than 7.5 $\mu g/m^3$. These levels in addition to predicted pollution concentrations from Public Dump vehicles are insignificant and below the AQOs. For the SSDS development vehicle and plant emissions are not considered to represent a significant source of air pollution (Ref 5.20). With regard to the WSD development little information is presently available, nevertheless assuming the number of vehicle movements are comparable to any one of the developments given above then it is likely that the WSD developments' impact from motor vehicle emissions will be insignificant.

5.105 The IWTS EIA (Ref 5.5) concluded that ventilation measures adopted within the cavern will ensure that the EPD criterion of 2 odour units at the site boundary will be met at all times. The Draft Environmental Assessment Report for the SSDS development (Ref 5.20) concluded that sensitive receivers are located sufficiently distant from Mount Davies to avoid such nuisance. However, provision should be made in the design of the works for scrubbing of the polluted air from the works in the cavern should it prove to be necessary due to the cumulative impacts in the area of changed landuses. It is not envisaged that the Water Services Department Service Reservoir will be a significant source of pollution. Therefore it is not believed that the above developments will have a significant cumulative impact on odours at sensitive receivers. The principal area of concern relating to odours for the Public Dump Study is likely to be near to the northern shore line. The sensitive receivers in this area are unlikely to be influenced by the above developments.

5.106 The Traffic Impact Assessment (Land) (Ref 5.18) identified four different options for locating the access road to the dump. Only two out of the four were considered feasible. These were the IWTS Option (construction of a separate access parallel to IWTS access road) and the Disused Track Option (upgrading the existing disused track near Mount Davis Road).

5.107 The first option may cause a greater impact in terms of air quality than the latter option due to greater construction works required, but the impact of predicted vehicular emissions given in paragraphs 5.88 and 5.104 indicate that the impact on sensitive receivers will, however, be minimal. Nevertheless, the Traffic Impact Assessment concluded that the upgrading of the Disused Track is a better option taking into account the cost, potential contractual complications and environmental objections to the IWTS option. With regard to the Disused Track option Receivers 1, 7 and 13 (See Table 5.1) may be affected by the upgrading and use of the track. Dust emission prevention methods specified in paragraph 5.54 will reduce the potential impact at the sensitive receivers.

5.108 SSDS and WSD developments will also coincide with the development of the Public Dump No detailed information is presently available on the WSD Service Reservoir activity to allow any detailed assessment of the cumulative impact. Nevertheless, impacts are likely to be similar to those of the SSDS during construction.

5.109 The SSDS sewage works Draft Environmental Assessment Report (Ref 5.20) states that most of the permanent installations will be situated below ground, such that both their construction and operation will be very low profile activities. A similar observation can be made for the WSD service reservoir. A preliminary review of working sites concluded that no severe or unavoidable environmental impact from construction and operational activities on sensitive receivers would be likely to occur from the SSDS development. With regard to air pollution the principal concerns raised were dust generation during construction and odour emissions during operation. TSP 1-hour levels at the two closest sensitive receivers were less than $200 \mu g/m^3$. These receivers are sufficient distance from the reclamation activities not to be adversely affected. Therefore the cumulative impact is likely to be below the $500 \mu g/m^3$ guideline for dust emissions over 1-hour. Following receipt of detailed information from the WSD development dust emission results should be compared to previous studies to ensure that the dust guidelines will not be exceeded at sensitive receivers.

5.110 Cumulative impacts on local air quality arising from the simultaneous operation of the Public Dump and Marine Barging Point at the former KTIP site are not envisaged to be significant due to their relative spatial displacement and the provision of mitigation measures. As the Marine Barging Point will only be operational until mid-1997, its environmental impact will also be of limited duration.

Conclusions and Recommendations

Public Dump

5.111 Dispersion modelling studies of dust emissions from on-site activities show that sensitive receivers are unlikely to be adversely affected by particulate levels, and concentrations will be below recommended air quality guidelines and ensure compliance with the 24-hour TSP level. The contractor should adhere strictly to agreed dust mitigation measures.

5.112 TSP and RSP monitoring should be undertaken at Receiver 13 and another suitable site (ie Receiver 1, 7 or 9) to ensure that AQOs and guidelines are complied with. The contractor should provide detailed dust mitigation methods and rigidly adhere to them.

5.113 It is difficult to quantify odours from the stagnant water area due to the uncertainty in its exact location and its variable size. However, the predicted zones are likely to be an over estimate and the water is likely to become stagnant for only part of the tidal cycle and would not persist for more than two hours. Sensitive receivers which may be affected by stagnant water odour are those to the north of Victoria Road (ie Receivers 2, 6, 8 and 10). Natural flushing on the subsequent portion of the tide will prevent the impact from persisting for more than a couple of hours and in due course the development of the SSDS works and its associated interception of drainage waters should further mitigate the potential for odour impacts from the stagnant water area.

5.114 Based on a worst-case dilution factor (D) for assessment, it is concluded that a short term odour problem may be detectable due to the embayment of stagnant water. It will be necessary to undertake odour assessment using an odour panel upon receipt of public compliants associated with the works to detect any unacceptable impacts during the operational phase of the Public Dump.

5.115 Emissions from Public Dump vehicles were found to be insignificant.

Marine Barging Point

5.116 Air quality assessment of the proposed Marine Barging Point has shown that worst case dust (TSP) 1-hour concentrations of up to about 400 $\mu g/m^3$ can be expected during construction. This is less than the guideline value of 500 $\mu g/m^3$, and respective standards for 24-hour (260 $\mu g/m^3$) and annual (80 $\mu g/m^3$) are also not exceeded at the nearest sensitive receiver. Actual dust concentrations can be reduced substantially by limiting the working area of the site and implementing dust suppression measures (eg watering site surface twice daily).

5.117 Operational impacts associated with the handling and tipping of public dump material at the barging point will result in lesser dust impacts at sensitive receivers than construction activities. Operational impacts can be effectively minimised by the enclosure of the tipping operation to eliminate wind drift. Increases in ambient vehicle pollutant (eg CO, NO_x) concentrations from traffic associated with the barging point alone will be negligible.

References

5.1 Royal Observatory (1991), Surface Observations in Hong Kong, 1990.

5.2 Royal Observatory (1993), Meteorological Data for Green Island, 1993.

5.3 Hong Kong Government, Environment Hong Kong 1993, Environmental Protection Department.

5.4 Hong Kong Government, Environmental Protection Department, 1993, Personal Communication - Air Quality Data for Western Central 1986-1992.

5.5 Scott Wilson Kirkpatrick, Consultancy Study for Island West Transfer Station, Environmental Monitoring for Kennedy Town Incineration Plant, August 1993.

5.6 Environmental Protection Department, Personal Communication, Air Quality Data, 1992, (From Initial Environmental Assessment - Consultancy Study for Island West Transfer Station July 1992).

5.7 Hong Kong Government, Environment Hong Kong (1991), Environmental Protection Department, Chapter 5, 1991.

5.8 Hong Kong Government, Environment Hong Kong (1989), Environmental Protection Department, Chapter 3, 1989.

5.9 Hong Kong Government, Environment Hong Kong (1990), Environmental Protection Department, Chapter 3, 1990.

5.10 Hong Kong Government, Environmental Protection Department, 1992, Air Quality Survey at Kerbside in Causeway Bay, Report No. EPD TP/15/92.

5.11 Green Island Reclamation Feasibility Study Technical Paper No. 21: Air Quality Existing Conditions. Ove Arup & Partners, Territory Development Department, Urban Area Development Office, 1989.

5.12 United States of America Environmental Protection Agency, Compilation of Air Pollutant Emission Factors AP-42.

5.13 Keddie A.W.C.,The Quantification of the Emission and Dispersion of Odours from Sewage Treatment Works, Wat. Poll Control, 266-279, 1982.

5.14 North A.A., Odours at a Sewage Treatment Works, Water Research Centre, Warren Spring Laboratory, Technical Report TR126, 1979.

5.15 Warren Spring Laboratory, 1993, Personal Communication.

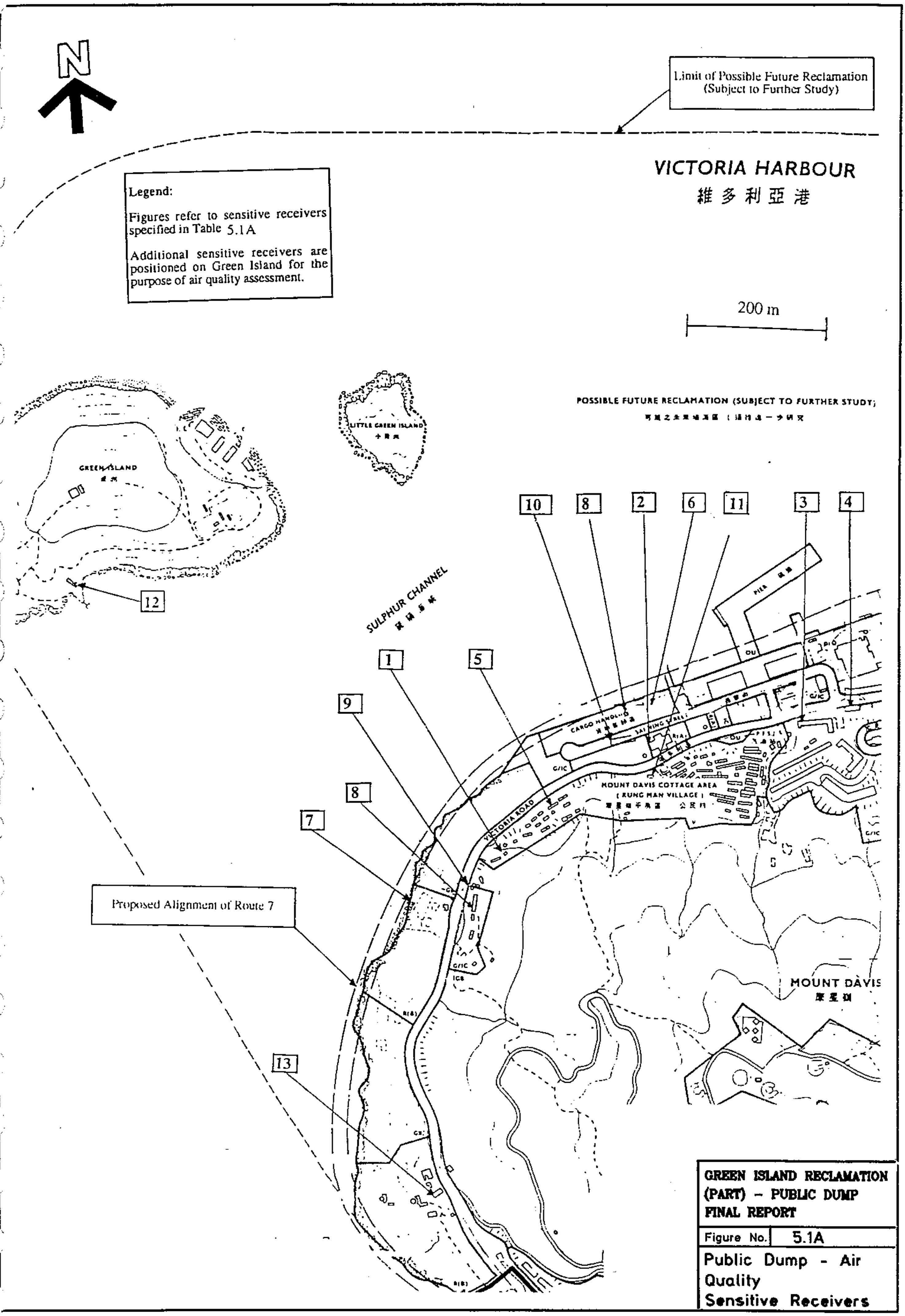
5.16 Green Island Reclamation Feasibility Study (1989), Technical Paper No.5: Reclamation Methods and Phasing. Ove Arup & Partners, Territory Development Department, Urban Area Development Office, 1989.

5.17 Green Island Reclamation (Part) - Public Dump, Review of Sequence of Works, Scott Wilson Kirkpatrick (Hong Kong), Civil Engineering Department, October 1993.

5.18 Green Island Reclamation (Part) - Public Dump, Traffic Impact Assessment (Land). Scott Wilson Kirkpatrick (Hong Kong), Civil Engineering Department, November 1993.

5.19 Green Island Reclamation Feasibility Study, Recommended Outline Development Plan. Ove Arup & Partners, Territory Development Department, Urban Area Development Office, June 1993.

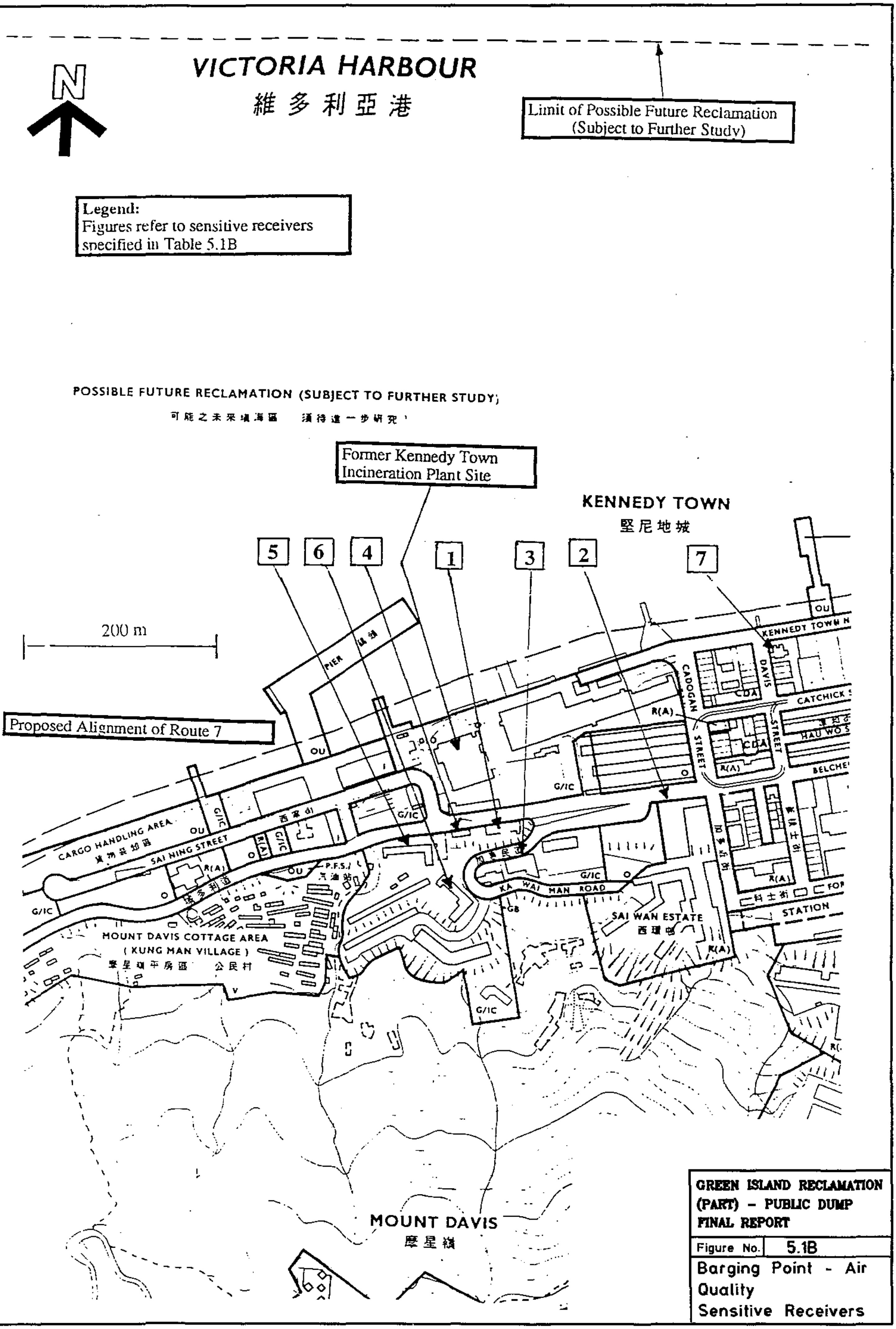
5.20 Strategic Sewage Disposal Scheme, Site Investigations & Engineering Studies Stages II, III & IV, Draft Environmental Assessment Report, Drainage Services Department, June 1992.



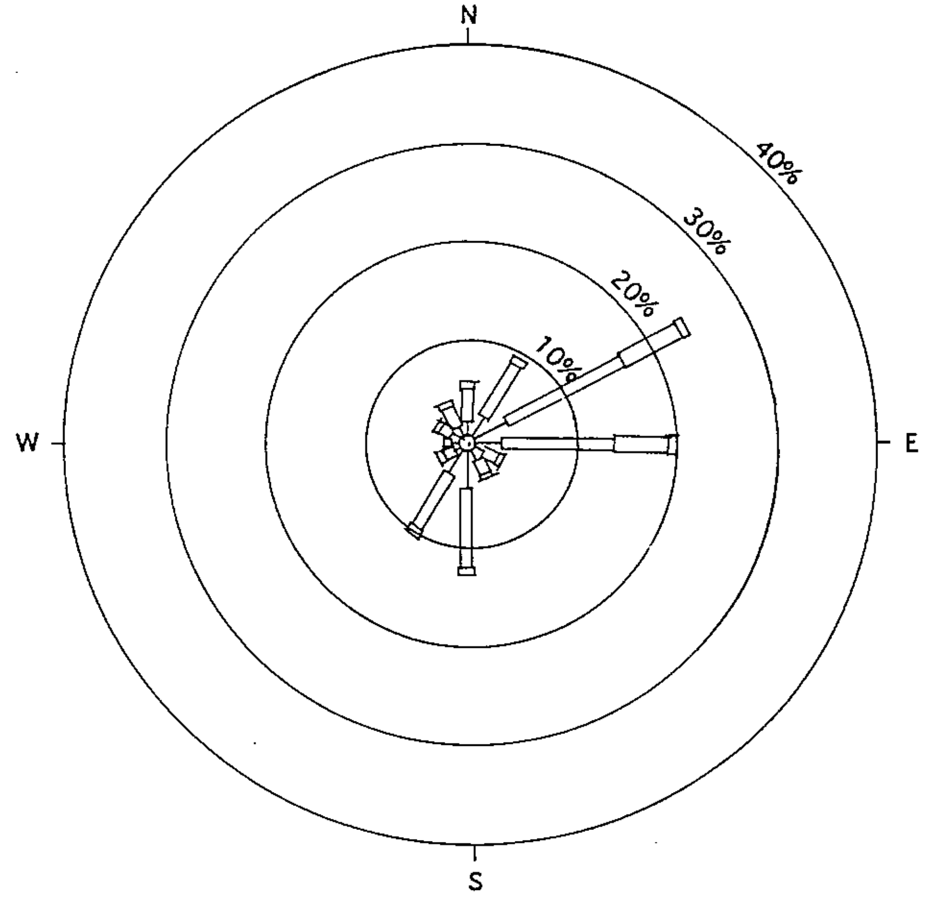
GREEN ISLAND RECLAMATION (PART) – PUBLIC DUMP FINAL REPORT

Figure No. 5.1A

Public Dump – Air Quality Sensitive Receivers



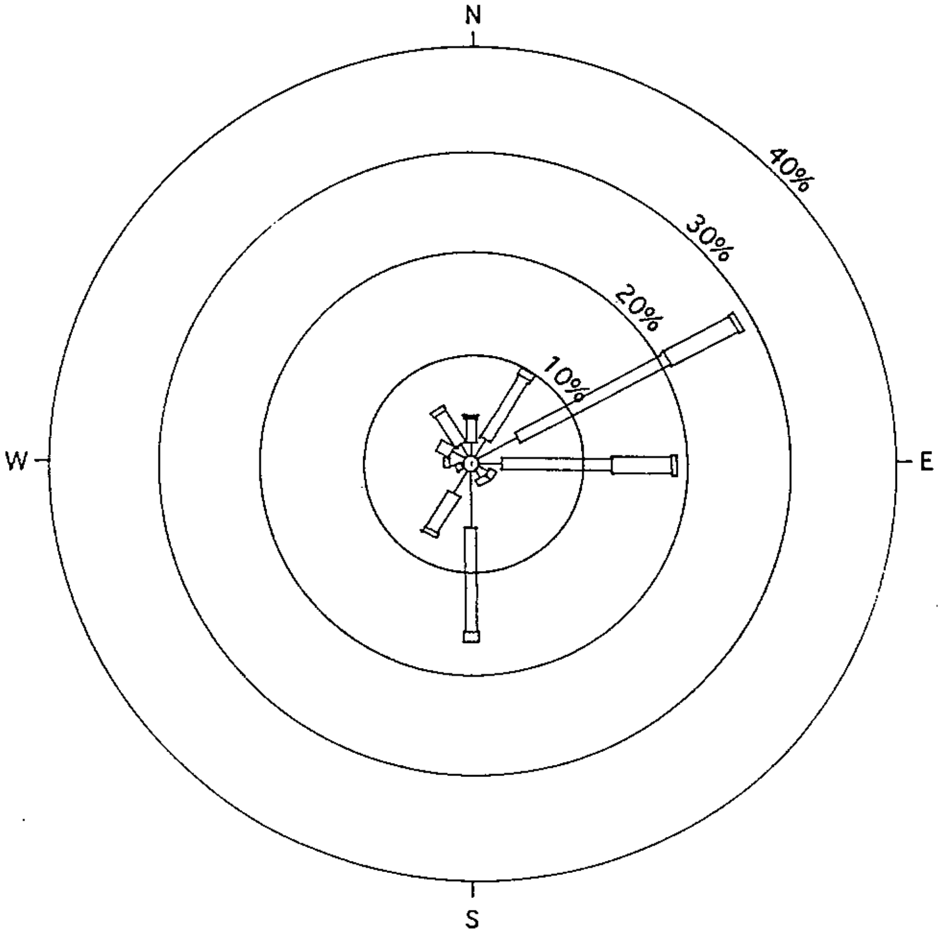
GREEN ISLAND RECLAMATION (PART) - PUBLIC DUMP FINAL REPORT	
Figure No.	5.1B
Barging Point - Air Quality Sensitive Receivers	



1974-1983

ANNUAL

NO. OF OBSERVATIONS	-	82756	
NO. OF VARIABLE	-	177	(.2%)
NO. OF CALM	-	1115	(1.3%)



JAN 1990 - DEC 1992

ANNUAL

NO. OF OBSERVATIONS	-	22275	
NO. OF VARIABLE WINDS	-	1	(.0%)
NO. OF CALM WINDS	-	0	(.0%)

LEGEND

0 10 20 30

PERCENTAGE FREQUENCY

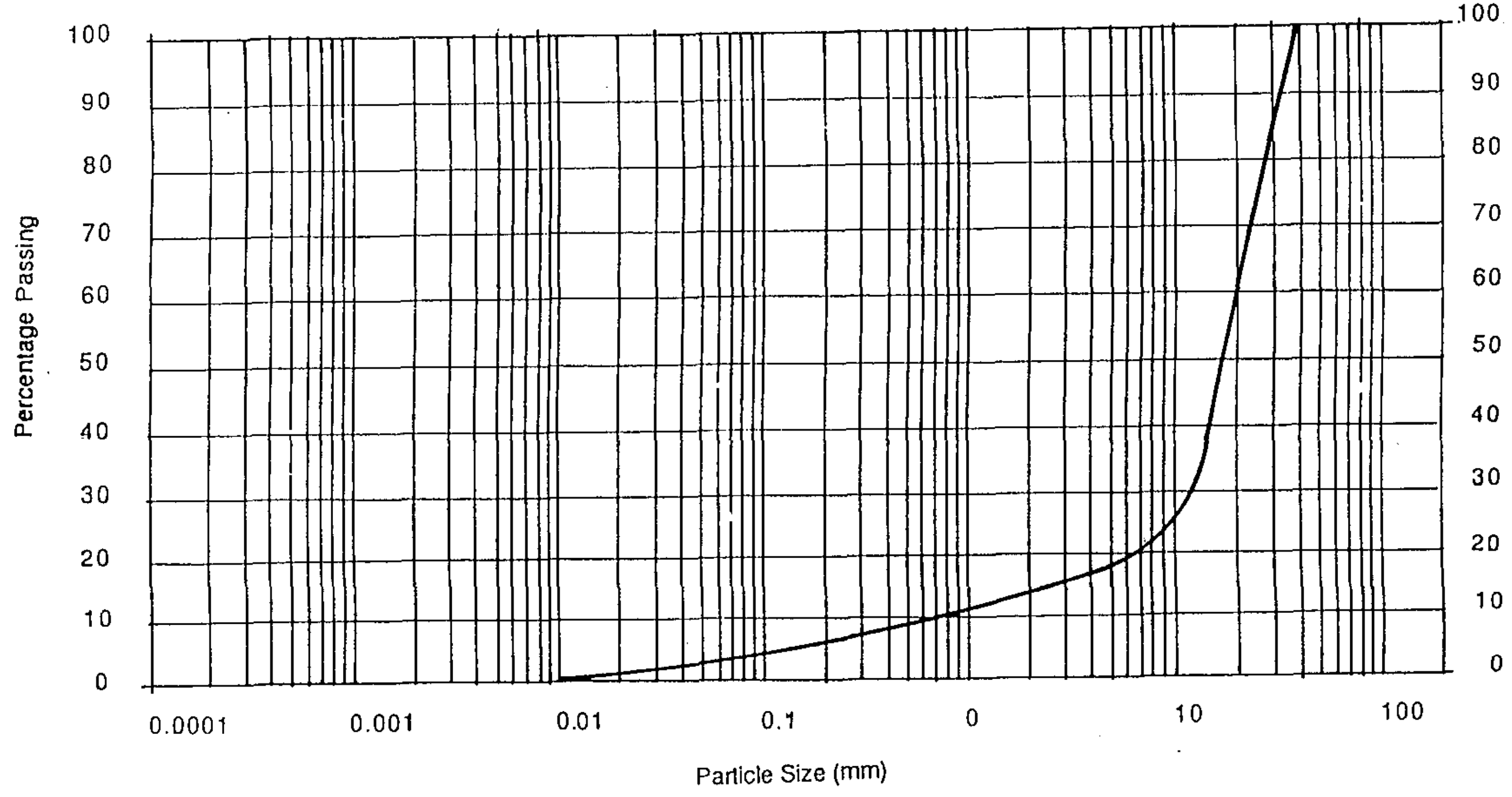
2-12	13-30	31-51	>51	km/h
0.1-3.2	3.3-6.2	6.3-14.2	>14.2	m/s
1-2	3-4	5-6	>6	Beaufort force

WIND SPEED

GREEN ISLAND RECLAMATION (PART) - PUBLIC DUMP FINAL REPORT

Figure No. 5.2

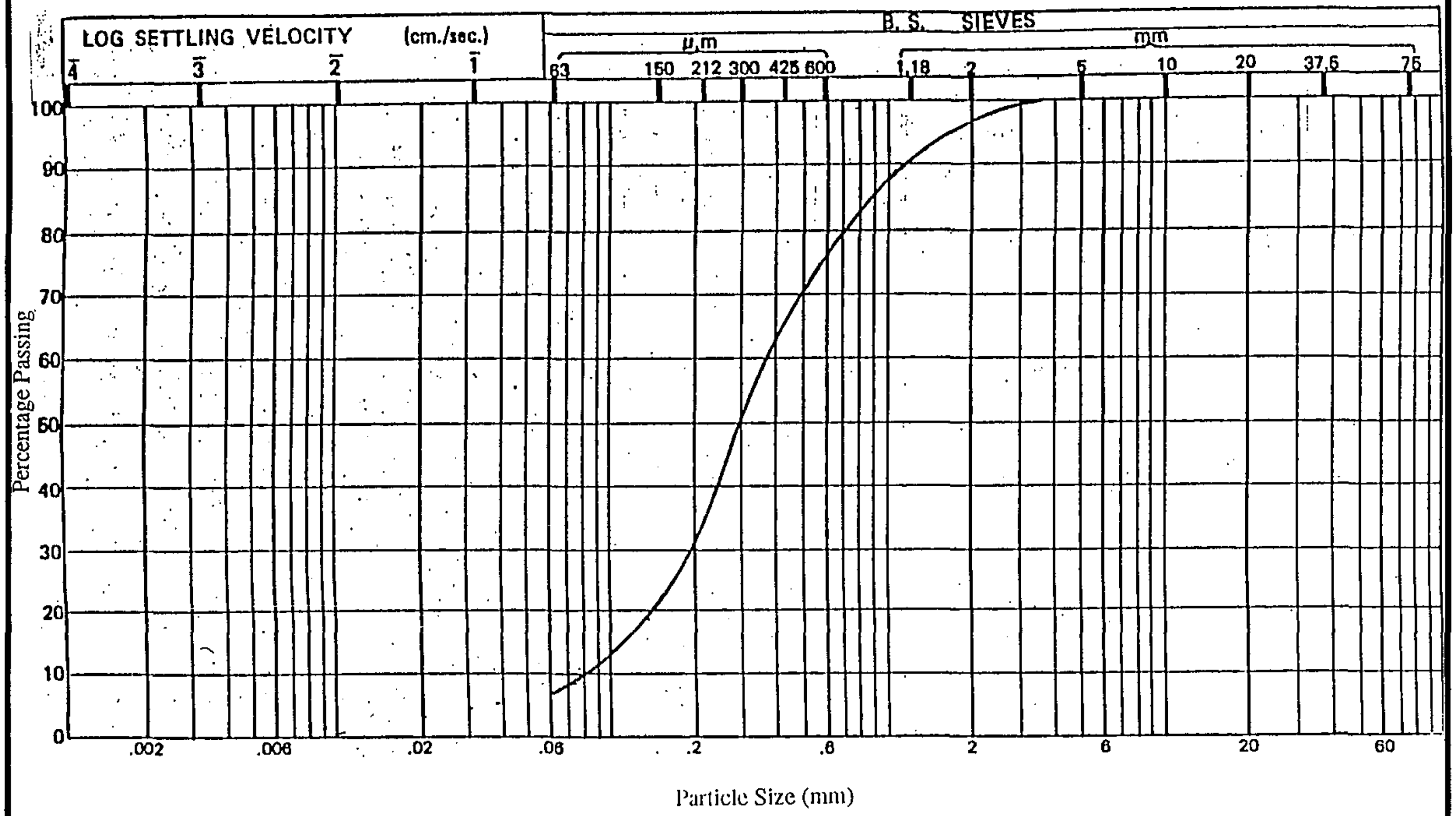
Annual Wind Roses for Green Island 1974-1983 and Jan 1990-Dec 1992



GREEN ISLAND RECLAMATION (PART) – PUBLIC DUMP FINAL REPORT

Figure No. 5.3

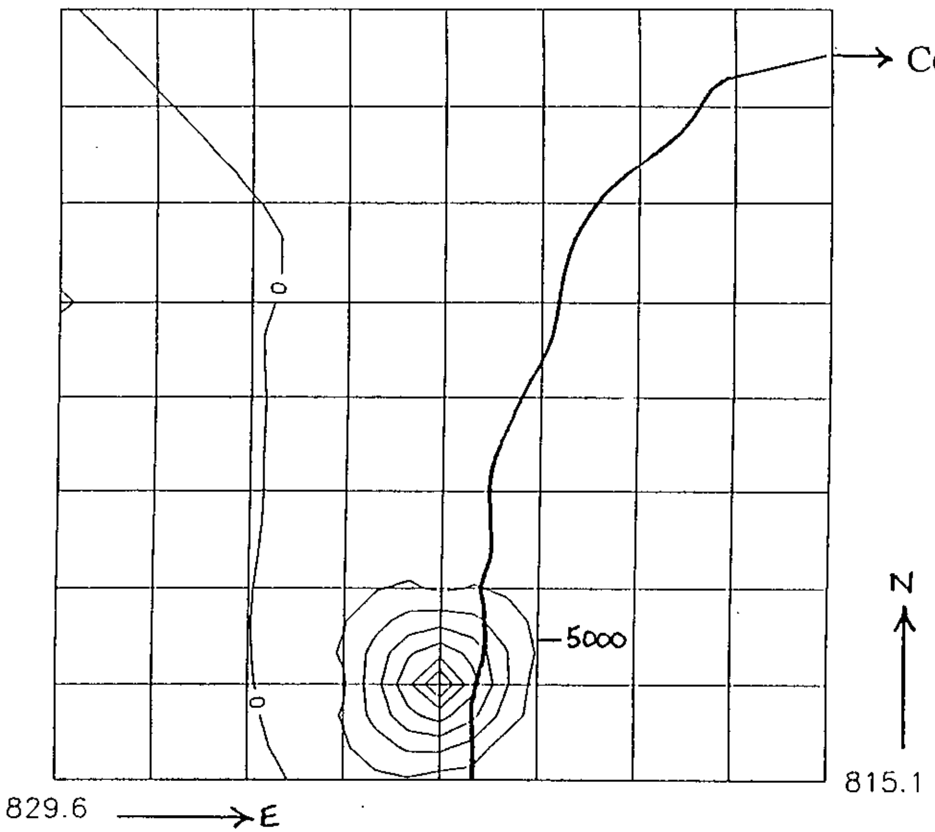
Particle Size Distribution Curve for Crushed Concrete



GREEN ISLAND RECLAMATION (PART) – PUBLIC DUMP
FINAL REPORT

Figure No. 5.4

Particle Size Distribution Curve for Marine Sand

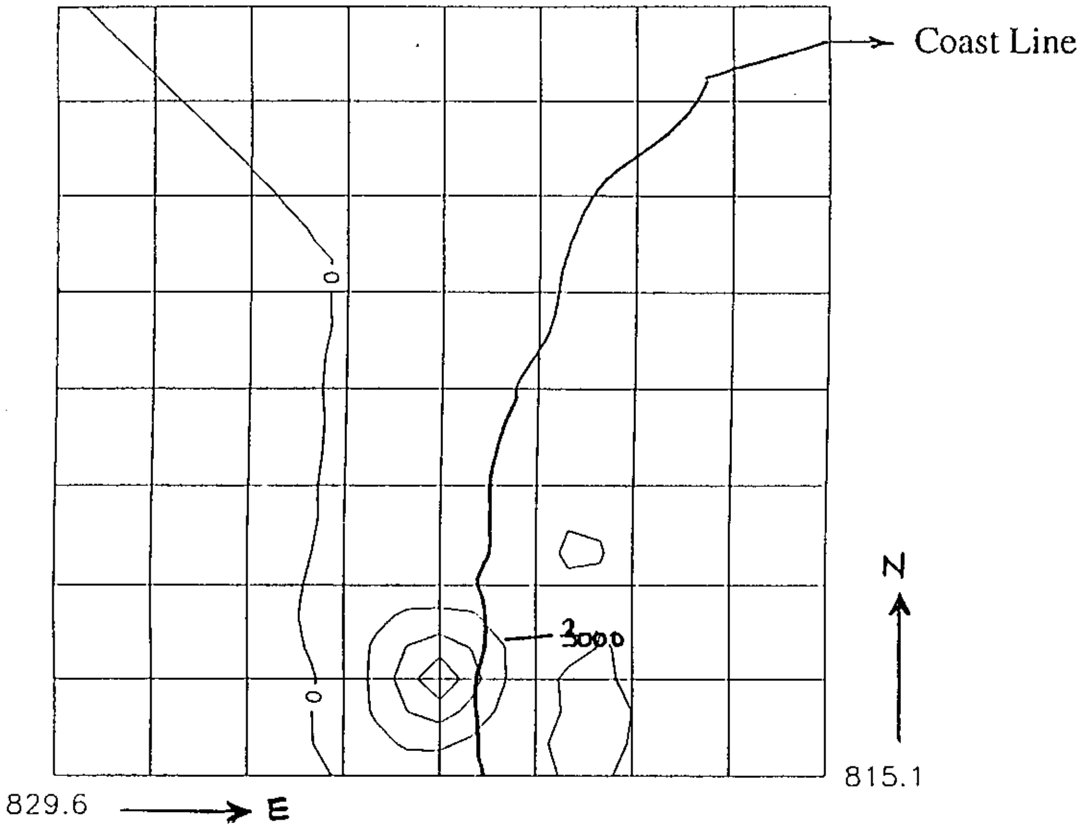


Concentration in $\mu g/m^3$
5000 $\mu g/m^3$ intervals

GREEN ISLAND RECLAMATION (PART) – PUBLIC DUMP FINAL REPORT

Figure No. 5.5

Green Island Concrete Plant (1-hour)

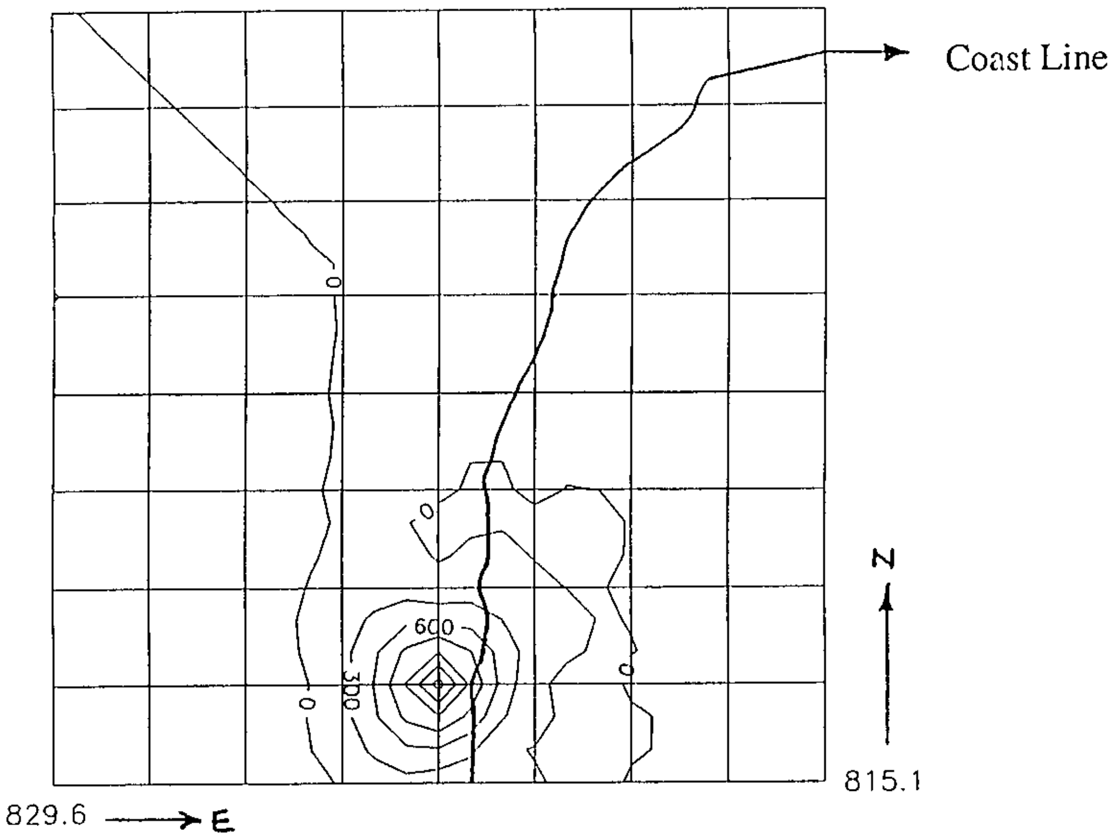


Concentration in $\mu g/m^3$
3000 $\mu g/m^3$ intervals

GREEN ISLAND RECLAMATION (PART) – PUBLIC DUMP FINAL REPORT

Figure No.	5.6

Green Island Concrete Plant (24-hour)

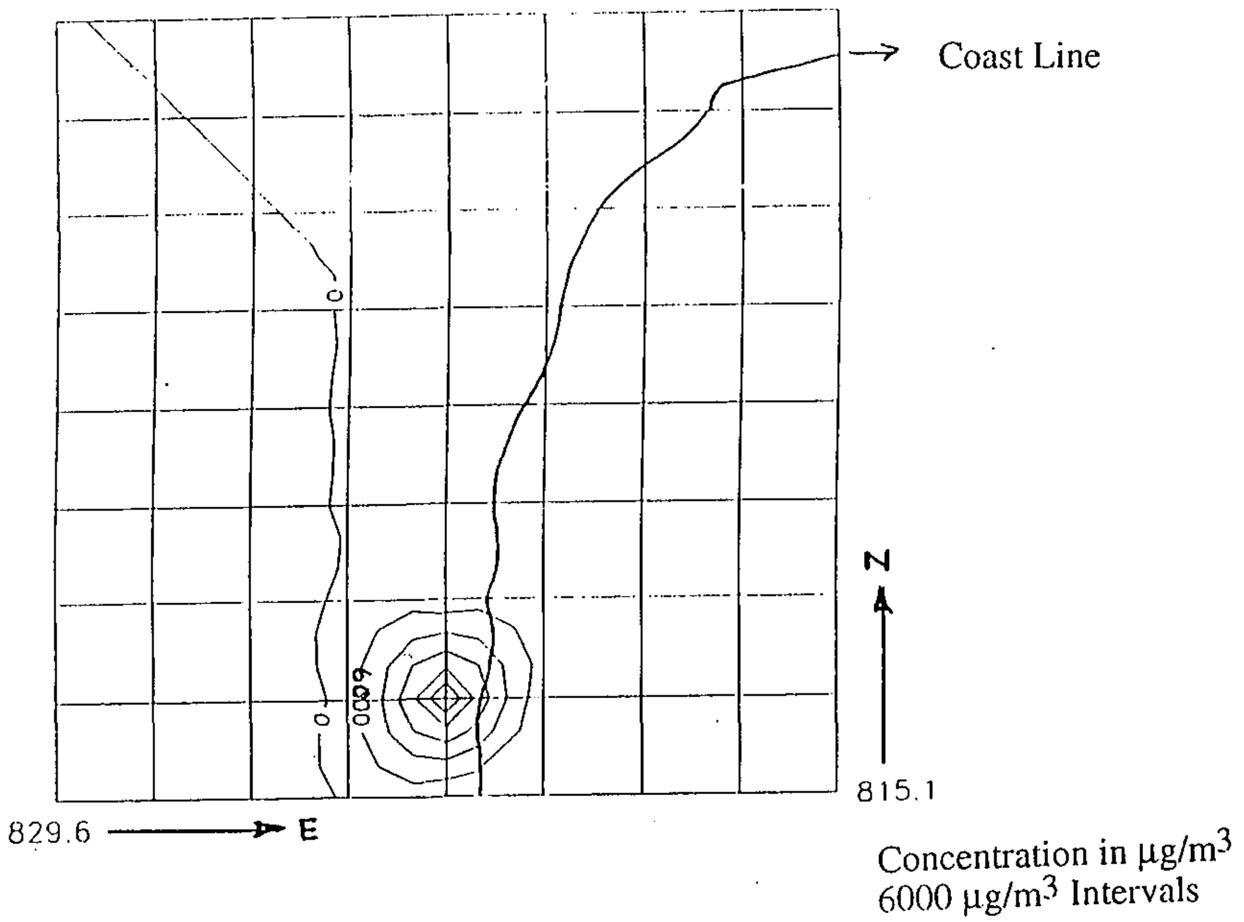


Concentration in $\mu g/m^3$
300 $\mu g/m^3$ intervals

GREEN ISLAND RECLAMATION (PART) - PUBLIC DUMP FINAL REPORT

Figure No.	5.7

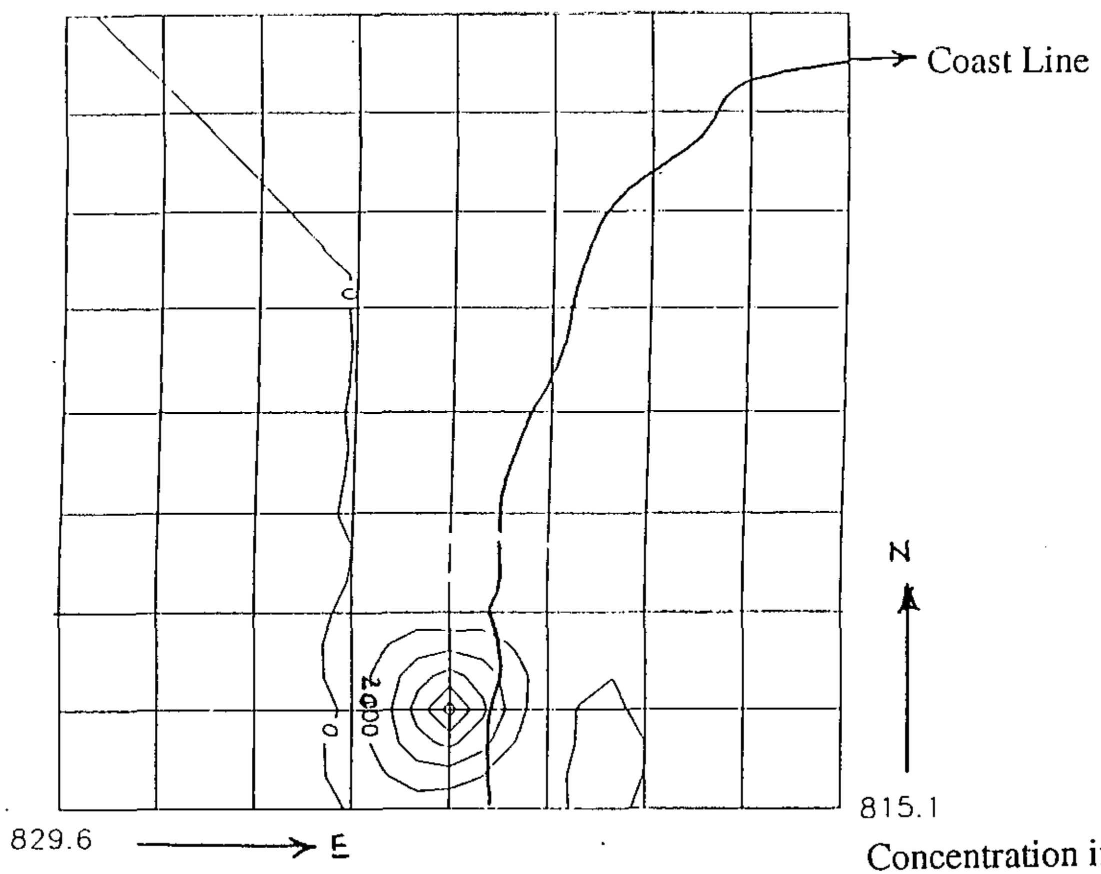
Green Island Concrete Plant (Annual)



GREEN ISLAND RECLAMATION (PART) – PUBLIC DUMP
FINAL REPORT

Figure No. 5.8

Green Island Rock Crushing Plant 1-hour (60 tonnes)

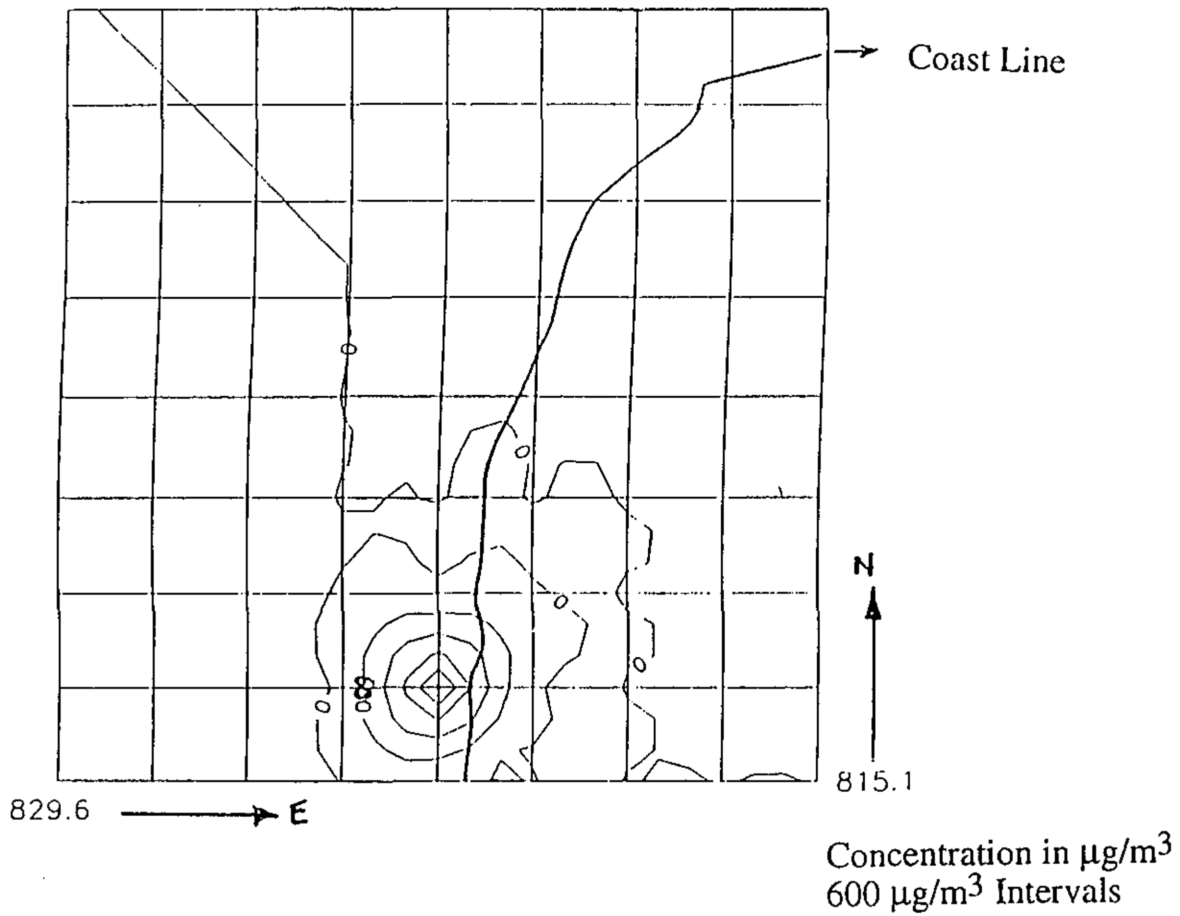


Concentration in $\mu g/m^3$
2000 $\mu g/m^3$ Intervals

GREEN ISLAND RECLAMATION (PART) - PUBLIC DUMP FINAL REPORT

Figure No. 5.9

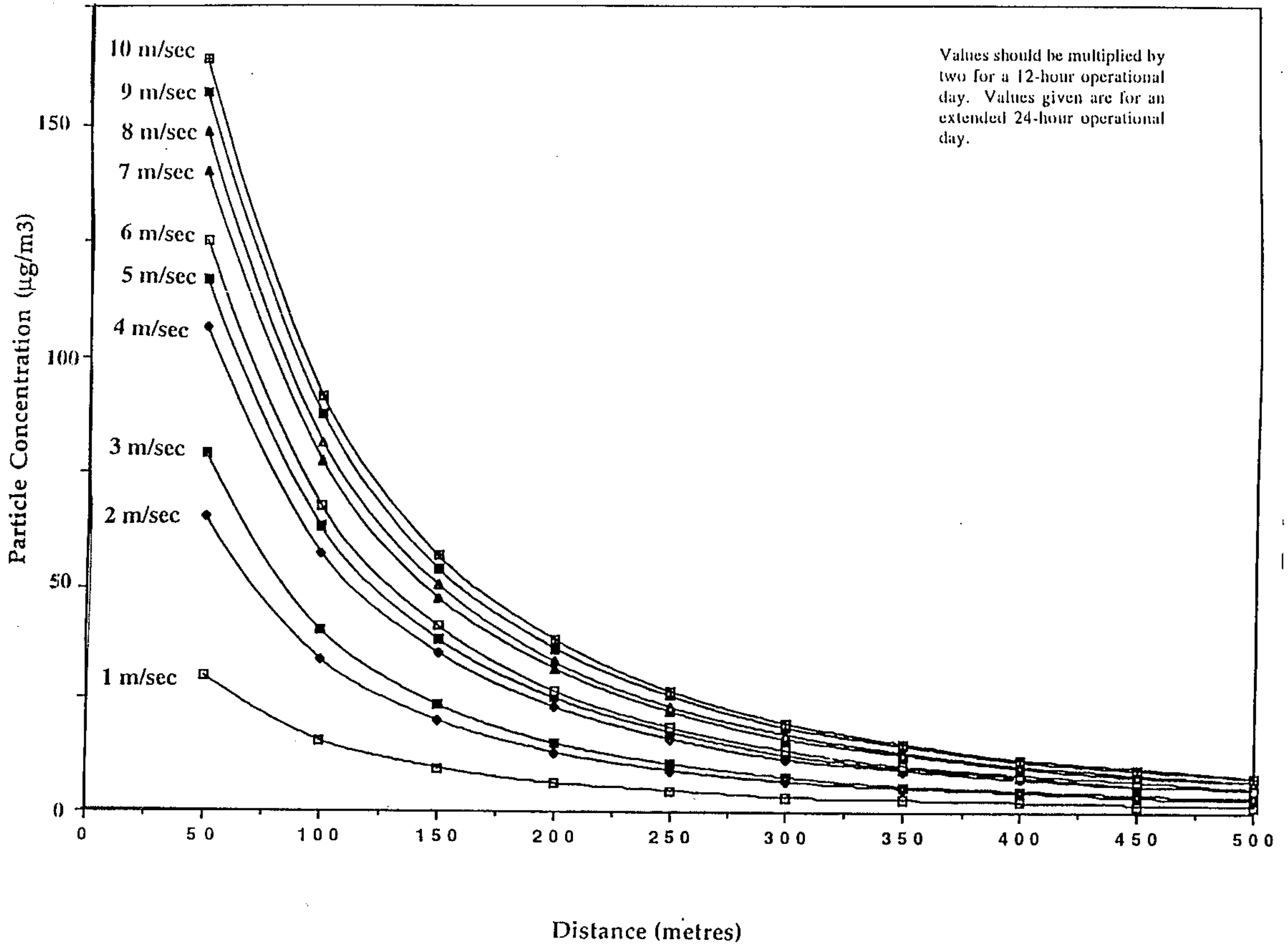
Green Island Rock Crushing Plant 24-hour (60 tonnes)



GREEN ISLAND RECLAMATION (PART) – PUBLIC DUMP FINAL REPORT

Figure No. 5.10

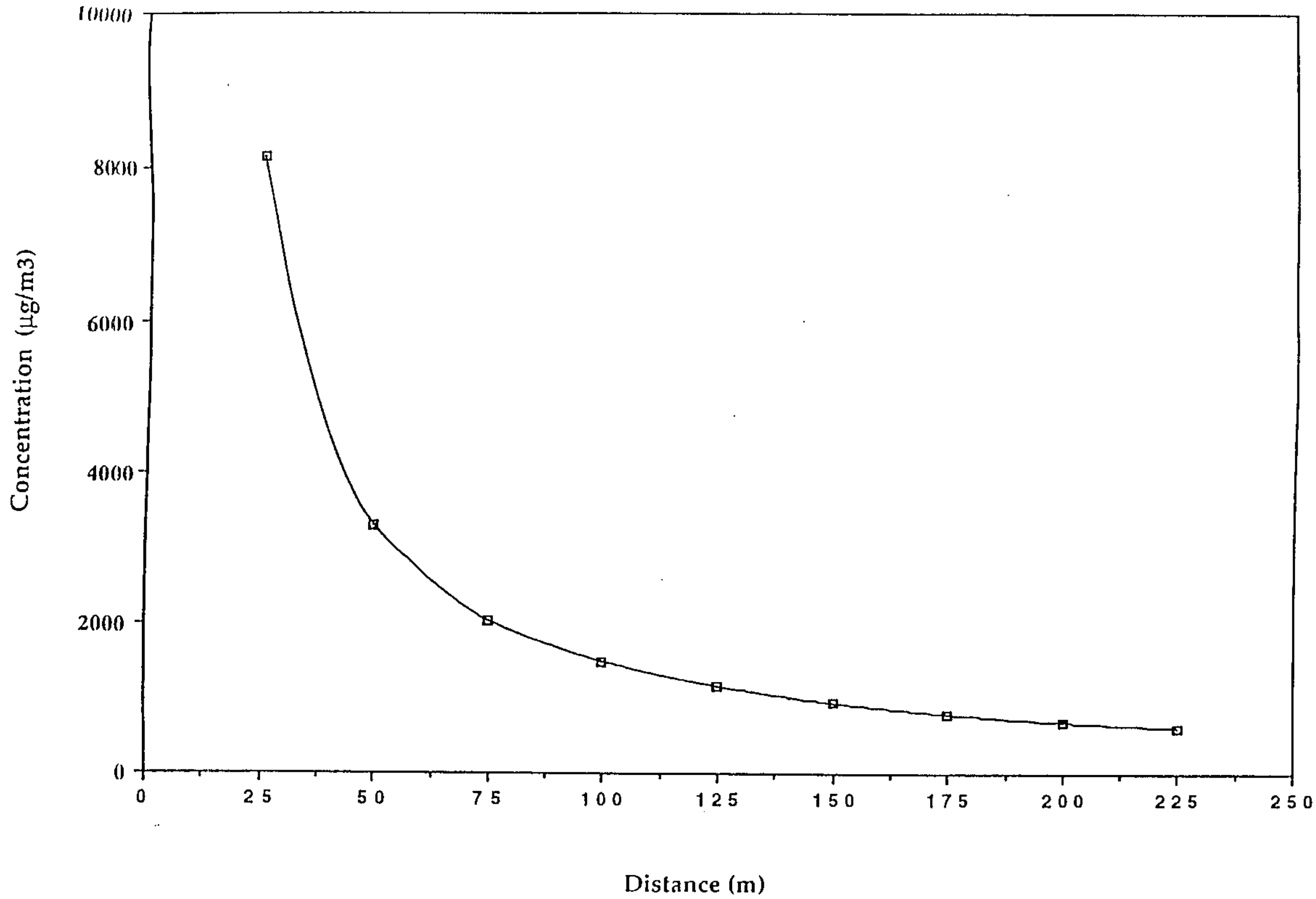
Green Island Rock Crushing Plant Annual (60 tonnes)



GREEN ISLAND RECLAMATION (PART) - PUBLIC DUMP FINAL REPORT

Figure No. 5.11

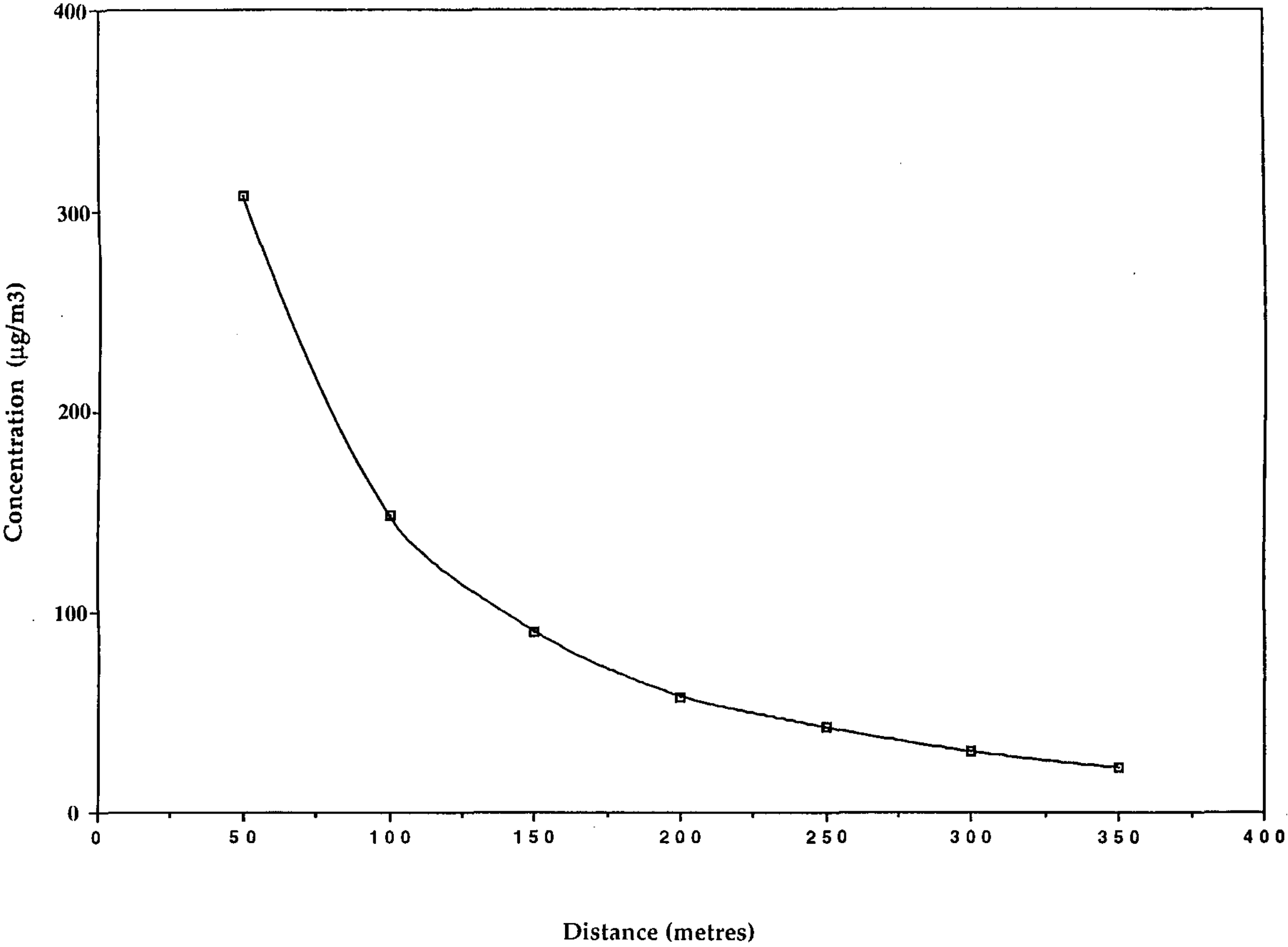
Predicted Dust Concentrations from Batch Drop Operation ($\mu g/m^3$) 1-hour as a Function of Wind Speed



GREEN ISLAND RECLAMATION (PART) – PUBLIC DUMP FINAL REPORT

Figure No. 5.12

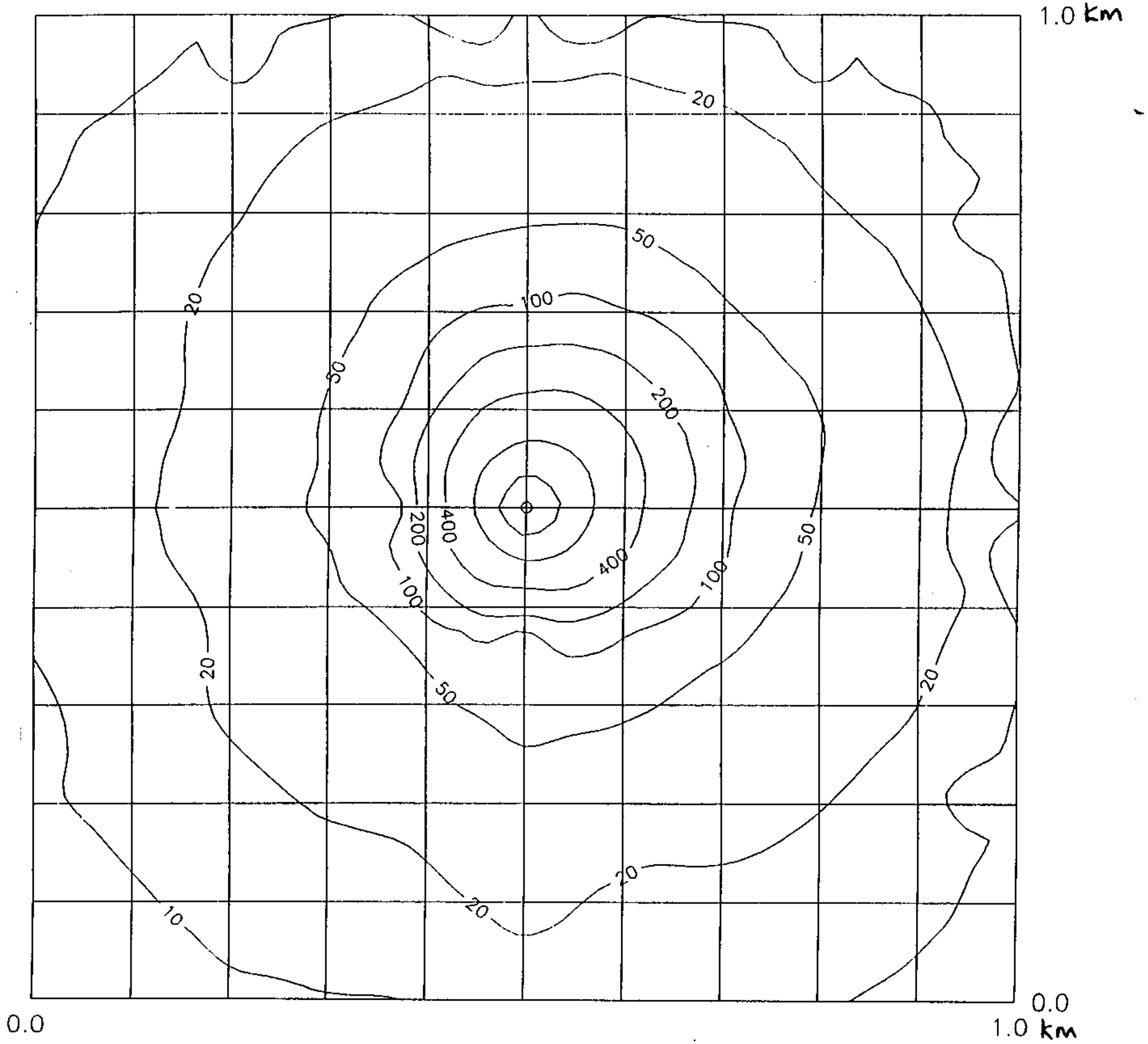
Predicted Dust Concentrations from Vehicular Movements on an Unpaved Road ($\mu g/m^3$) 1-hour



GREEN ISLAND RECLAMATION (PART) – PUBLIC DUMP FINAL REPORT

Figure No. 5.13

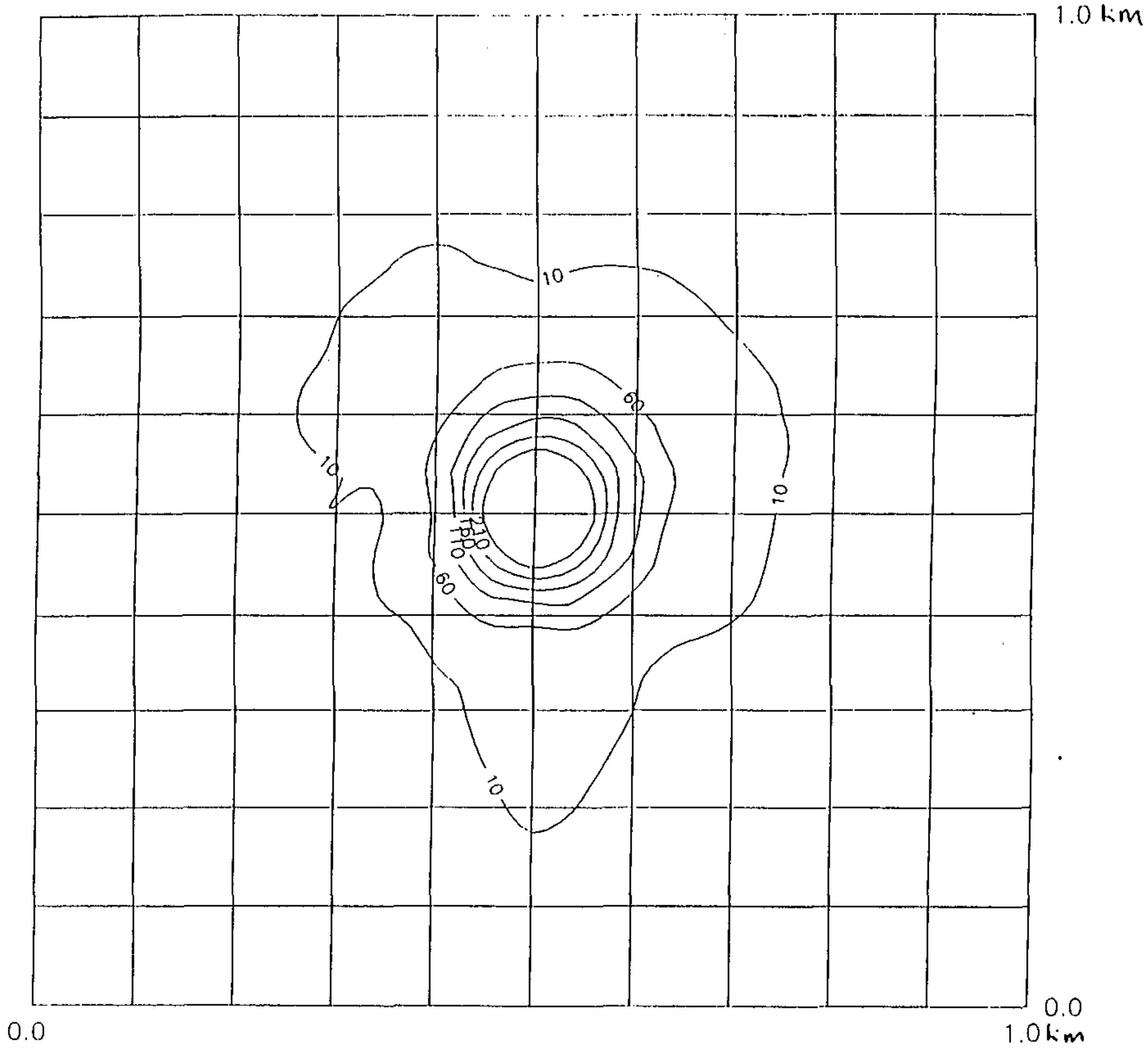
Predicted Dust Concentrations from Construction Activity ($\mu g/m^3$) (Crushed Concrete) 1-hour



GREEN ISLAND RECLAMATION (PART) – PUBLIC DUMP FINAL REPORT

Figure No. 5.14

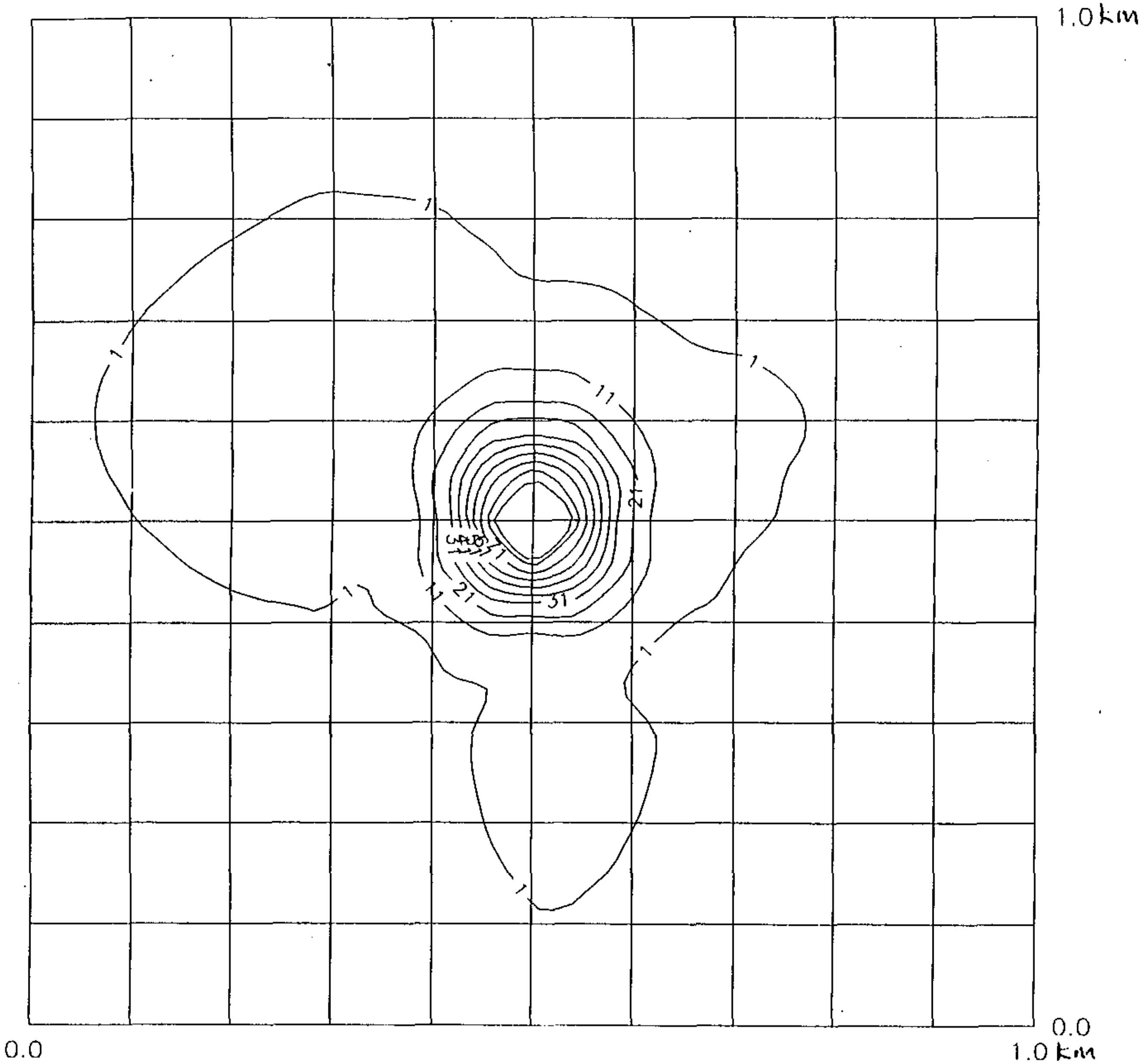
Green Island Active Work Area 1-hour



GREEN ISLAND RECLAMATION (PART) – PUBLIC DUMP FINAL REPORT

Figure No. 5.15

Green Island Active Work Area 24-hour

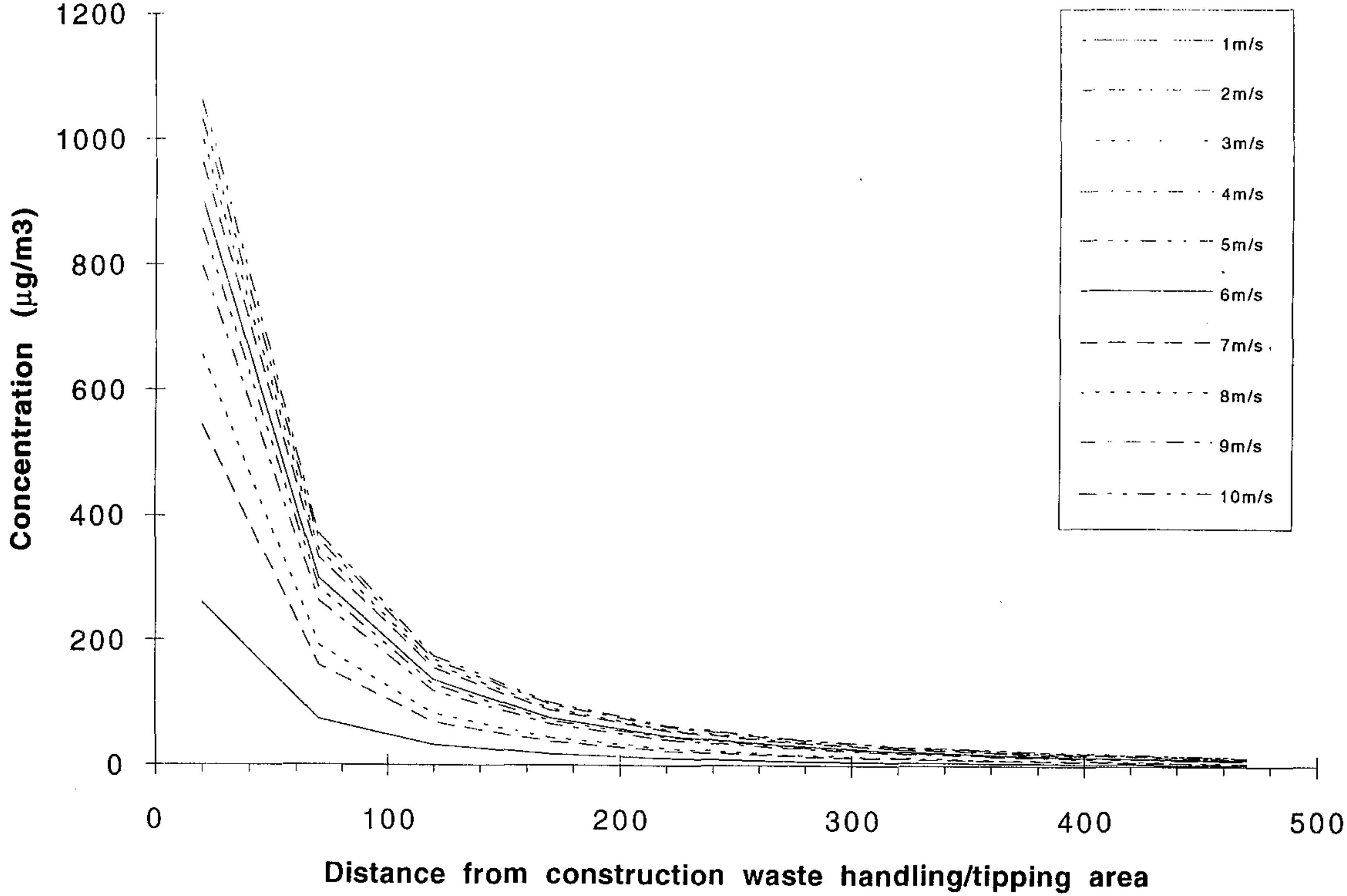


GREEN ISLAND RECLAMATION (PART) - PUBLIC DUMP FINAL REPORT

Figure No.	5.16

Green Island Active Work Area Annual

Dust Concentrations Over Distance from Construction Waste Handling/Tipping at Marine Barging Point for Different Wind Speeds (Roughness Length of 375 cm)



GREEN ISLAND RECLAMATION (PART) - PUBLIC DUMP FINAL REPORT

Figure No. 5.17

Dust Concentrations at Marine Barging Point

6. SEWERAGE IMPACT

Introduction

6.1 This chapter considers the existing surface water drainage and foul sewerage systems that may affect, or be affected by the construction and operation of the proposed Green Island Public Dump.

6.2 The public dump proposals and any necessary remedial measures to minimize their impact on the existing drainage and sewerage system will need to be compatible with future proposals for the Green Island Reclamation as a whole. With this in mind, the findings and recommendations of the Central, Western and Wan Chai West Sewerage Master Plan Study (Ref 6.1) and the Green Island Reclamation Feasibility Study (Ref 6.2) have been extensively reviewed to ascertain potential problem areas associated with the existing and adjacent sewerage and drainage systems.

6.3 The Final Initial Assessment Report detailed the available information that had been obtained during the course of the study and made a preliminary assessment of the impacts of construction and operation activities together with a consideration of cumulative impacts. This Report concluded that several proposed major infrastructure projects in the vicinity of Green Island would cause impacts on the adjacent existing sewerage and drainage systems.

6.4 In addition, a Sewerage Impact Study was required to consider existing sewerage and drainage systems on the north side of Victoria Harbour which were to be affected by major reclamation works, as the associated discharge locations were required to be agreed for water quality modelling purposes.

Environmental Standards and Guidelines

6.5 The environmental standards and guidelines relating to sewerage are concerned with discharges from outfalls and related quality impacts. The Water Quality Objectives (WQOs) as detailed in the Technical Memorandum on Effluent Standards (Ref. 6.3) relate to the limits that make effluents acceptable for discharge into foul sewers, stormwater drains, inland and coastal waters.

6.6 Effluents which are diverted into foul sewers that lead to a treatment plant with microbial processes must meet more stringent standards for certain toxic metals in order that the treatment process is not adversely affected.

6.7 Most of the existing stormwater drains in the study area discharge directly into inshore waters as shown on Figures 6.1 and 6.2. The diversion of effluents will not normally be permitted to them, unless appropriate standards are met.

6.8 For combined sewers it is necessary to consult DSD, whether these are to be considered as foul sewers for the purpose of fixing standards. There should be no discharge of stormwater within a confined water area.

6.9 Any proposed sewerage remedial measures would have to accord with the Civil Engineering Design Manual and would have to be compatible with proposals and recommendations for the Central, Western and Wan Chai West Sewerage Master Plan Study.

Background Information and Monitoring Data

Foul Sewerage

6.10 The Central, Western and Wanchai West Sewerage Master Plan Study includes results of recent surveys and analysis of the existing sewerage systems in that vicinity and established that only some 30% to 50% of the sewage generated in the study area enters foul sewers. The remainder is assumed to enter the stormwater system.

6.11 The Sewerage Masterplan indicated that there were at least three previously unknown foul discharges discovered located in Western District around Belcher Bay. All other foul sewers are collected and the effluent direct inland and eastwards for treatment at the screening plants of Wanchai and Central.

6.12 The position of these three existing foul discharges which most directly affect the proposed public dump have been confirmed by field investigation and by the examination of as-constructed drainage drawings received from Government. These three outfalls are shown on Figure 6.3. Based on the assessment which has been carried out, it is considered that there are no other existing foul sewers which discharge directly to inshore waters in the vicinity of the public dump.

6.13 From as-constructed drawings an assessment has been made of the hydraulic capacity of the three existing foul outfalls which are located opposite Davis Street, North Street and opposite Queens Road West respectively. Government has confirmed that there is no available information on the effluent quantities generated by the catchments which discharge to these three existing outfalls. However, as their sizes are small, being 225mm and 375mm in diameter, then it is considered that by assuming a worst case scenario with the outfalls flowing full, the discharge quantities are relatively low. The estimated maximum discharge capacities from the foul discharge outfalls are given in Table 6.1. The respective estimated pollution loadings for the outfalls are given in Table 6.2

Table 6.1 : Estimated Maximum Discharge Capacity of Foul Sewer Outfalls

Outfall	Location	Outfall Size	Maximum Discharge Capacity
Foul Outfall No. 1	Davis Street	225mm dia.	71 l/s
Foul Outfall No. 2	North Street	225mm dia.	61 l/s
Foul Outfall No. 3	Queens Road West	375mm dia.	43 l/s

6.14 Proposals under the Belcher Bay Reclamation project will have an impact on the existing sewerage and drainage systems around Belcher Bay and the effect on these three existing foul sewer outfalls in particular has been assessed.

6.15 From the assessment, it is concluded that two of the three existing foul sewers will have to be redirected inland to the sewage treatment works during the advanced works for the Belcher Bay reclamation project. Only the existing foul sewer opposite Davis Street (225 mm dia.) will continue to discharge to inshore waters after the reclamation project commences and this has been allowed for in the water quality modelling carried out as part of this study (see Chapter 7). However, part of the sewer system along Davis Street has been diverted inland already by DSD, thereby reducing the catchment area and flows which will directly discharge to inshore waters. In order to direct the remaining foul sewer system a substantial length of sewer would have to be relaid to new gradients in order to connect to the new foul sewer system further inland. The design of DSD's new sewer system in the vicinity would need to be assessed to establish whether it would have the capacity for this extra flow. This approach would be a sensible course of action to improve water quality at the seafront.

Table 6.2 : Discharges within the Study Area (Existing) (Refer to Figure 6.1 for Locations)

Stormwater Outfalls Established under Sewerage Master Plan	Estimated Pollution Load (kg/d)			Remarks
	BOD	COD	TKN	
T	1,482	2,973	166	
U	1,482	2,973	166	
V	298	626	238	
W	145	305	25	
X	393	704	58	
Y	320	1,120	43	
Z	731	1,690	37	
AA	760	1,673	87	
BB	437	929	55	
CC	298	639	38	
DD	76	159	14	
EE	146	308	28	
FF	79	171	11	
GG	30	68	2	
HH	19	44	1	
II	19	44	1	
JJ	22	49	1	
KK	11	24	1	
LL	11	24	1	
Additional Foul Sewer Outfalls Identified	Estimated max. discharge (l/s) (4 x DWF)	Average Daily Flow (DWF)	BOD (kg/d)	
Foul Sewer Outfall No. 1 (225ø) at Davis Street (D)	71	1,533m³/d	383	-
Foul Sewer Outfall No. 2 (225ø) at North Street (N)	61	1,318m³/d	330	} To be diverted } inland under } Belcher Bay
Foul Sewer Outfall No. 3 (375ø) at Queen's Rd West (Q)	43	929m³/d	232	} Reclamation } Project to Sewage } Treatment Works

NB: Loads for Outfalls No. 1 - No. 3 obtained by calculating maximum hydraulic capacity of these small diameter pipe outfalls from as-constructed drawings, which is taken as peak flow (4 x DWF), and multiplying average flow (DWF) by a factor of 0.25kg/m^3 to estimate equivalent load for a given flow of foul sewage expressed as kg of BOD per day.

Stormwater Drainage

6.16 There are nineteen existing stormwater discharges around Kennedy Town which may have an impact on the project. These existing outfalls which are annotated as AA to LL and T to Z as shown on Figures 6.3 to 6.6. There are only five outfalls however which are located within the boundary of the proposed public dump (annotated as HH, II, JJ, KK and LL). Pollution loads for the discharges from each of these nineteen outfalls have been estimated in the Sewerage Master Plan Study, with those further to the east of the proposed dump tending to discharge the greater loading. (Refer to Table 6.3).

6.17 On detailed assessment of the Sewerage Master Plan Study however, three stormwater outfalls, again in the Belcher Bay area, required to be accurately investigated by field survey and with as-constructed drawings to ensure that adequate information was obtained for water quality modelling purposes as these had not been sufficiently investigated as part of the master plan.

6.18 Information obtained on the future Belcher Bay Reclamation Project also shows that a series of existing surface water outfalls which currently discharge to Belcher Bay are to be intercepted, and redirected to collector box culverts discharging through the proposed seawall of the new reclamation. These existing outfalls which are annotated as AA, Z, Y, X, W, V, U and T on Figure 6.4, are estimated to comprise some 50%-70% of the sewage generated in the study area. Their anticipated discharge locations following the implementation of the Belcher Bay reclamation are shown on Figure 6.7.

6.19 Tables 6.2 and 6.3 show the estimated pollution loadings from the discharges within the study area under the existing condition and those anticipated at commencement of the Green Island Public Dump works.

Remote Outfalls

6.20 In order to carry out the Green Island water quality modelling a number of existing outfall pollution loads away from the immediate vicinity of Green Island itself were considered as these affected the baseline for the water quality of the Harbour as a whole. A number of these existing outfalls will be affected by the proposed West Kowloon Reclamation project and the proposed Central Reclamation project and would effectively become "land-locked" as a result of the reclamation works. Although the exact locations of the discharge loads concerned were unlikely to have any significant effect on water quality at Green Island, these outfall locations had to be repositioned to an appropriate discharge point to the satisfaction of EPD for modelling purposes (see Chapter 7).

6.21 In consultation with EPD it was agreed that the three existing sewage outfalls from Lai Chi Kok, Sham Shui Po and Tai Kok Tsui be assumed to discharge to the proposed submarine outfall at Stonecutters Island in accordance with the North West Kowloon Sewerage Scheme. Other Kowloon Stormwater outfalls affected by the reclamations were assumed to discharge to the nearest open water and similarly, those existing outfalls along the Central waterfront would be assumed to be simply extended such that they extend to the water for direct marine discharge.

Impact of Construction Activities

Public Dump

6.22 From the sequence of works planned for the Green Island Public Dump it can be established that two existing stormwater drains will be affected by the Stage I filling works, and three existing stormwater drains will be affected by the Stage II works. As can be seen from Table 6.1, the pollution loadings from these outfalls are likely to be minor compared with other outfalls near Belcher Bay. Nevertheless, as the construction of the seawalls for the public dump proceeds, it will be necessary to divert these drains, in order to prevent embayment of polluted effluent (refer to Figure No. 6.8).

Table 6.3: Discharges within the Study Area (At Commencement of Green Island Reclamation (Public Dump)) (Refer to Figure 6.2 for Locations)

Stormwater Outfalls Established under Sewerage Master Plan	Estimated Pollution Load (kg/d)		
	BOD	COD	TKN
T	1,482	2,973	166
Eastern Collector Box Culvert (U, V, W, X)	2,318	4,608	487
Western Collector Box Culvert (Y, Z, AA)	1,811	4,483	188
BB	437	929	55
CC	298	639	38
DD	76	159	14
EE	146	308	28
FF	79	171	11
GG	30	68	2
HH	19	44	1
II	19	44	1
JJ	22	49	1
KK	11	24	1
LL	11	24	1
Additional Foul Sewer Outfall Identified	**Estimated max. discharge (l/s) (4 x DWF)**	**Average Daily Flow (DWF)**	**BOD kg/d**
Foul Sewer Outfall No. 1 (225ø) at Davis Street (D)	71	1,533m³/d	383

6.23 To minimize uncontrolled discharges into the confined waters between the seawalls, temporary channels and pipe connections could readily be incorporated into the Stage I filling works extending southwards through the western seawall.

6.24 For the Stage II filling, temporary diversions would be required to three more existing outfalls and it may be more appropriate initially for the three discharges to be extended directly towards the reclamation face. At a later stage once reclamation had reached a certain extent, these discharges could then be directed into a more permanent drainage system with discharge towards the western seawall as shown on Figure 6.8.

6.25 Runoff from the site following rainfall events has the potential to contain high solids load. Site drainage should be managed to prevent such runoff from entering harbour waters. Small runoff holding tanks could be used as a part of the construction site drainage management scheme to allow settlement of solids to take place before runoff enters the harbour. Such construction site drainage management measures would be subject to approval by relevant Government departments.

6.26 If any temporary fuel or oil stores are to be located on-site to supply construction vehicles, it is recommended that these be placed on an impervious surface and bunded to prevent spills polluting the harbour waters. It would also be advantageous if oil storage and filling points can be restricted to designated areas thereby minimising potential sources of pollution. Facilities for clean-up (eg absorbent materials, vacuum pumps) should be made available as necessary. The contractor should also be required to provide a perimeter drainage for the designated area with oil interceptors.

6.27 The surface water outfalls that drain into the Sulphur Channel and adjacent areas may also contain foul discharges. The management of these discharges together with the need to maintain access to the existing seawall will be particularly difficult during the initial phases of public dumping. Once reclamation has proceeded sufficiently it will be possible to construct temporary channels to carry polluted flows away from the reclamation area. As the project progresses these temporary structures will be replaced with reinforced concrete drainage. The construction of the temporary channels and pipe connections should be given a high priority in the reclamation schedule and should be built as early as is possible in order to minimise uncontrolled discharges into the confined waters between the seawalls.

Marine Barging Point

6.28 The development of the Marine Barging Point will not result in the diversion of sewers or stormwater outlets, or result in the embayment of contaminated marine waters. As such no sewerage impact during the construction is envisaged.

Impact of Operational Activities

Public Dump

6.29 Based on the proposed configuration/phasing arrangement for the public dump it can be seen that five existing stormwater outfalls will be directly affected by the public dump in its operational phase. It is considered that the three southernmost of these existing outfalls should be intercepted in the vicinity of the existing coastline and, as a permanent measure, directed south to the western seawall for discharge. There is faster flowing waters beyond the western seawall as described in the water quality assessment (Chapter 7), and this will aid dispersion of the polluting loads.

6.30 The two existing stormwater outfalls located further to the north which are also affected by the public dump, should be temporarily diverted until such time that a permanent connection can be made to the stormwater collection system, which has been proposed under the Green Island Reclamation Feasibility Study. This stormwater collection system, which will run along the approximate alignment of the existing seawall, will pick up the other fourteen or so existing stormwater discharges from Kennedy Town. In order to facilitate the connection to the new system, the final length of these two existing storm drains may have to be diverted again (refer to Figure 6.8).

6.31 It is considered that the one remaining small diameter foul sewer outfall located to the west of Belcher Bay opposite Davis Street need not be diverted. This will continue to have a limited impact on operational activities with regard to water quality and this is covered in greater detail in the water quality assessment (Chapter 7).

6.32 It is to be noted that under the Green Island Reclamation Feasibility Study it is proposed that a collector foul sewer will also run west-east along the approximate alignment of the existing seawall to receive flow from both the new reclamation, and where necessary, from Kennedy Town. This would be a similar system to the stormwater collection system mentioned in 6.20 above.

Marine Barging Point

6.33 No sewerage impact during the operation of the Marine Barging Point is envisaged. Staff mess facilities should be appropriately connected to sewer.

Impact Following Completion (Public Dump)

6.34 By the time the public dump project reaches completion, stormwater and foul sewerage discharges should have been adequately intercepted, collected and diverted so as to eliminate any potential impact as a result of the formation of the Green Island Public Dump.

6.35 There may be potential impact from the surface run-off drainage system from the completed reclamation should the reclamation be used for warehousing and storage activities. This would be due only to accidental spillage of fuel and oil into the drainage system and could be mitigated during the engineering design stage by the incorporation of oil/petrol interceptors near the outfall discharge location of the proposed reclamation drainage systems, particularly any discharging through the temporary seawall to the north-east side of the reclamation.

Cumulative Impacts

6.36 It is considered that drainage for the IWTS and in particular *any* proposal associated with the barging point and marine frontage will not be substantially affected by, and should not impact upon, the Green Island Public Dump. Similarly for other proposed future developments including Route 7, SSDS Sewage Treatment Works and the WSD Service Reservoir which are projects that are anticipated to coincide with the period over which the Green Island Public Dump will be operational (1996-2002), but which also are assessed as not resulting in any significant cumulative sewerage impacts.

6.37 This is principally because by the time the public dump project becomes operational, stormwater and foul sewerage discharges should have been adequately intercepted, collected and diverted so as to eliminate any potential impact. Also, the Route 7, SSDS Sewage Treatment Works and the WSD Service Reservoir are all located at elevated positions overlooking the public dump site and are situated to the east of operations. Sewerage and drainage discharges will be diverted either to permanent collector systems directing flows eastwards to treatment, or direct to discharge south of the western seawall where the faster flowing water provide dispersion and dilution.

6.38 The current proposals under the Belcher Bay Reclamation works have been taken into account in the assessment of impact associated with the adjacent existing sewerage systems. Details of the changes to the system have been appraised and included in the water quality model accordingly.

6.39 According to the current works programme for the Central, Western and Wan Chai Sewage Master Plan construction is scheduled to commence from early 1996 for completion by 2000. Concurrent reclamation associated with Green Island during this period will increase traffic loads in the area significantly. Close coordination will be required to minimise interference between the sewerage works and works associated with the Public Dump.

6.40 As part of the SSDS it is possible that there may be a requirement for an area of land for construction of a secondary level sewage treatment plant for Hong Kong Island and Kowloon on the Green Island reclamation area. This would be in addition to the Mount Davis underground sewage treatment plant. No firm decision is likely about this until at least mid-1995 and there will not be a requirement for the plant if the proposal for the SSDS Stage II oceanic outfall is retained. If the plant were to be built, construction would be required after 1988 for commissioning before 2003. The land area required would be likely to be 20-30 ha.

Conclusions and Recommendations

6.41 From this study it has been established that there are five stormwater discharges that would be directly affected by the Green Island Public Dump. The feasibility of intercepting and diverting these southwards towards the western seawall of the Green Island Public Dump has been assessed as an appropriate permanent or semi-permanent measure. The discharge to fast flowing waters there will aid dispersion and dilution and thereby avoid deterioration of water quality. The northernmost of these existing outfalls may, in the long-term, be more appropriately diverted to future collector drains along the alignment of the existing Kennedy Town seawall which would transfer the effluent eastwards.

6.42 The locations and flow rates of all existing foul and stormwater discharges within the study area have been established and pollution loads estimated. There are several major infrastructure projects in the planning stage in the vicinity of Green Island which will each have some impact on the adjacent sewerage systems. Proposed changes to the sewerage systems have been identified and their impacts assessed, particularly in the case of the Belcher Bay Reclamation which impacts on the existing outfalls with the greatest pollution loadings. Findings have been incorporated into the water quality assessment.

6.43 There are no significant cumulative sewerage impacts in relation to the IWTS barging point.

6.44 Recommendations for the diversion and interception of stormwater drains during the construction and operational phase are provided.

6.45 There are as yet no proposals to divert the existing small diameter foul sewer outfall discharging opposite Davis Street. The effect of this outfall has been addressed as part of the water quality assessment (Chapter 7).

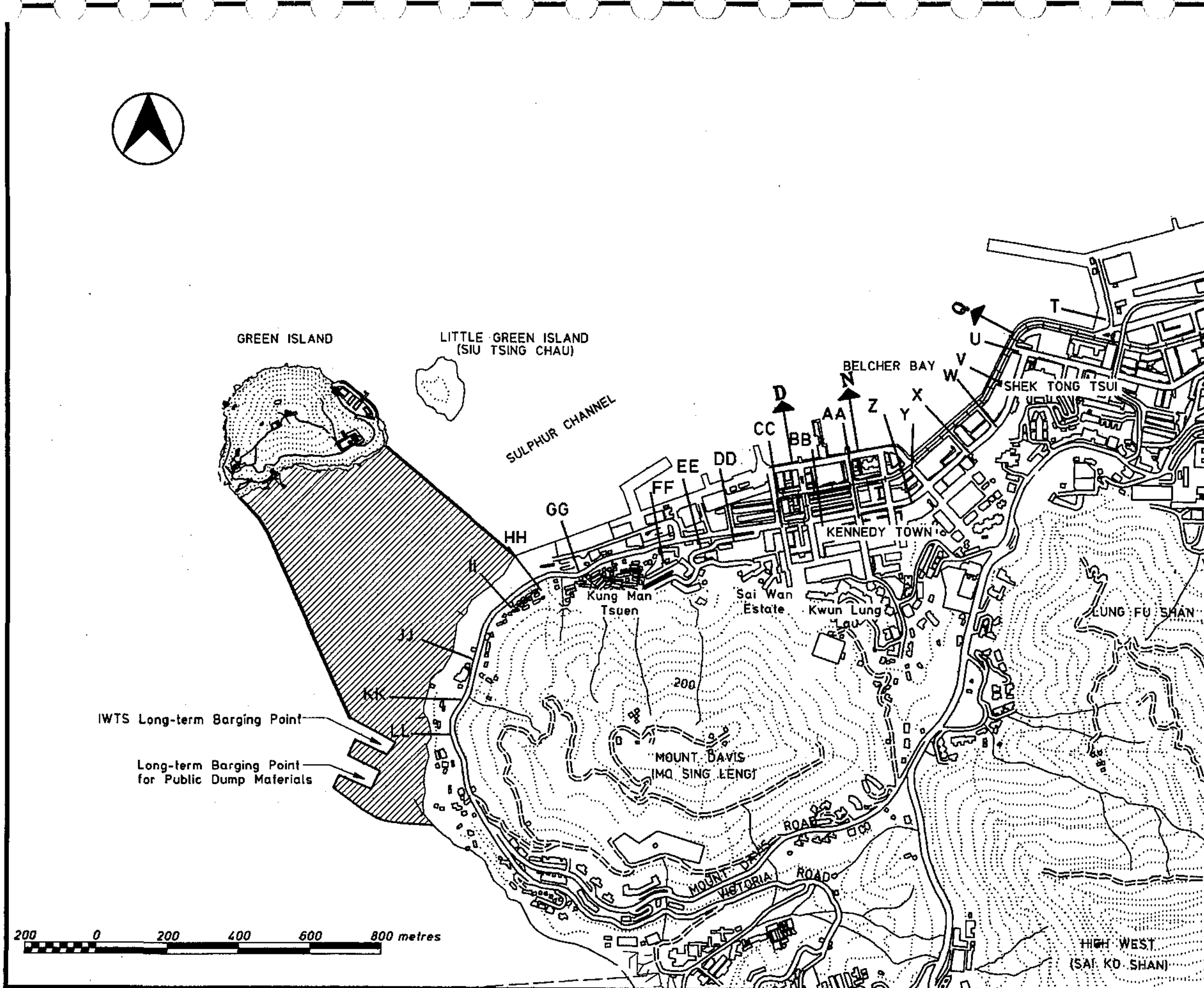
6.46 Under the Water Pollution Control Ordinance, all effluents discharging within a Water Control Zone are subject to obtaining a licence from EPD and complying with the conditions stated therein.

References

6.1 Central Western and Wan Chai West Sewerage Master Plan Study Final Report. Balfours International (Asia). Environmental Protection Department, 1991.

6.2 Green Island Reclamation Feasibility Study. Ove Arup & Partners. Territory Development Department, Urban Development Office, 1989.

6.3 Technical Memorandum, Standard for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters. Environmental Protection Department, January 1991.



Legend

Foul Sewer Outlet

Stormwater Outlet

Notes:

1. Letter codes shown for stormwater outlet are those given in Central, Western and Wanchai Sewerage Master Plan.

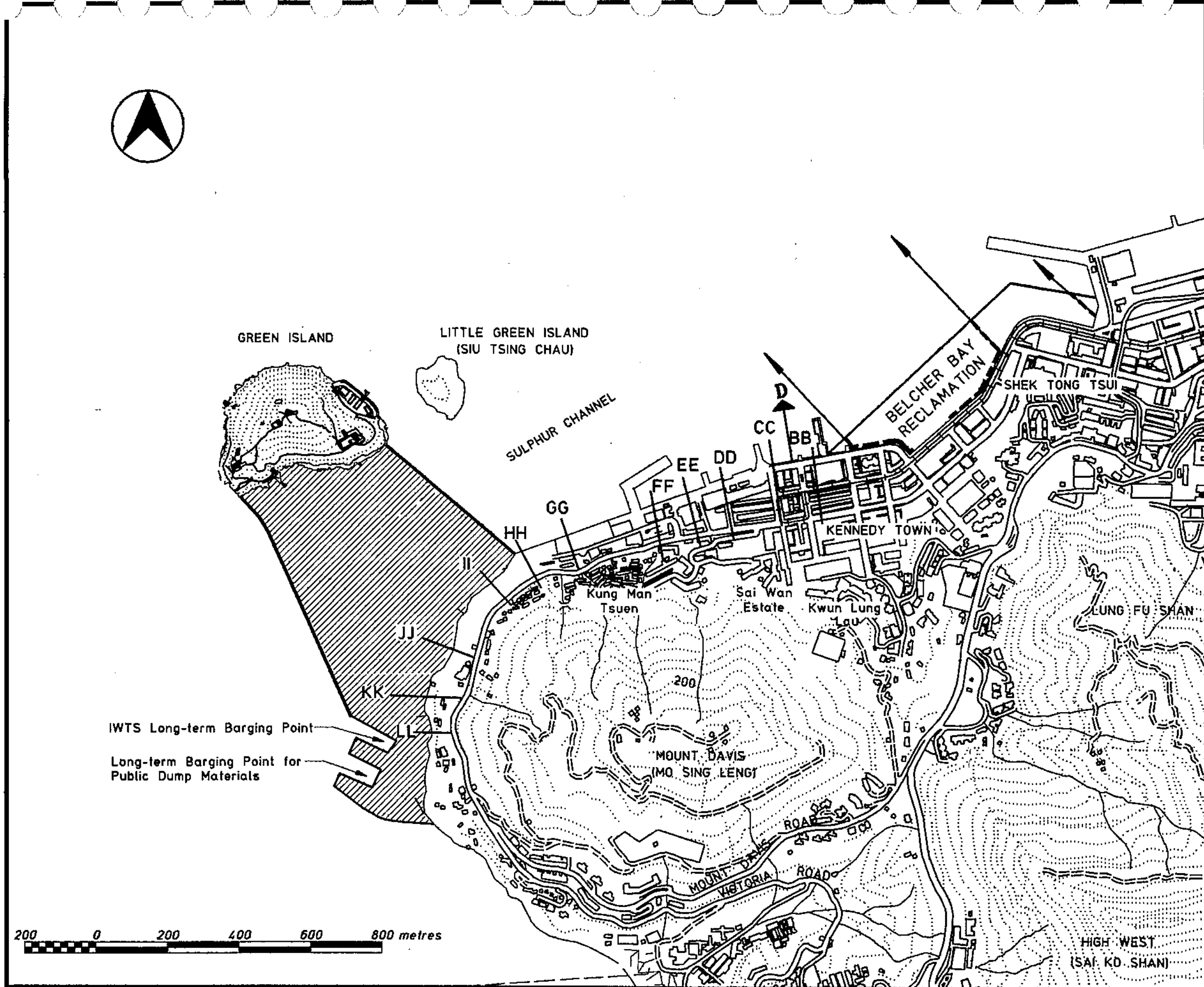
2. Foul Sewers:
   D=Davis Street
   N=North Street
   Q=Queen Street

GREEN ISLAND RECLAMATION (PART) – PUBLIC DUMP FINAL REPORT

Figure No. 6.1

Existing Foul Sewer and Stormwater Outlets in Study Area

SWK AutoCAD D:\FINAL6 1 19940713.1344 Plot 1 : 10.0000



Legend

Foul Sewer Outlet

Stormwater Outlet

Proposed Box Culvert Outlet

Notes:

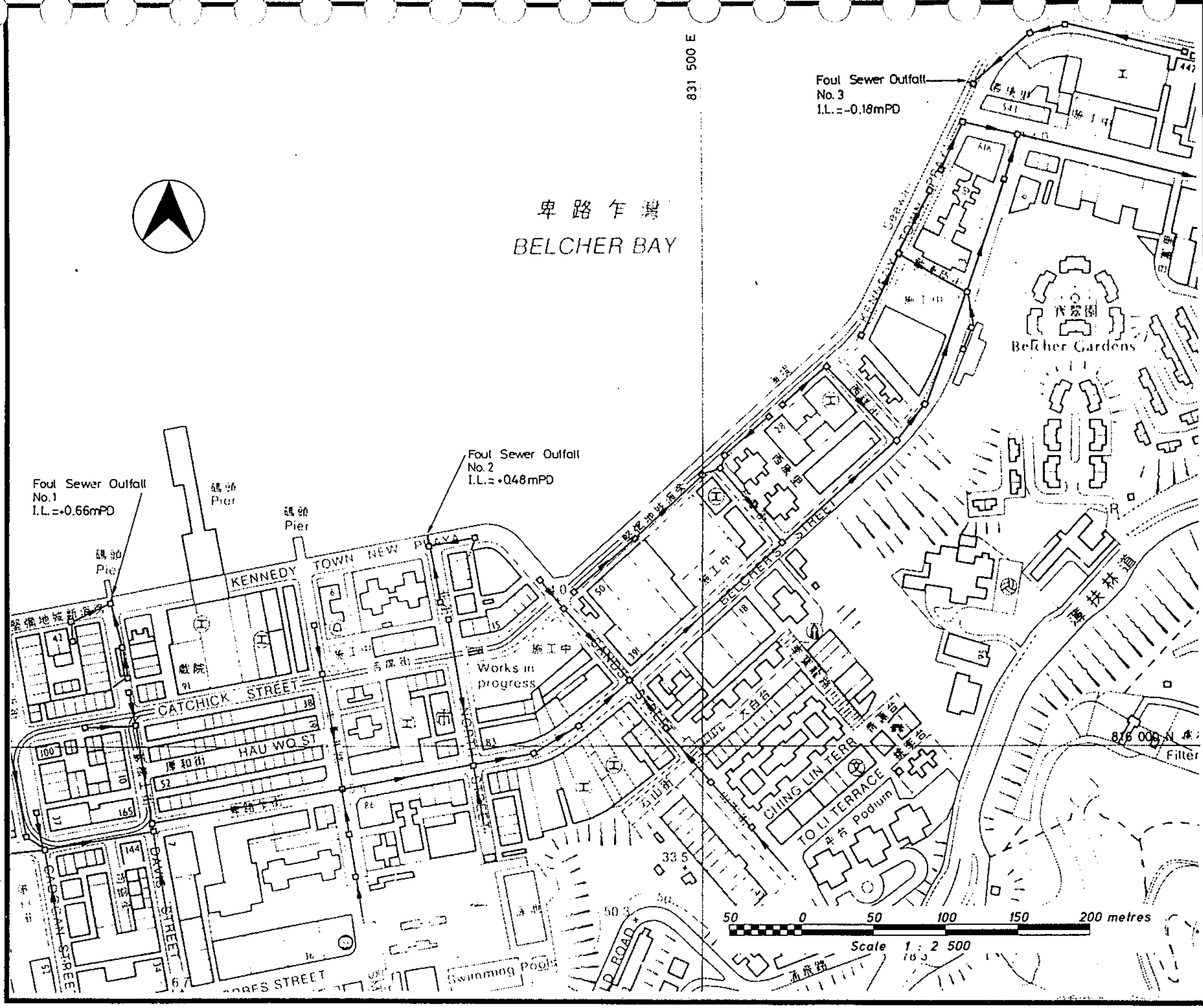
1. Letter codes shown for stormwater outlet are those given in Central, Western and Wanchai Sewerage Master Plan.
2. Outfalls T, U, V, W, X, Y, Z and AA are diverted to 3 proposed box culverts constructed under Belcher Bay Reclamation project.
3. Two foul sewer outlets are directed inland to discharge to screening plants under the Reclamation project.
4. Foul Sewers:
   D= Davis Street.

GREEN ISLAND RECLAMATION (PART) - PUBLIC DUMP FINAL REPORT

Figure No. 6.2

Baseline Foul Sewer and Stormwater Outlets in Study Area

SWK AutoCAD D:\FINAL6 2 19940713.1344 Plot 1 : 10.0000



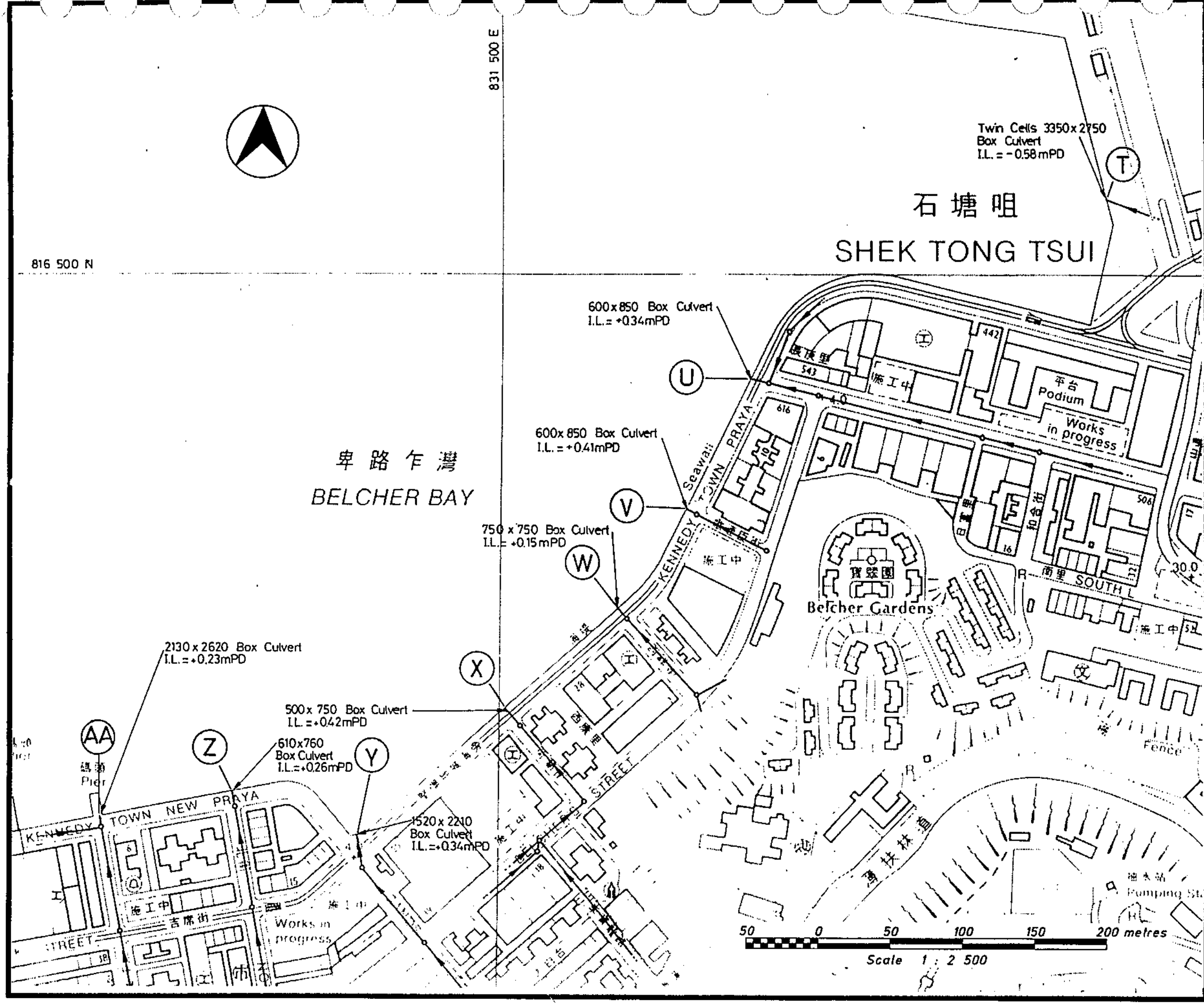
Legend

Existing Foul Sewer Manhole and Pipe

GREEN ISLAND RECLAMATION (PART) - PUBLIC DUMP FINAL REPORT

Figure No. 6.3

Details of Existing Sewer Discharge



Legend

Existing Stormwater Manhole and Pipe

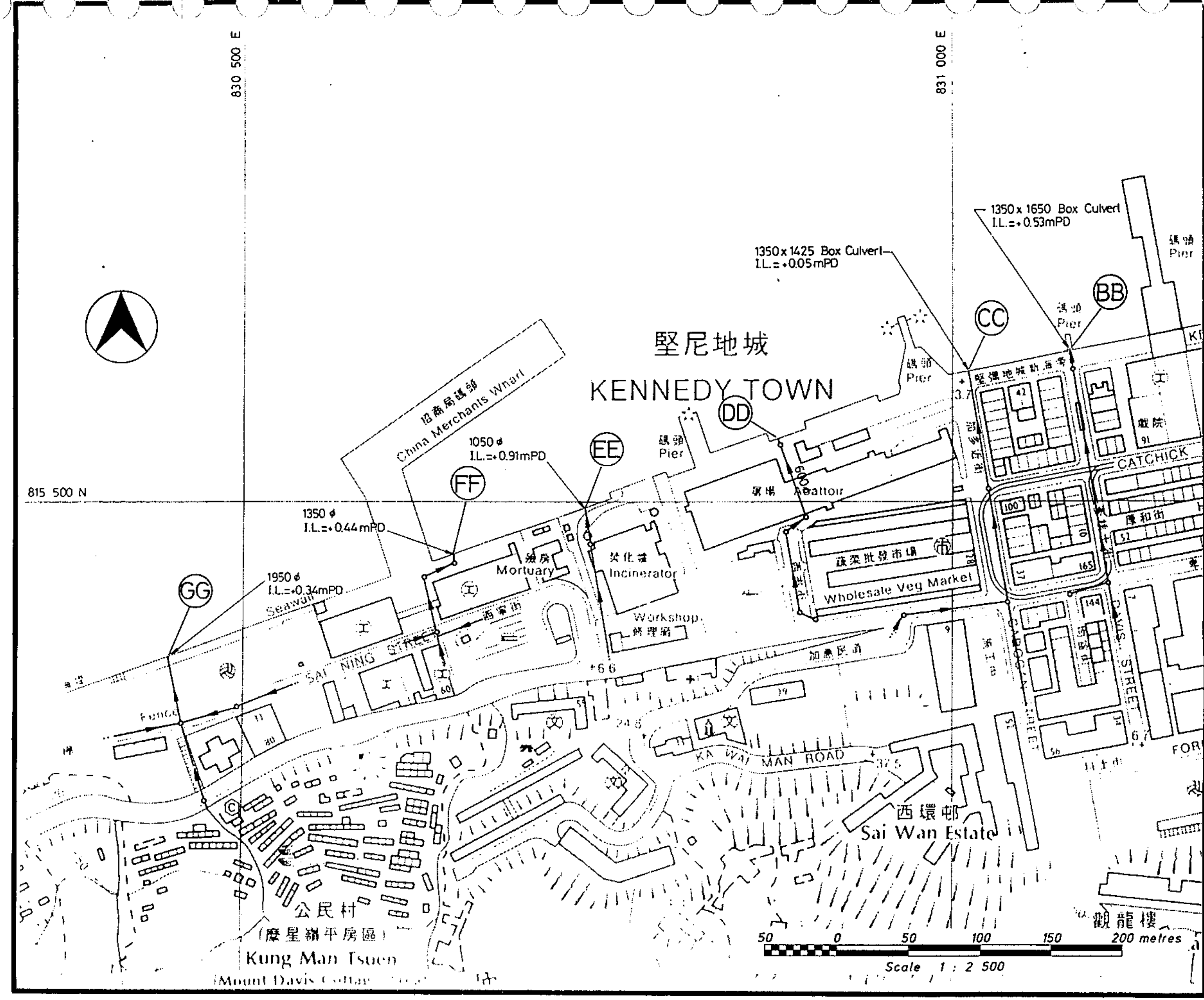
Note:

1. Letter codes shown for stormwater outlet are those given in Central, Western and Wanchai Sewerage Master Plan.

GREEN ISLAND RECLAMATION (PART) – PUBLIC DUMP FINAL REPORT

Figure No. 6.4

Details of Existing Surface Water Discharges within the Study Area (Sheet 1 of 3)



Legend

—o— Existing Stormwater Manhole and Pipe

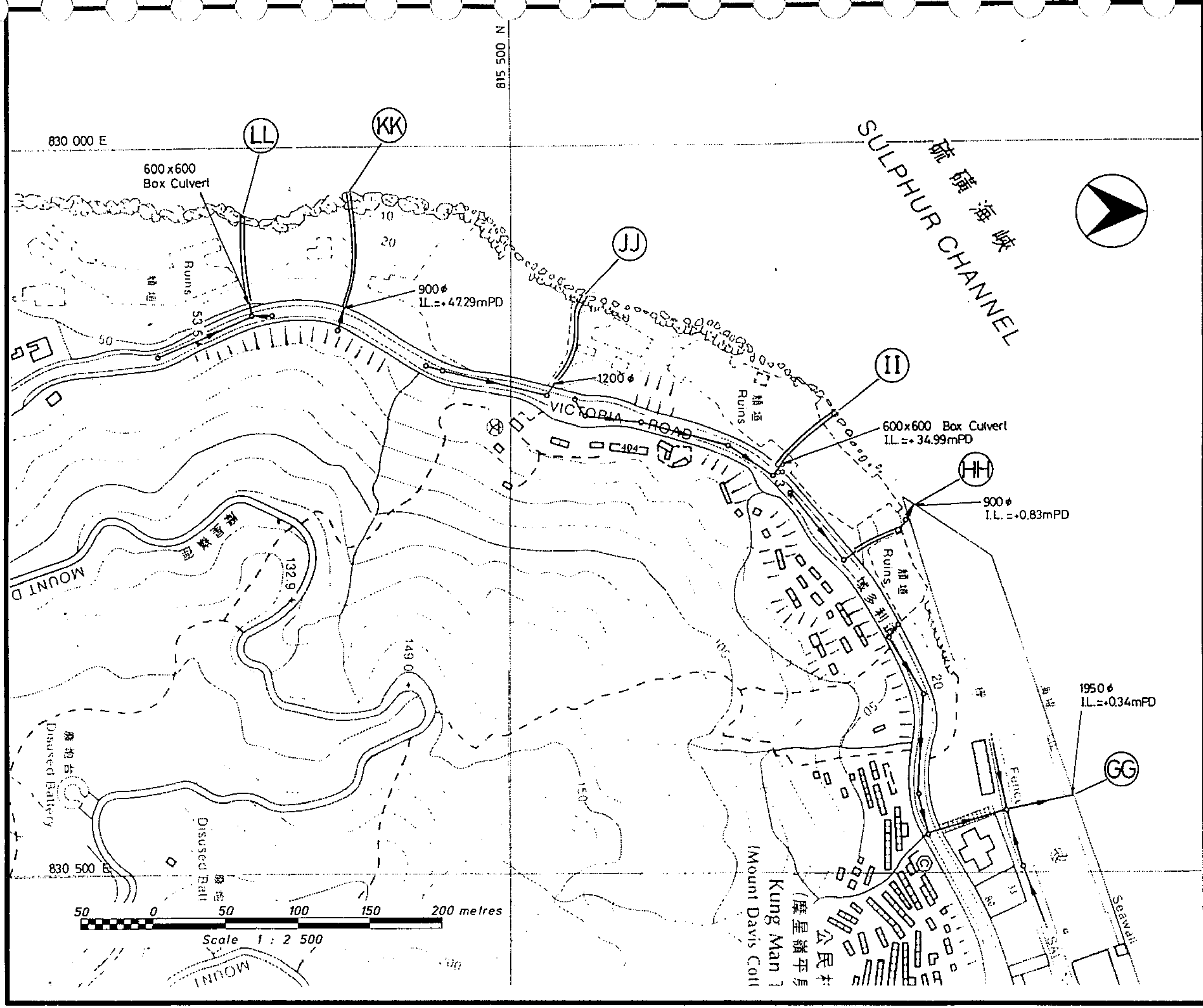
Note:

1. Letter codes shown for stormwater outlet are those given in Central, Western and Wanchai Sewerage Master Plan.

GREEN ISLAND RECLAMATION (PART) – PUBLIC DUMP FINAL REPORT

Figure No.	6.5

Details of Existing Surface Water Discharges within the Study Area (Sheet 2 of 3)



Legend

- Existing Stormwater Manhole and Pipe
- Existing Channel/ Natural Watercourse

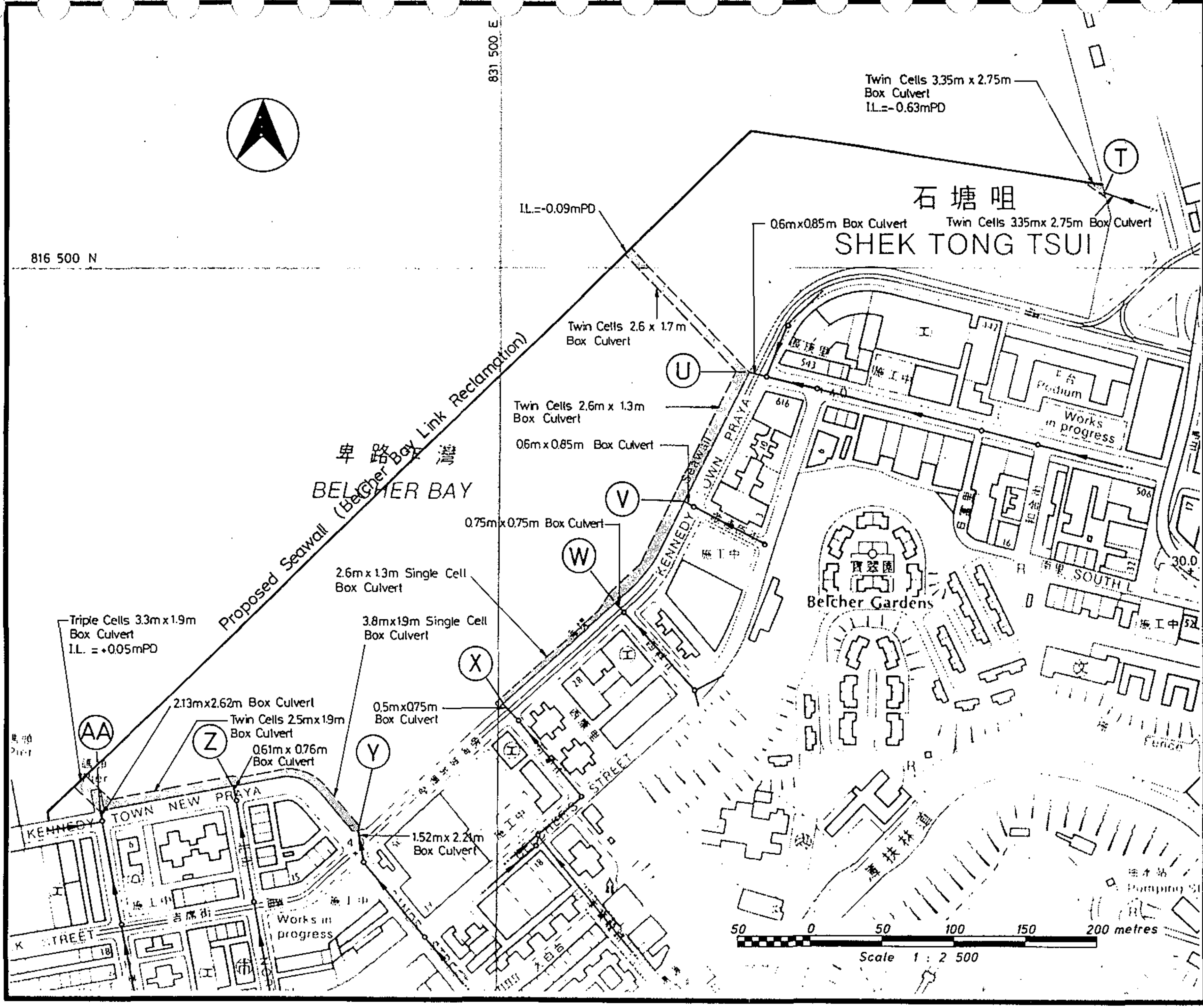
Note:

1. Letter codes shown for stormwater outlet are those given in Central, Western and Wanchai Sewerage Master Plan.

GREEN ISLAND RECLAMATION (PART) – PUBLIC DUMP FINAL REPORT

Figure No. 6.6

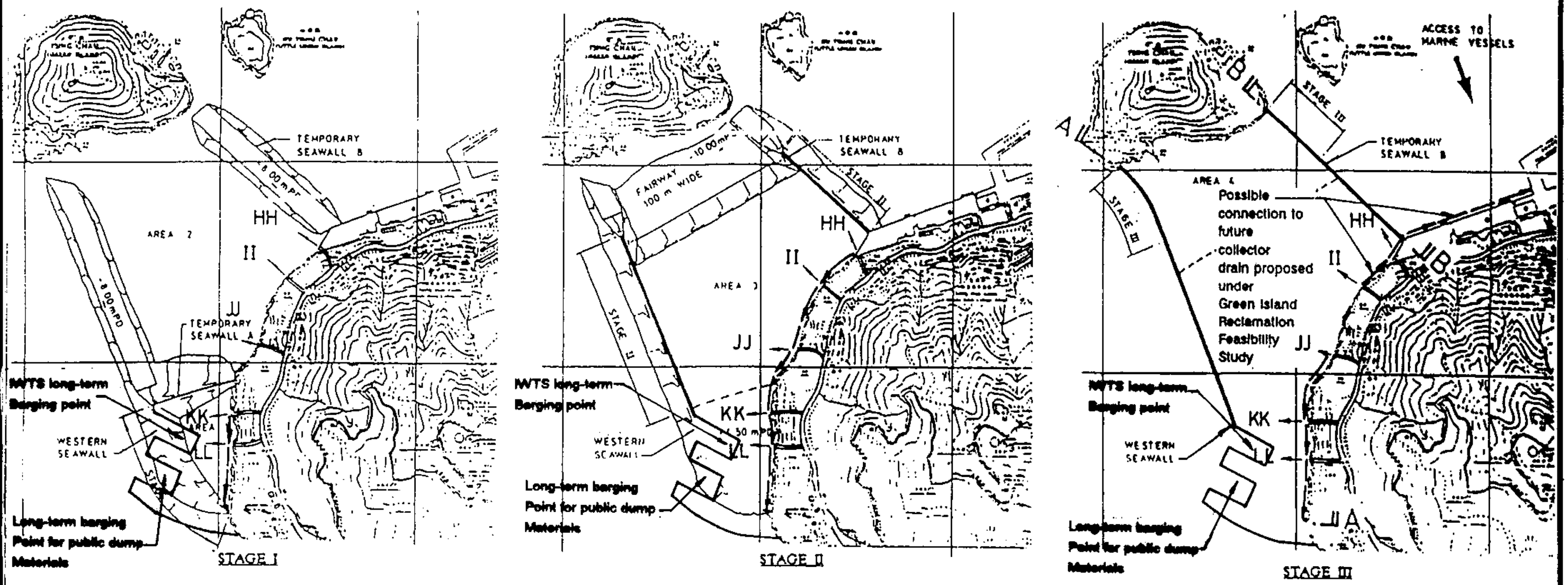
Details of Existing Surface Water Discharges within the Study Area (Sheet 3 of 3)



GREEN ISLAND RECLAMATION (PART) - PUBLIC DUMP FINAL REPORT

Figure No. 6.7

Anticipated Discharges to Belcher Bay at Commencement of Green Island Reclamation



1. Outfalls shown in more detail of Figure 6.6
2. Outfalls KK & LL diverted through western seawall

1. Remaining outfalls diverted through western seawall

GREEN ISLAND RECLAMATION (PART) - PUBLIC DUMP FINAL REPORT

Figure No. 6.8

Discharges Directly Affected by the Reclamation

7. WATER QUALITY AND DREDGED SEDIMENTS

Introduction

7.1 The creation of the reclamation for the purposes of public dumping between the western end of Hong Kong Island and Green Island has the potential to bring about changes in water quality both during the construction phase and as a result of its physical presence. Changes which are caused may result in the water quality breaching the Government's prescribed water quality objectives (WQOs) and/or affecting specific users, Sensitive Receivers, of the marine environment.

7.2 By the very nature of the works being carried out, the construction of the reclamation will inevitably result, temporarily, in localised changes in marine water quality.

7.3 Activities which may result in changes in marine water quality over a wider area are identified as:

- Dredging existing sediments;
- Placement of material for the construction of the retaining sea walls;
- Placement of construction waste between the sea walls;
- Modification of the existing hydrodynamic regime in the Sulphur Channel and along the adjacent coastline sections reducing the dispersion and dilution of surface, storm and sewer discharges;
- Discharges from the activities carried out on the reclamation following its completion.

7.4 The extent of possible changes have been investigated using the WAHMO (WAter Quality and Hydrodynamic MOdels) water quality, bacterial dispersion and sediment plume transport models.

7.5 Differences in water quality between the baseline condition and that resulting from the partial and complete closure of the Sulphur Channel predicted by the water quality modelling have been evaluated and compared with relevant WQOs. Under neither scenario was water quality changed in such a way that the objectives were breached. Specific mitigation measures over and above good working practices are therefore not required in terms of construction or operational activities or phasing of activities. In this context "good working practices" cover those which, by common sense, will be carried out to avoid unnecessary additional impacts; examples include ensuring that barge doors are shut, positioning grabs centrally over the barge before releasing material and loading barges evenly to avoid listing and consequent overspilling.

7.6 It is also proposed to develop the 0.6 ha site presently occupied by the Kennedy Town Incinerator Plant (KTIP) as a reception area for public dump material delivered by road for transport to the Green Island and other public dump/reclamations. The change of use of the area has potential implications for marine water quality. Due to the short timescale available for this element of the study no additional water quality or sediment data have been collected; the assessment is based on the data already available. No mathematical modelling of sediment plumes, water quality or bacterial dispersion has been undertaken of the proposed KTIP development but the assessment carried out has indicated that, in the absence of significant amounts of dredging of the contaminated sediments, no unacceptable impacts on water quality should result.

Background Information & Monitoring Data

7.7 Marine water quality data reported by the EPD (Refs 7.1-7.4) together with data from the EPD marine water quality database, the Belcher Bay background water quality monitoring programme (Ref. 7.5) and a specific water quality monitoring programme (Ref. 7.6) have been used in this study. The Green Island Link Preliminary Feasibility Study (Ref. 7.7) included analysis of sediments in the project area; these, together with data from the EPD marine sediment quality database and data from two surveys carried out specifically for this project (Refs. 7.8 & 7.20), have been used to provide information on the sediment quality in the construction and immediate area. Marine water quality data were also sought from the Western Harbour Crossing Environmental Assessment (Ref 7.9).

Environmental Standards and Guidelines

7.8 Marine water quality in Hong Kong is managed through the process of assignment of Beneficial Uses (BUs) to Water Control Zones (WCZs). The locations of the ten WCZs within the territorial waters are shown in Figure 7.1.

7.9 The Public Dump part of the Green Island Reclamation area lies within the Victoria Harbour WCZ, immediately adjacent to the Western Buffer WCZ. The Western Buffer Zone is relatively narrow and the potential impact of the activity on the Southern Waters WCZ was therefore also considered.

7.10 Of these three zones the Southern Waters and Western Buffer Zones have already been gazetted; it is anticipated that Victoria Harbour will be gazetted by 1995. BUs have already therefore been prescribed for the Southern Waters and the Western Buffer Zone.

7.11 The range of BUs which have been identified as applicable for Hong Kong waters are (Ref 7.10):

- BU-1 As a source of food for human consumption
- BU-2 As a resource for commercial fisheries and shell fisheries
- BU-3 As a habitat for marine life and a resource for human exploitation
- BU-4 For bathing
- BU-5 For secondary contact recreation - diving, sail-board and dinghy sailing
- BU-6 For domestic and industrial purposes
- BU-7 For navigation and shipping including the use of officially approved and endorsed sheltered harbours and typhoon shelters as temporary havens
- BU-8 For aesthetic enjoyment.

7.12 Not all BUs are applicable to all WCZs. The complete BU range has been applied to those WCZs which are already gazetted: Western Buffer and Southern Waters. At the present time no BUs are prescribed for Victoria Harbour WCZ but, for assessment purposes, similar BUs have been used in this study for Victoria Harbour WCZ. This does not imply that these will be assigned to Victoria Harbour when it is gazetted.

7.13 In order to maintain the water quality in any zone appropriate to the assigned BU water quality parameters are required to be controlled (Ref. 7.10). For different BUs different numerical absolutes, acceptable changes or qualitative standards are applied; these are defined as the WQOs Ref (7.10). In relation to the application of BU-1 to marine waters the use is best maintained, and the health of the consumer protected by, restricting levels of substances or micro-organisms in any food derived directly or indirectly from the water, eg fish, crustaceans or molluscs.

7.14 For the Southern and the Western Buffer WCZ WQOs have already been defined and these have been used as the level against which to compare both the present water quality and also the predictions from the water quality modelling. These WQO values are given in Table 7.1.

7.15 Because Victoria Harbour WCZ has not yet been gazetted WQOs have not been defined.

7.16 The WQO values are generally based on annual means or percentiles and are appropriate for comparisons of the long term changes in water quality. The annual range of some of the water quality parameters may be high even over a single tidal cycle, giving rise to values which are markedly different from the WQOs.

7.17 There are sea water pumping station intakes both for air conditioning and flushing water intakes along the western end of the northern edge of Hong Kong Island and on the western side of the Kowloon Peninsular. There is also a proposal for a station at Telegraph Bay. The locations of these are shown in Figure 7.2.

7.18 WQOs have been defined by Water Supplies Department (WSD) for sea water at intake points of sea water pumping stations for flushing and are shown in Table 7.2. In addition, there are cooling water intakes for the power stations on Tsing Yi and Lamma Islands.

7.19 The feeding behaviour of marine filter feeders such as mussels is not significantly affected by suspended solids concentrations as high as 100mg/l; good to moderate freshwater fisheries are found in waters with concentrations in the range 25-80mg/l. In Hong Kong marine waters mariculture is carried out in areas where concentrations are as high as 26mg/l (Ref. 7.11). Within the immediate works area there are no sensitive biological receivers, important fish spawning grounds or fish culture zones. The closest mariculture zones are located at Lo Tik Wan, Sok Kwu Wan and Ma Wan.

7.20 Criteria for the classification of sediments, based on their degree of contamination, have been defined in a Technical Circular issued by EPD (Ref. 7.12); these criteria are given in Table 7.3.

Water Quality Monitoring Data

7.21 As part of its role in monitoring and protecting the marine environment the Hong Kong Environmental Protection Department carries out routine water quality surveys throughout the Territory's waters throughout the year. Water quality summaries for the years 1988 to 1991 in water areas adjacent to the project area, Hong Kong Island West and Victoria Harbour West, are given in Tables 7.4 to 7.7. For the years 1988 to 1990 the values given are the result of an aggregation of data from a number of sampling locations within the general areas bounding the construction area. The nominal boundaries of the water areas are indicated in Figure 7.3. For 1991, values are given for the same areas but also for the four specific locations in those areas (Table 7.8).

Table 7.1 : Water Quality Objectives for the Southern and Western Buffer WCZs

Water Quality Parameter	Objective	Part of Zone
Offensive odour, tints and colours	not to be present	whole zone
Visible foam, oil, grease, scum, litter	not to be present	whole zone
E.coli	Annual Geometric Mean not to exceed 610/100ml.	secondary contact recreation sub-zone fish culture subzone
Dissolved Oxygen within 2m of the bottom	not less than 2mg/l for 90% of samples	marine waters
Dissolved Oxygen depth averaged	not less than 4mg/l for 90% of samples not less than 5mg/l for 90% of samples	marine waters except fish culture sub zone fish culture sub zone
pH value	values to be 6.5-8.5 change due to human activity discharge less than 0.2	marine waters except bathing waters
Salinity	change due to waste less than 10% of natural ambient level	whole zone
Temperature Change	change due to waste discharge not to exceed 2 Centigrade degrees	whole zone
Suspended Solids	waste discharge not to raise the natural ambient level by 30% nor cause the accumulation of suspended solids which may adversely affect the marine communities	marine waters
Toxic Substances	not to be present at levels producing significant toxic effects	whole zone
Unionised Ammonia	annual mean not to exceed 0.021mg/l	whole zone
Nutrients	not be present in quantities that cause excessive algal growth annual mean depth average inorganic nitrogen not to exceed 0.1mg/l	marine waters

Table 7.2 : Target Limits for Water Quality Objectives for Water Taken for Flushing

Water Quality Parameter	Target Limit
Colour	< 20 Hazen Units
Threshold Odour No.	< 100
Turbidity	< 10 NTU
E.coli	< 20 000/100ml
Dissolved Oxygen	> 2mg/l
BOD	< 10 mg/l
Suspended Solids	< 10 mg/l
Synthetic Detergents	< 5 mg/l
Ammoniacal Nitrogen	< 1mg/l

Table 7.3 : Concentrations of heavy metals and PCB in marine sediments and boundary values for EPD Class A,B and C sediments.

	Determinand (mg/kg)							
	Cd	Cr	Cu	Pb	Hg	Ni	Zn	PCB
Background	0.05	7	7	19	0.07	10	40	<0.005
Class A	<1	<50	<55	<65	<0.8	<35	<150	
Class B	1.0-1.4	50-79	55-64	65-74	0.8-0.9	35-39	150-190	
Class C	>=1.5	>=80	>=65	>=75	>=1.0	>=40	>=200	

Table 7.4 : Summary of Water Quality for the Year 1988 in Water Areas Adjacent to the Project Area.

		HK Island West	Victoria Harbour West
Temperature (deg C)	Surface	22.4 16.0 - 28.7	22.3 15.3 -28.7
	Bottom	20.4 15.9 - 26.0	21.5 15.1 - 28.1
Salinity (ppt)	Surface	29.5 22.3 - 32.7	30.4 23.8 - 32.7
	Bottom	32.8 31.5 - 34.1	32.1 28.7 - 34.1
Dissolved Oxygen (% sat)	Surface	87 62 - 119	76 44 - 131
	Bottom	77 41 - 93	64 33 - 93
pH		8.2 8.0 - 8.4	8.2 7.8 - 8.6
Secchi disc (m)		2.5 0.9 - 6.5	1.9 0.7 - 4.3
Turbidity (NTU)		8.8 3.2 - 31.1	8.8 2.1 - 28.2
Suspended Solids (mg/l)		8.1 0.8 - 28.0	10.4 1.8 - 57.0
BOD (mg/l)		0.6 0.1 - 1.2	1.1 0.2 - 3.3
Inorganic N (mg/l)		0.18 0.08 - 0.38	0.29 0.06 - 0.62
Total N (mg/l)		0.56 0.32 - 0.81	0.75 0.36 - 1.46
PO_4-P (mg/l)		0.02 <0.01-0.03	0.04 <0.01-0.08
Total P (mg/l)		0.04 0.02 - 0.07	0.07 0.02 - 0.19
Chlorophyll (μg/l)		2.7 0.2 - 11.0	7.3 0.2 - 60.0
E.coli (no/100ml)		72 0 - 455	599 0 - 13666

Table 7.5: Summary of Water Quality for 1989 in Water Areas adjacent to the Project Area

		HK Island West	Victoria Harbour West
Temperature (deg C)	Surface	22.9 16.5 - 28.6	23.0 15.3 -28.4
	Bottom	22.2 18.4 - 27.6	22.5 15.3 - 28.2
Salinity (ppt)	Surface	29.8 11.7 - 34.0	30.6 19.1 - 33.1
	Bottom	32.1 30.3 - 33.7	31.3 25.9 - 33.3
Dissolved Oxygen (% sat)	Surface	88 71 - 118	74 39 - 131
	Bottom	79 23 - 97	69 26 - 99
pH		8.5 8.2 - 8.8	8.3 8.0 - 8.9
Secchi disc (m)		1.8 1.1 - 3.4	1.4 0.6 - 3.0
Turbidity (NTU)		7.0 2.9 - 15.4	8.8 2.5 - 37.0
Suspended Solids (mg/l)		4.8 0.0 - 18.0	8.6 2.0 - 30.0
BOD (mg/l)		0.7 0.1 - 1.5	0.9 0.1 - 3.2
Inorganic N (mg/l)		0.14 0.08 - 0.20	0.29 0.06 - 1.58
Total N (mg/l)		0.42 0.23 - 0.75	0.62 0.26 - 2.32
PO_4-P (mg/l)		0.02 <0.01-0.08	0.03 <0.01-0.19
Total P (mg/l)		0.04 0.02 - 0.08	0.06 0.02 - 0.28
Chlorophyll (μg/l)		4.1 0.2 - 16.0	4.2 0.2 - 24.0
E.coli (no/100ml)		89 5 - 1250	960 0 - 11133

Table 7.6: Summary of Water Quality for 1990 in Water Areas adjacent to the Project Area

		HK Island West	Victoria Harbour West
Temperature	Surface	23.5 16.1 - 28.6	23.0 15.9 -28.9
(deg C)	Bottom	21.9 16.0 - 27.6	22.6 15.8 - 28.4
Salinity	Surface	29.7 23.0 - 32.6	30.2 22.3 - 32.4
(ppt)	Bottom	32.3 31.2 - 34.1	31.2 27.3 - 32.6
Dissolved Oxygen	Surface	93 56 - 151	80 29 - 146
(% sat)	Bottom	76 47 - 105	69 43 - 116
pH		8.3 7.8 - 8.9	8.3 7.7 - 8.8
Secchi disc (m)		2.5 1.4 - 3.5	2.1 0.5 - 5.0
Turbidity (NTU)		5.3 2.0 - 14.7	5.6 1.5 - 17.5
Suspended Solids (mg/l)		3.9 1.2 - 12.7	6.4 0.9 - 28.3
BOD (mg/l)		0.7 0.1 - 1.9	0.8 0.2 - 2.0
Inorganic N (mg/l)		0.16 0.09 - 0.30	0.28 0.06 - 0.56
Total N (mg/l)		0.59 0.35 - 1.18	0.86 0.42 - 2.69
PO_4-P (mg/l)		0.02 <0.01-0.04	0.03 <0.01-0.08
Total P (mg/l)		0.09 0.04 - 0.46	0.08 0.03 - 0.13
Chlorophyll (μg/l)		1.3 0.3 - 3.5	3.2 0.2 - 15.3
E.coli (no/100ml)		143 7 - 1150	692 27 - 18000

Table 7.7 : **Summary of Water Quality for 1991 in Water Areas adjacent to the Project Area.**

		HK Island West	Victoria Harbour West
Temperature (deg C)	Surface	22.9 17.0 - 27.3	22.1 16.5 -25.8
	Bottom	21.2 16.9 - 24.5	21.7 16.3 - 28.0
Salinity (ppt)	Surface	28.5 15.8 - 32.9	30.5 23.2 - 33.1
	Bottom	32.8 31.2 - 34.0	31.7 28.4 - 33.3
Dissolved Oxygen (% sat)	Surface	100 65 - 126	88 54 - 138
	Bottom	82 36 - 142	70 35 - 137
pH		8.1 7.6 - 8.5	8.1 7.7 - 8.6
Secchi disc (m)		1.9 0.8 - 3.4	1.4 0.5 - 3.0
Turbid: (NTU)		4.7 1.6 - 14.0	9.4 1.0 - 38.3
Suspended Solids (mg/l)		6.3 1.2 - 18.7	12.3 1.0 - 50.3
BOD (mg/l)		1 <1 - 2	1 <1 - 3
Inorganic N (mg/l)		0.27 0.09 - 0.70	0.39 0.04 - 0.90
Total N (mg/l)		0.61 0.22 - 1.10	0.87 0.41 - 2.73
PO_4-P (mg/l)		0.03 0.01-0.05	0.05 0.01-0.08
Total P (mg/l)		0.11 0.04 - 0.43	0.13 0.05 - 0.40
Chlorophyll (μg/l)		1.6 0.2 - 9.1	1.3 0.2 - 8.5
E.coli (no/100ml)		181 25 - 4800	870 18 - 19000

Table 7.8 : Summary of Water Quality for 1991 at four stations adjacent to the Project Area

		Victoria Harbour West		Hong Kong Island West	
		VM7	VM8	WM1	WM2
Temperature (deg C)	Surface	22.2 16.7 - 25.8	22.1 16.5 -25.7	22.8 17.0 - 27.3	23.0 17.1 - 27.0
	Bottom	21.8 16.5 - 28.0	21.7 16.3 - 26.0	20.8 17.0 - 24.5	21.5 16.9 - 24.5
Salinity (ppt)	Surface	30.6 23.7 - 32.7	30.5 23.2 - 33.1	29.7 19.9 - 32.9	27.2 15.8 - 32.8
	Bottom	31.6 28.4 - 33.1	31.8 29.0 - 33.3	33.1 31.8 - 34.0	32.5 31.2 - 33.2
Dissolved Oxygen (% sat)	Surface	82 60 - 124	94 54 - 138	101 68 - 126	99 65 - 124
	Bottom	63 35 - 88	77 39 - 137	81 36 - 140	83 45 - 142
pH		8.0 7.7 - 8.5	8.1 7.9 - 8.6	8.3 8.1 - 8.7	8.1 7.7 - 8.4
Secchi disc (m)		1.4 0.6 - 2.6	1.3 0.5 - 3.0	2.4 1.4 - 4.5	1.7 0.8 - 2.4
Turbidity (NTU)		7.5 1.5 - 19.0	11.3 1.0 - 38.3	2.9 0.6 - 7.2	5.2 1.8 - 14.0
Suspended Solids (mg/l)		9.5 2.0 - 22.0	15.0 1.0 - 50.3	3.8 0.7 - 13.0	7.1 1.2 - 18.7
BOD (mg/l)		1 <1 - 3	1 <1 - 2	1 <1 - 2	1 <1 - 1
Inorganic N (mg/l)		0.44 0.21 - 0.90	0.34 0.04 - 0.78	0.13 0.06 - 0.31	0.30 0.15 - 0.70
Total N (mg/l)		0.96 0.52 - 2.73	0.77 0.41 - 1.74	0.61 0.30 - 1.61	0.66 0.33 - 1.06
PO_4-P (mg/l)		0.06 0.02 - 0.08	0.04 0.01-0.07	0.02 <0.01-0.03	0.03 0.01-0.05
Total P (mg/l)		0.13 0.05 - 0.33	0.12 0.05 - 0.40	0.09 0.03 - 0.51	0.11 0.04 - 0.43
Chlorophyll (μg/l)		1.2 0.2 - 7.6	1.4 0.2 - 8.5	1.5 0.2 - 5.6	1.4 0.2 - 3.1
E.coli (no/100ml)		1500 40 - 19000	240 18 - 6000	24 0 - 250	62 25 - 170

7.22 Two intensive water quality surveys were carried out in the proposed project area on a spring tide 12-13 September 1993 and a neap tide 17-18 September 1993 to provide data for the calibration of the water quality model and an indication of the "within-tide" variation of water quality parameters. The locations of the sampling points and the transect are shown in Figure 7.4.

7.23 The water quality data for both tides are summarised in Table 7.9 which shows the mean values for each parameter and the "within-tide" range for suspended solids in the upper and lower water layers. There was little "within tide" variation shown by BOD, Chlorophyll and the nitrogen species.

7.24 The data from the Belcher Bay background water quality monitoring programme (Ref. 7.5), the intensive survey and EPD surveys for suspended solids have been examined and the summary data are presented in Table 7.10. The locations of the sampling stations are shown in Figures 7.3 and 7.4. The data for Belcher Bay (collected over the period 15 June - 5 July 1993) and for Green Island show the wide variations which can occur over short periods of time.

7.25 Dissolved Oxygen concentrations were measured in the Sulphur Channel as part of the intensive survey. Tidal mean and range values in the upper and lower layers for %-saturation are summarised in Table 7.11: position GI-C and transect GI-C' are indicated in Figure 7.4. The values at the upper end of the range tend to occur during the hours of daylight and the lower during darkness. This pattern of variation is a function of algal photosynthetic activity and is normal for marine waters.

7.26 In order to establish the present level of compliance with the WQOs, the summary data in Tables 7.4 to 7.8, the original data for locations VM7 and VM8 and those described above are compared with the WQO values which apply to Southern and Western Buffer WCZs and which, for the purposes of this study, are being used as guidelines for Victoria Harbour.

E Coli

7.27 The geometric mean values for each of the years 1988 to 1991 all lie below the WQO values.

Dissolved Oxygen

7.28 The dissolved oxygen values reported by the EPD annual summaries are given as % saturation rather than the absolute concentration specified in the WQO. Percentage compliance of concentrations of dissolved oxygen (mg/l) with the WQO for the years 1988 to 1991, for locations VM7 and VM8, are summarised in Table 7.12.

pH Value

7.29 For both areas the annual mean values lie within the prescribed range but the upper value of the annual range extends beyond the upper range limit. These values do not coincide with times of high phytoplankton biomass, indicating that the exceedences are not due to high primary productivity.

Table 7.9 : Water Quality Summary Data - Green Island Intensive Surveys

	Neap Tide						Spring Tide					
Station	GI-A		GI-B		GI-C		GI-A		GI-B		GI-C	
Layer	U	L	U	L	U	L	U	L	U	L	U	L
Suspended Solids mg/l	19 11-27	30 19-47	25 11-41	41 16-67	22 12-32	32 18-55	6 3-13	8 5-11	6 5-8	6 4-9	6 4-9	9 4-19
BOD mg/l	<2	<2	<2	<2	<2	<2	<2	<2	2	2	2	2
TON mg/l	0.1	0.1	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1
NH4-N mg/l	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
TKN mg/l	0.3	0.5	0.4	0.4	0.5	0.6	0.6	0.7	0.5	0.5	0.5	0.5
Chl_a mg/m3	1.3	1.6	1.4	1.8	1.3	1.8	1.0	1.0	1.0	1.0	1.0	1.0
E. coli /100ml	550	960	500	750	460	490	700	550	200	520	370	330

Table 7.10 : Background Suspended Solids Concentrations In and Adjacent to the Project Area. (Mean and Range Values as mg/l)

	Surveys		Belcher Bay				Green Island		
	HKIW	VHW	A	B	C	D	GI-A	GI-B	GI-C
Depth Average	5.7 0-28	9.4 0.9-57	8.3 1.4-31.6	9.0 1.8-30.8	7.9 1.4-25.3	9.9 1.6-40.6			
Upper Layer			6.8 1.9-14.6	6.5 1.9-11.6	5.6 1.4-10.2	5.9 1.9-10.7	12 3-27	15 5-41	14 4-32
Lower layer			11.4 1.5-30.8	12.6 2.1-29.4	11.6 1.9-24.2	16.9 2.3-39.7	19 5-47	23 4-67	20 4-55

Table 7.11 : Dissolved Oxygen % Saturation Green Island Intensive Survey

	Neap Tide				Spring Tide			
Station	GI-C		GI-C'		GI-C		GI-C'	
Water Layer	U	L	U	L	U	L	U	L
Dissolved Oxygen % Saturation	72 54-79	72 52-79	72 48-80	70 50-76	77 70-84	75 63-89	74 64-83	75 68-88

Table 7.12 : Percentage compliance of Dissolved Oxygen concentrations with WQOs

Table 7.12 : Percentage compliance of Dissolved Oxygen concentrations with WQOs

	Depth Average not less than 4mg/l (% compliance)		Bottom 2m not less than 2mg/l (% compliance)	
	VM7	VM8	VM7	VM8
1991	100	96	100	100
1990	81	92	100	100
1989	69	100	96	100
1988	81	96	100	100

Salinity

7.30 No absolute values are set for salinity. The WQO relates to changes relative to the ambient salinity which would be applied at the boundary of a defined mixing zone.

Temperature Change

7.31 No absolute values are set for temperature. The WQO relates to changes relative to the ambient temperature and would be applied in a similar way to the salinity value.

Suspended Solids

7.32 No absolute values are set for suspended solids other than that set as a target by WSD; the EPD WQO relates to changes relative to the ambient suspended solids. However the target value for flushing water is 10mg/l and a guideline for cooling water is a maximum of 150-200mg/l aimed at limiting wear of intake pumps. Maximum values reported by EPD in Victoria Harbour West and in the Hong Kong Island West areas are in the region of 57mg/l and 13 mg/l respectively. Similar maximum values to those for Victoria Harbour are found in the Belcher Bay data and the Intensive surveys undertaken for this study.

7.33 Annual means in the Harbour occasionally exceed 10 mg/l while those at Hong Kong Island West area do not, being in the range 3.8-8 mg/l. The mean values for Belcher Bay, upper layer and depth averaged, also lie below 10mg/l.

Toxicants

7.34 No data are presented in the EPD annual reports on toxicants in the water column. The presence of fish in the harbour, attached filter feeders on the ferry piers, active bivalve mollusc collection within the harbour and phytoplankton growth indicate that the Victoria Harbour water quality is sufficient to support at least a limited marine ecosystem. However, data from the EPD sediment monitoring station VS6 indicates that the sediments are contaminated with copper and lead.

7.35 The operation of the mariculture zones at Lo Tik Wan and Sok Kwu Wan, active trawl fishing and the range of species described in the Chapter in this report on Marine Ecology indicate that the waters of the Western Buffer and Southern WCZs are also able to support a wide range of marine organisms.

Unionised Ammonia

7.36 The concentration of the icthyotoxic un-ionised ammonia in the water for any given total ammonia concentration is a function of both temperature and pH. Data for 1991 have been extracted from the EPD data base for locations VM7 and VM8 to provide a guide to the-un-ionised ammonia concentrations and are summarised in Table 7.13. At both stations the estimated annual mean concentration is below the prescribed WQO value. The within-tide averaged ammonia concentrations determined during the intensive surveys for both neap and spring tides are 0.1mg/l. The water temperatures are higher than the annual average being of the order of 28°C. Although not measured during the survey, typical September pH values at VM7 and VM8 are in the region of 8.2-8.3. Under these conditions 12.7%, 0.013mg/l, of the ammonia present will be in the un-ionised form. This is comparable with the annual data presented for VM7 and VM8 above.

Table 7.13 : Ammonia concentrations measured at EPD monitoring locations

	VM7	VM8
Total Ammonia mgN/l	0.30	0.19
Temperature deg C	22	22
pH	8.0	8.1
% un-ionised Ammonia	4.3	5.9
Un-ionised Ammonia mgN/l	0.013	0.011

Nutrients

7.37 At all locations for which data were examined the annual average inorganic nitrogen concentration exceeds the WQO value, giving rise to the concentrations of algal growth indicated by the chlorophyll-a concentrations at the upper ends of the ranges shown in Tables 7.4 - 7.6.

Sediments

7.38 Data from the EPD data archive have been provided for site VS6 in Victoria Harbour, a similar location to VM7 shown in Figure 7.3. Further data from sediment analysis in the vicinity of Green Island are presented in the Green Island Link Preliminary Feasibility Study (Ref. 7.7). The data most relevant to this study are from sites DC12 and DC13 adjacent to the lines of the proposed seawalls; and from two stations, DC1 and DC2, lying between VS8 and the project area (Figure 7.5). Figure 7.6 shows the locations of known foul sewer and surface and storm water discharges into the immediate vicinity of the reclamation as identified by the Central, Western and Wan Chai West Sewerage Master Plan Study.

7.39 The data for VS6 showed that the sediments were contaminated, particularly with copper; the data from the DC coded stations indicated that the sediments were classifiable as Class A (uncontaminated). Based on this information a further survey was carried out in November 1993 following the guidelines given in Works Branch Technical Circular No 22/92 (WBTC 22/92) (Ref. 7.14) at nine locations along the lines of the proposed seawalls. These data are shown in Table 7.14.

7.40 The November 1993 survey revealed that, whilst concentrations of Chromium, Copper, Mercury, Nickel and Zinc were all less than the limit values defined by EPD Technical Circular 1-1-92 for Class A sediments, those of Cadmium at Stations 1-8 exceeded the Class C limit and the concentration at Station 9 the Class B limit. Similarly concentrations of Lead at Stations 1-8 exceeded the Class C limit while Station 9 concentration was within the Class A limit. The contaminated nature of the sediments was contrary to expectations and a further survey was therefore undertaken in April 1994 to confirm these findings and to investigate the depth of contaminated sediment.

7.41 The April 1994 survey results, based on a sampling strategy which comprised triplicate cores being taken at 4 positions (2 on the line of each seawall) and tested at three depths demonstrated without exception that the samples were within the Class A category as defined by the EPD Technical Circular 1-1-92. These latest survey data are presented in Table 7.15.

Table 7.14: Sediment Heavy Metal Concentrations in Victoria Harbour and the Project Area Concentrations are given as mg/kg dry sediment

Date	Aug/ 91	Aug/ 92	Sept /92	Nov/ 92	1991				Nov/9 3								
Statio	**VS6**	**VS6**	**VS6**	**VS6**	**DC1**	**DC2**	**DC12**	**DC13**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Cd	9.2	<0.5	<0.5	<0.5	0.5	0.6	0.7	0.6	3.4	3.2	2.6	2.7	3.2	2.8	3.2	3.5	1.3
Cr	73	52	43	51	18	16	16	16	43	41	33	32	42	41	36	40	8
Cu	255	215	109	130	7	9	16	13	50	39	30	23	41	32	33	37	20
Hg	1.2	.35	.16	.12	.04	.04	.06	.03	.25	.25	.23	.40	.25	.22	.31	.27	.36
Ni	29	31	25	25	11	9	10	9	29	30	25	25	30	27	28	31	7.5
Pb	83	56	47	75	23	23	20	16	118	101	79	79	102	90	108	108	52
Zn	175	150	117	165	41	42	55	37	136	101	82	67	102	91	97	100	66

Table 7.15: Sediment Survey Results - April 1994

Metal (units: mg/Kg)	Site No.	1			2			5			7		
	Replicate Ref.	A	B	C	A	B	C	A	B	C	A	B	C
Cd	Depth 1*	AC	AC	AC	AC	AC	AC	AC	AC	AC	AC	AC	AC
	2	AC	AC	AC	AC	AC	AC	AC	AC	AC	AC	AC	AC
	3	AC	AC	AC	AC	AC	AC	AC	AC	AC	AC	AC	AC
Cr	1	31	26	26	30	26	26	27	34	28	23	30	30
	2	30	33	35	13	12	13	35	36	39	28	29	31
	3	24	29	29	10	13	13	28	29	34	30	31	30
Cu	1	36	33	16	20	6.2	12	10	13	13	18	14	20
	2	15	31	18	9.0	< 1	3.7	40	39	50	8.3	8.6	10
	3	4.1	12	11	< 1	< 1	< 1	13	11	19	9.7	9.6	12
Hg	1	0.16	0.41	0.09	0.16	0.06	0.06	0.06	< 0.05	0.06	0.18	0.23	0.34
	2	0.32	0.32	0.31	0.22	0.14	0.16	0.21	0.14	0.35	0.20	0.19	0.23
	3	0.48	0.43	0.30	< 0.05	< 0.05	< 0.05	0.26	0.26	0.22	0.24	0.27	0.25
Ni	1	18	9.5	17	18	20	16	16	8.6	9.1	11	18	19
	2	20	20	21	6.6	7.0	5.1	19	19	18	14	19	21
	3	18	21	20	8.4	7.5	8.8	17	7.6	18	11	22	21
Pb	1	21	10	< 9	9.4	< 9	< 9	< 9	< 9	< 9	37	15	25
	2	34	32	26	10	< 9	< 9	30	21	21	27	13	20
	3	14	35	23	< 9	< 9	< 9	15	20	19	26	23	40
Zn	1	100	85	65	68	55	62	56	68	68	80	90	89
	2	95	110	100	33	23	37	100	94	100	77	80	83
	3	57	91	84	19	20	16	88	80	110	82	83	92

* - Section 1 = Top (0-0.1m from top); Section 2 = Middle (approx 0.9-1.0m from top); Section 3 = Lower (approx 1.9-2.0m from top as available)

Numerical Modelling

7.42 Specific mathematical models from the suite of WAHMO models have been used to investigate the impact of the different phases of the programme of works. A hydrodynamic model was set up and the results used for sediment plume, water quality and bacterial dispersion modelling. Model runs have been carried out using either the 100m or 50m grid whichever was most appropriate to the model being used.

Hydrodynamic Modelling

7.43 The WAHMO hydrodynamic model was run by the Port Development Division of the Hong Kong Government Civil Engineering Department (CED). Models of two grid sizes were run: a 100m model which was run for four tide conditions (dry and wet season neap and spring tides); and a 50m model which was run for two tides only, the dry season spring tide and the wet season neap tide. The models were based on the CED Lantau Port and Western Harbour calibrated 100m model.

7.44 The baseline conditions for the modelling included the following planned or committed developments:

- Chek Lap Kok
- North Lantau Reclamation
- Lantau Fixed Crossing
- Container Terminal 8
- Container Terminal 9
- West Kowloon Reclamation (North and South)
- Central and Wan Chai Reclamation
- Kowloon Point Reclamation
- Kellett Bank Dredging
- South Tsing Yi Borrow Pit (depths after completion of Terminal 7 construction)
- Belcher Bay Reclamation (all three phases)

7.45 The models were run for the following layouts:

- CASE 1 - Existing conditions
- CASE 2 - Baseline conditions (with the above reclamations and developments included but not the Green Island Reclamation)
- CASE 3 - The scenario at the end of Stage 1: seawalls and fill to -8m PD
- CASE 4 - The scenario at the end of stage 2: the width of the Sulphur Channel reduced to 100m
- CASE 5 - The full development scenario: the Sulphur Channel completely closed

7.46 The 100m model results files were used for running the Sediment Plume and Water Quality models as described below although, owing to the limited resolution of the 100m model in simulating the 100m wide channel, Case 4 was not examined using the Water Quality model. The 50m model results files were used for an assessment of the potential for scour in the reduced-width Sulphur Channel and for bacterial dispersion modelling.

7.47 Results of the hydrodynamic model runs for both grid sizes have been produced in four formats: time history plots (at the locations shown in Annex I Figure 1); vector plots; contour plots and float track plots. The results are presented in Annex I of this report.

Scour Hole Assessment

7.48 An assessment of the potential for a scour hole to develop owing to the modified flow patterns arising from the reclamation was made using the results from the 50m model. In previous studies (Reference 7.17), it was concluded that dry season spring tide conditions, in the absence of wave action, generated the largest bed stresses in Hong Kong waters and would be the controlling factor for erosion of natural marine mud deposits if reclamation works caused local acceleration of the tidal flows. CED carried out simulations of dry season tidal flows using the WAHMO models on a 50m grid for both existing conditions and when the seawalls and public dump development had reached the point where a 100m wide channel had been created.

7.49 For the marine muds likely to be found on the bed, the peak depth mean velocity at which erosion of the sea bed would begin should lie in the range 0.6m/s to 0.7m/s (Reference 7.18) where the surface mud deposits are assumed to have a critical shear stress for erosion of $0.4N/m^2$. If erosion takes place, as the bed surface mud is eroded, the newly exposed denser mud deposits are assumed to dilate so that erosion will always continue as long as the shear stress exceeds $0.4N/m^2$. Eventually, either an inerodible bed material would be exposed or the increase in water depth caused by the erosion would result in reduced water speeds and further erosion would cease.

7.50 From the simulations of existing conditions (Figure 7.7) and the simulation of the 100m wide channel (Figure 7.8), it can be seen that the model predicts that in the channel along the southern shore of Green Island, the water speeds will increase from the order of 0.2m/s to 0.4m/s-0.6m/s in both the surface and bed layers. It could be expected that some erosion of the bed material will take place until the scour hole formed results in reduced water speeds such that no further erosion takes place. In Reference 7.17, it was assumed that water depths would increase in proportion to the increase in water speeds except in areas where the original water speed was less than 0.5m/s. In Reference 7.19, the background theory and method of calculation of erosion of marine mud under tidal currents is given and, for the water depths expected in the channel, with peak speeds of 0.6m/s or less, it is expected that bed stresses would barely reach $0.4N/m^2$ and any erosion of the sea bed would be minimal. With peak bed stresses very close to the equilibrium value, the rate of any erosion would be very small.

7.51 Although the model uses a relatively fine resolution of 50m, the channel is only 100m wide and it is possible that the model may have underpredicted peak speeds in the narrow channel. However, based on this preliminary assessment of the model results, it is not thought that a significant scour hole would develop. Any local erosion of the sea bed in the channel would be expected to take place at a rate of the order of 10-30cm/year.

7.52 If scour does occur it will only be after the Sulphur Channel has been reduced to 100m in width and dredging activities have stopped. The environmental impact of sediments lost to the water column through scour, therefore, will not be concurrent with sediment losses arising from dredging activities and their cumulative effect does therefore not need to be considered. Any scour of the sea bed would occur on the falling ebb tide when tidal flows are sufficiently strong and, if dumping operations are confined to the rising flood tide only, then any sediment lost during dumping would not have an additive impact on any suspended sediment derived from erosion of the sea bed.

7.53 The analysis carried out has been based on a brief assessment of the model results and known mud properties and it is concluded that a significant scour hole would not develop although there could be some local bed erosion (excluding scour at, for example, the ends of the sea walls caused by very local flow accelerations). A more detailed assessment would be required to refine the estimated rate and extent of any erosion.

Sediment Plume Modelling

7.54 In order to assess the impact of the dredging activity and dumping a sediment plume model was used to determine the excursion of the suspended solids plume and to investigate increases in concentration which might be expected to occur in the vicinity of the marine water intakes and the mariculture zones.

7.55 Sediment plume transport modelling has been carried out in order to determine possible effects of dredging for the seawall construction and subsequent dumping of waste on the sensitive receivers identified.

7.56 The sediment plume simulations were based on the 100m grid WAHMO two dimensional two layer model of dry season spring tidal flows set up by the Civil Engineering Department of the Hong Kong Government.

Scenarios

7.57 The conditions simulated were: Case 2, simulation of spoil losses during the dredging along the line of the seawall ("**Dredging Condition**"); and Case 3, following partial construction of the seawalls to examine the sediment plumes arising from the losses of fine material to suspension during dumping activities ("**Dumping Condition**").

Loads - Dredging Condition (Construction Phase)

7.58 The dredging operations were represented by four sediment sources in the model. These were positioned at regular intervals along the line of the proposed western wall of the reclamation area between Green Island and Hong Kong Island. The source distribution was designed to simulate the movement of a dredger along the line of the wall.

7.59 The source terms were derived by assuming that 190,000m^3 of sediment are to be dredged over a one week period, that dredging is continuous over that time, that the sediment dry density is 488kg/m^3 and that 3% of the dredged material will be lost to the water column as fines. The certainty of the rate of loss is low and values of 3% and 5%, based on the expected range of losses, have both been used in previous similar studies; as a guide to sensitivity, sediment concentration at any point would simply have been 1.6 times those reported if the 5% value had been adopted. The extent of the plume is determined by the hydrodynamic conditions and rate of re-deposition of the sediment losses.

7.60 The calculated sediment losses were divided equally between the four sources. In order to examine worst case conditions, the spoil losses were assumed to enter the water column at the sea surface in order to minimise any immediate re-settling of the sediment to the sea bed. The model was run for three consecutive tidal cycles to allow the sediment plume to develop and the plots of the model results were taken from the third tide of the sequence.

Loads - Dumping Condition (Operational Phase)

7.61 The source term was initially derived by using the given dumping rate of 1,300,000m^3/year and assuming a 10 hour working day for 295 days in the year (440m^3/hour) and the model was run to simulate a continuous dumping operation using this dumping rate. In practice, the dumping would be intermittent and only occur for 10 hours per day but, in the simulations, continuous dumping was assumed in order to ensure the simulation covered dumping at the expected rate at all states of the tidal cycle. The simulations, therefore, may have overestimated the larger area background concentrations generated by the dumping but will not have underestimated the more local area sediment plumes which would be generated during and shortly after dumping.

7.62 Following completion of the simulations, it was agreed between CED and EPD to allow dumping on the rising flood tide only to reduce sediment losses to the East Lamma Channel. Flood tide conditions (assumed to extend from low water slack tide until the tidal flows reverse) can be assumed to persist for between 12 and 16 hours per day depending on the particular tidal conditions at any time. This tidal window is longer than the 10 hour working day assumed in calculating the sediment loss rates and so the sediment loss rate during dumping for this mode of operation will be no larger than that calculated below assuming a 10 hour working day. The impact of the different modes of operation of the dump are discussed further below.

7.63 It was estimated that the fines content of the dump material would lie in the range of 15% to 30% by volume and a mean value of 22.5% was used to estimate the losses to suspension. It is to be expected that the particle size distribution of the dump material will be more variable than natural marine sediments where sorting by tidal currents may reduce the range of particle sizes in any particular sample.

7.64 In the absence of more detailed information on the nature and variability of the dump material, it was decided to retain the same mass of fines per cubic metre of dump material (488kgm) as for the natural marine mud and this assumption is discussed further below. Assuming 3% losses to suspension as before, the source term was divided equally over 5 sources spread over the extent of the dumping area and fines were released throughout the water column in order to allow some sediment to be trapped behind the submerged seawalls if hydraulic conditions allow.

7.65 The model was run for three consecutive tidal cycles with all model results being plotted from the third tide.

Sediment Transport - Dredging Condition (Construction Phase)

7.66 During the dry season spring tide Case 2 (Annex II, Figures 1 and 2), the suspended mud plume on the ebb tide extends south south east from the dredging site into the East Lamma Channel (Annex II Figures 1a-d). On the flood tide (Annex II Figures 1e-f) the plume is directed towards Green Island and around its western side. At the time of high water slack, Annex II Figures 1g-h, the suspended mud concentrations throughout the plume are less than 10ppm except close to the sediment sources. The only contact the plume makes with the coastline occurs south east of Green Island at peak ebb flows and at low water where the plume is within a few hundred metres of Hong Kong Island. Concentrations in this area, however, are less than 5ppm.

7.67 Some of the spoil lost to suspension settles to the sea bed over a relatively narrow area defined by the area impacted by the plume and the local hydraulic conditions (Annex II Figures 2a-d). By comparing the deposits at high slack water (Annex II Figure 2d) and at peak ebb tide flows (Annex II, Figure 2a), some resuspension of mud deposits can be seen. Where the simulated deposition occurs near to the shoreline (apart from that of Green Island itself) deposits are less than 0.1kg/m^2 in three days; approximately 0.03kg/m^2/day. This is equivalent to a deposition rate of 1mm or less in three days. Even around the area to be dredged and the area extending north of Green Island, deposition rates are less than 1kg/m^2 in three full tidal cycles, equivalent to only 2mm deposition in 3 days.

7.68 Long term bed levels in the area to be affected by the deposition are, on the whole, stable. It is highly probable that the spoil deposits will not consolidate fully and will be relatively easily re-eroded during subsequent storm events and be dispersed over a larger area (Ref. 7.15).

Sediment Transport - Dumping Condition (Operational Phase)

7.69 Assuming a continuous loss rate of 440m³/hour (7.61), during the ebb tide (Annex II Figures 3a, 3b) the suspended mud plume extends south south east parallel to the coast of Hong Kong Island. In the upper layer, concentrations are generally less than 5ppm with only a few isolated areas with concentrations between 5 and 10 ppm. In the lower layer, concentrations are generally less than 15ppm, except for a small isolated area offshore of Hong Kong Island which may have been generated by re-erosion of settled material. In practice, if dumping only takes place for 10 hours per day, the general background concentrations would be lower than predicted but the sediment plume extending directly from the dump site should be appropriate. The simulations showed that suspended sediment concentrations and the extent of the plumes reduced quite rapidly towards high water slack tide where only the immediate area of the dump site experiences concentrations greater than 1ppm. If dumping is then stopped on the ebb tide, any residual sediment in suspension at high water slack over the dump site should be dispersed very rapidly and any elevations in sediment concentrations in the East Lamma Channel would be small and short lived. Having used the continuous dumping rate in the simulations, the model results already reflect conditions for dumping at the appropriate rate on the rising flood tide perhaps overestimating the suspended sediment concentrations slightly.

7.70 The area in which the dumping is taking place has concentrations which tend to be higher for most stages of the tide. At low water slack (Annex II Figures 3c, 3d), the plume still extends south south east with concentrations in the upper layer being less than 5ppm whilst those in the lower layer are less than 10ppm. At times of peak flood and high water (Annex II Figures 3e-h) the plume stays close to Green Island with a small plume extending around the eastern side of the Island in which concentrations of the order of 15ppm occur in the upper layer. Concentrations exceed 1ppm about three hundred metres offshore of Hong Kong Island.

7.71 Although some resuspension of mud deposits occurs during the tidal cycle, a general accumulation of deposits during the tide can be seen in Annex II Figures 4a-d. Along the coast of Hong Kong Island south east of Green Island, deposits are less than $0.5kg/m^2$ over three days. A few hundred metres offshore, the deposition rate reaches approximately $1kg/m^2$ in the three day period.

7.72 Deposition near the dump site (Annex II Figures 4a-d) exceed $1kg/m^2$ as was expected. An area extending north of the eastern side of Green Island has deposits of up to $1kg/m^2$. It should be noted that, as for the dredging losses, fines deposited on the sea bed in areas which are naturally stable can be expected to be re-eroded during storm conditions and subsequently dispersed. No significant loss of depth is expected to be caused by the accumulation of fine material lost to suspension during the dumping operations.

Evaluation of the sediment plume modelling results

7.73 Comparison of the sediment plumes generated by dredging and dumping show that, for the dumping operation, surface layer concentrations are lower but bed layer concentrations are higher than for the dredging operation. The maximum possible loss rate for dumping (if all fine material was assumed to go into suspension) could be up to 3 times larger than the losses during dredging operations but there must be some uncertainty in the rate of loss of fine material. Unlike the natural sea bed, it is to be expected that there will be considerable variability in the fines content of each load of dump material. Much of the fine material could be granular behaving more like sand than mud in the water column and this material will settle to the bed much more quickly than mud with a subsequent reduction in the concentration of suspended material in the plume. The results from the plume simulations should be considered to indicate the extent of the plume which would form under dry season spring tide conditions.

7.74 Figure 7.2 shows the location of the identified sensitive receivers within the area of the sediment plume model. Examination of the flow vectors for wet and dry season, spring and neap tides indicated that the worst-case conditions would occur for dry season spring tides. The concentration contours of the plume in the upper and lower layers calculated at four states of the tide (peak ebb, low water slack, peak flood and high water slack) are shown in Figures 1-4 in Annex II.

7.75 The predicted increases in concentration when superimposed on background levels are compared with the concentrations which might result in water quality problems for the sensitive receivers. Background concentrations of suspended solids in Hong Kong Island West, Victoria Harbour West, four locations in the vicinity of Belcher Bay (Ref. 7.5) and from specific intensive surveys carried out in the region of Green Island for this study (Ref. 7.6) are given in Table 7.10.

7.76 It is clear from a comparison of the concentration contour plots that the lowest contour of the plume +1mg/l does not reach as far as the seawater intakes on the western side of the Kowloon Peninsular, Tsing Yi Island or those in the vicinity of the Macau Ferry Terminal. Those which are within the excursion length of the +1mg/l contour are the WSD intake at Kennedy Town and the proposed intake at Telegraph Bay. The mariculture zones at Lo Tik Wan and Sok Kwu Wan on the east side of Lamma Island are sufficiently far away from the dredging and dumping zone not to be within the area of travel of the +1mg/l concentration boundary of the plume.

Water Quality Modelling

7.77 The two dimensional, two layer tidal water quality model used for this study is one of the WAHMO suite of models. For this study it has been run to a grid size of 100m using flow results files produced by CED from which information on the depth of the cells and on the two horizontal flow components at each of the cell faces are obtained.

7.78 The model calculates the distribution of 15 substances; there are also a number of derived quantities such as benthic oxygen demand. The basic equation that the model solves for each of the 15 substances is the two-dimensional conservation of mass equation which deals with effects of advection (flow), diffusion (mixing), interactions (transformation and decay) and loading. There is a separate equation for each layer and allowance is made for vertical flow and mixing between layers. The equations are solved using finite difference methods. The data input to the model consists of the effluent loadings, the chemical and algal rate coefficients, the incident light, the open boundary conditions and the water depths and flows from the hydrodynamic model. The resulting water quality over a full tidal cycle is then predicted throughout the whole model area and detailed water quality results plotted out over that cycle (time-history plots) at a number of pre-specified locations.

7.79 The results of simulations are output in two forms. The first, in the form of the time history plots, shows the concentrations of dissolved oxygen expressed as % saturation, BOD, ammoniacal nitrogen, oxidised nitrogen, organic nitrogen, chlorophyll_a, suspended solids and *E. coli* over a full tidal cycle in the upper and lower layers of the model for each scenario compared with the baseline condition. For the second form of output, tidally averaged concentrations are given in tabular form for all of the stations including all of those used in the model calibration. Both sets of output are presented in Annex III of this report.

Scenarios

7.80 Four layouts were simulated for four tide types (i.e. all combinations of wet and dry season, spring and neap tides). The four layouts were:

Existing conditions - for calibration purposes;
Baseline conditions - including a number of reclamations that will be in place by the time the Green Island reclamations start;
Scenario 1 - having the same shoreline as the baseline, but with changes in depths associated with the submerged seawalls;
Full Scenario - the final reclamation.

Pollution Loads

7.81 All loads discharging within the model boundaries were included, based on the WAHMO model loads and updated with available Sewage Master Plan data. Details of loads in the neighbourhood of Green Island are shown in Tables 7.16 and 7.17 and their locations in Fig 7.4. For the Full Scenario five small outfalls, labelled HH to LL, were re-positioned to the southern boundary of the reclamation.

Existing Conditions - Model Calibration

7.82 In order to ensure that the comparisons between baseline and scenario situations were done under realistic conditions, a form of calibration was carried out using four sets of available data. The first set of data was that used for calibration of the original WAHMO model. Seventeen of those stations, numbers 2 to 18, were within the current model boundaries. This data set consists of time-series measurements over approximately one tidal cycle and was obtained in 1987.

7.83 The second set of data comprised routine measurements taken in 1991 for four EPD monitoring stations within the model, labelled WM1, WM2, VM7 and VM8. This data set comprised maximum and minimum values over the year, so the same data were used for each tide/season combination.

7.84 The third set of data comprised 3 points surveyed in September 1993 under this study, labelled GI_A, GI_B and GI_C. These data were only available for wet season comparisons.

7.85 The fourth data set was the WAHMO survey data of 1992 and 1993. Only one point lay within the present model grid, labelled WQ7.

Table 7.16 : Pollution Loads from Surface and Storm Water Discharges and Three Additional Foul Sewers into the Project Area - Model Calibration

Source Identifier	Pollution Load (kg/day)		
	BOD	COD	TKN
TU	2964	7946	332
V	298	626	238
W	145	305	25
X	393	704	58
Y	320	1120	43
Z	731	1690	58
AA	760	1673	87
BB	437	929	43
CC	298	639	30
DD	76	159	14
EE	146	308	28
FF	79	171	11
GG	30	68	2
HH	19	44	1
II	19	44	1
JJ	22	49	1
KK	11	24	1
LLMM	11	24	1
Davis St. Sewer, **D**	383		
North St. Sewer, **N**	330		
Queen's Rd. West Sewer, **Q**	232		

Table 7.17: Pollution Loads from Surface and Storm Water and the Undiverted Foul Sewer Discharges into the Project Area - Scenarios.

Source Identifier	Pollution Load (kg/day)		
	BOD	COD	TKN
T	1482	3973	166
Eastern Collector Box Culvert (U,V,W,X)	2318	5608	487
Western Collector Box Culvert (Y,Z,AA)	1811	4483	188
BB	437	929	43
CC	298	639	30
DD	76	159	14
EE	146	308	28
FF	79	171	11
GG	30	68	2
HH	19	44	1
II	19	44	1
JJ	22	49	1
KK	11	24	1
LLMM	11	24	1
Davis St. Sewer, D	383		

7.86 These points are listed in Table 7.18 and their locations are shown in Annex III Fig 1. Table 7.18 also includes one additional point, identified as LOC1, which was used in the comparison of baseline and scenario results. Of these 26 stations, 18 are shown in the calibration plots: WAHMO stations WH07 to WH09, WH12 and WH14 to WH18; EPD monitoring stations WM1, WM2, VM7 and VM8; survey points GI_A, GI_B, and GI_C; and SOM station WQ7. These are indicated with an asterisk in Table 7.18.

7.87 The boundary conditions were taken from a previous model of the area produced by EPD. These were time-variant conditions.

7.88 Most parameters remained constant throughout the study. The values used are shown in Table 7.19; those indicated with an asterisk were adjusted from the WAHMO values to obtain the calibration.

7.89 A number of constants were changed between wet and dry season as shown in Table 7.20.

Table 7.18 : Green Island Reclamation - Modelling Station Identification

No.	ID	Description	Easting	Northin
1	WH02	WAHMO station No. 2	841635	816823
2	WH03	" " " 3	838904	818207
3	WH04	" " " 4	838801	817450
4	WH05	" " " 5	836208	816306
5	WH06	" " " 6	836036	816585
6 *	WH07	" " " 7	834799	818004
7 *	WH08	" " " 8	834009	817247
8 *	WH09	" " " 9	832601	817506
9 *	WH10	" " " 10	833065	819000
10	WH11	" " " 11	832550	820994
11 *	WH12	" " " 12	830318	821493
12	WH13	" " " 13	827349	825204
13 *	WH14	" " " 14	829682	819131
14 *	WH15	" " " 15	828186	815902
15 *	WH16	" " " 16	827000	815995
16 *	WH17	" " " 17	826000	809998
17 *	WH18	" " " 18	831035	812376
18 *	WM1	EPD Monitoring station	830692	812468
19 *	WM2	" " "	827859	816197
20 *	VM7	" " "	832515	817487
21 *	VM8	" " "	830368	817119
22 *	GI_A	1993 Green I. survey Point A	830490	816050
23 *	GI_B	1993 Green I. survey Point B	830265	816440
24 *	GI_C	1993 Green I. survey Point C	829645	815676
25 *	WQ7	SOM Station WQ7	827221	811455
26	LOC1	Additional location	831325	816825

Table 7.19 : Water Quality Model Calibration Parameter Values.

Parameter	Value
EX, EY	10.0
EXC, EYC	0.0
SBED0	100.0
DKC	0.23
DKN	0.23
DKAM	0.20
DKON	0.05
ASP	0.55
ALP	0.07
ASR	0.05
ALR	0.05
HNS	0.03
TIK	2.6*
QCN	7.0
QCCHL	0.15*
QCP	50.0
FREAR	1.5
RESPMAX	20.0
ROXN	0.06
SETTLING	0.08
EROSION VELOCITY	1.2
TAUD	0.10
TAUE	0.2
SSDEPMIN	3.0
EXTS	0.03
T90DARK	36.0
T90LIGHT	1.2

7.90 The model was run over 14 tides and results obtained over the final tide. The first 10 tides were run on a coarse 900 m grid, the next two on a 300 m grid and the final two on the 100 m grid. Output was produced every third time step, i.e.,hourly, starting with the first step of a tide. There were therefore the same number of points (25) output from both the 25 hour (75 step) wet season tides and the 24 hour 20 minute (73 step) dry season neap tide. The dry season spring tide of 25 hours 20 minutes (76 steps) produced 26 points.

Table 7.20 : Water Quality Model constants

Parameter	Units	Wet Season	Dry Season
Vertical diffusion coefficient	m^2/s	0.000001	0.01
Air temperature	°C	28	16
Day length	Hours	13.3	11.0
Radiation input	$MJ/m^3/day$	19	12

Baseline Conditions

7.91 For the baseline conditions, the only changes in addition to those already incorporated in the flow files were the relocation of a number of loads that would otherwise be on land together with modifications in loads taking account of proposed changes in the outfall locations associated with the Belcher Bay Reclamation. Boundary conditions used were the same as for the equivalent calibration run.

7.92 Results from the model run were output at all 26 stations in Table 7.18. The results were stored and used for comparison with the results from the scenario runs in the form of time series plots at a subset of 10 stations: WAHMO station WH14; the 4 EPD monitoring points WM1, WM2, VM7 and VM8; the three 1993 survey locations, GI_A, GI_B, and GI_C; SOM station WQ7; and additional location LOC1. The locations of the monitoring points are shown in Annex III Fig 2. Average values over a tide, at all 26 stations in Table 7.18 and in each layer, were also calculated and are presented in tables in Annex III Appendix 2 under each Scenario.

Scenarios

7.93 Scenario I required the inclusion of the submerged seawalls to a depth of -8.00m PD and 50% filling to -10.0m PD as defined at the end of Stage I of the Sequence of Works, simplified in the flow model files to represent walls and fill both being to -8.0m PD. The Full Scenario required the completion of the project with the closure of the Sulphur Channel as defined by the completion of Stage III of the Schedule of Works.

7.94 Results were generated for the same ten time-history locations that were used in the baseline simulation so that comparisons could be made. Full results are presented in Annex III Appendices 3 and 4.

Bacterial Dispersion Modelling

Introduction

7.95 The WAHMO two layer bacterial dispersion model, driven by the 50 m grid hydrodynamic data files provided by the CED, was used to investigate the possible impact of the construction, operation and final configuration of the Green Island Public Dump Reclamation on the dispersion of bacteria from the outfalls in the immediate vicinity of the works area.

7.96 The bacterial dispersion model simulates bacterial discharges by releasing many particles over a tidal cycle from a zone above an outfall representing the effective starting point of the plume after the processes of initial dilution and buoyant spreading have taken place. For a deep outfall in stratified water this zone could represent an initial field trapped at some distance below the surface. Particles are moved by the tidal currents as supplied in the flow files and diffused by a random walk process in 3 dimensions, with the length of the random walk step depending on a diffusion coefficient. Numbers of bacteria associated with each particle are evaluated according to time of day of discharge as discharge rates are assumed to follow a given diurnal pattern, and these numbers are reduced according to the appropriate decay rate taken from a diurnal profile of T90, the time taken for a 90% reduction in bacterial numbers. At each hour of the day concentrations are estimated by dividing the total number of bacteria in each model cell by the volume of that cell.

7.97 The model was previously calibrated during the WAHMO studies against dye releases through Wan Chai East Outfall into Victoria Harbour in 1987 and experiments were also carried out measuring bacterial decay in containers exposed to natural radiation during the WAHMO Study. Rates of diffusion and bacterial decay are expensive to measure for individual studies and the values used in previous studies in this area are considered acceptable for the purpose of comparing the effects of changing flow patterns on the relative changes in distribution of bacterial concentration.

7.98 Four different scenarios were investigated:

- Baseline — *model includes other reclamations and developments in place at the time of the project but not the dump itself (hydrodynamic model reference Case 2)*
- Scenario 1 — *model includes depth changes associated with completion of the seawalls to -8m PD (hydrodynamic model reference Case 3)*
- Scenario 2 — *model includes particl closure of the Sulphur Channel to 100m width (hydrodynamic model reference Case 4)*
- Full Scenario — *model includes completed reclamation (hydrodynamic model reference Case 5)*

The Baseline, Scenario 1 and Full Scenario are the same conditions as those simulated by the tidal water quality model. Scenario 2 is additional, enabled by the finer resolution of the 50m model to investigate the effects of the 100m wide channel.

7.99 Following the completion of the runs described it was observed that the loads from Outfalls Y and Z had been omitted from the loading file. A further run of the dry season spring tide baseline condition was therefore carried out with corrected loads to assess the significance of this omission. During this run a higher BOD to *E.coli* conversion factor (1.20) was applied to the remaining foul sewer outfall from Davis Street.

Loads

7.100 Details of the outfalls and their respective loads are provided in Table 7.21 below. In determining the *E.coli* values for the stormwater outfalls from the BOD loadings associated with each outfall, the Sewerage Master Plan ratio of 0.74 for Drainage Area 35 was applied.

Table 7.21. Points of discharge and *E.coli* loadings used in baseline modelling

Outfall Ref	Easting	Northing	Load 10^{10}/s	
			Original	*Re-run*
T	831850	816600	1.10	*1.10*
U,V,W	831550	816350	1.72	*1.72*
Y,Z,AA	831220	816180	0.56	*1.34*
BB	831084	816150	0.33	*0.33*
CC	831012	816140	0.22	*0.22*
DD	830877	816100	0.06	*0.06*
EE	830742	816080	0.11	*0.11*
FF	830649	816040	0.06	*0.06*
GG	830446	815960	0.02	*0.02*
HH	830252	815860	0.01	*0.01*
II	830188	815820	0.01	*0.01*
JJ*	830050	815600	0.01	-
JJ,KK,LL*	829950	815313	0.01	*0.03*
D (Foul sewer)	831048	816250	0.28	*0.45*

NB: * Because of the re-distribution of particles to simulate the revised loading pattern for the dry season spring tide re-run, the load at outfall JJ was too small to be modelled independently so this load was combined with KK-LL.

7.101 The modelled outfalls and their loads represent the cases derived for baseline conditions under the sewerage impact element of the Green Island study and are the same as those used in the two layer tidal water quality simulations. In the first scenario the coastline remains unchanged from the baseline condition and the same outfall positions were used. For Scenario 2 the width of the Sulphur Channel between Green Island and Hong Kong Island is greatly reduced as the development of the reclamation progresses and the small outfalls discharging there, HH to LL are all diverted to the South-Western edge of the reclamation. The completed reclamation, Scenario 3, assumes the same diversion.

Modelling Parameters

7.102 Parameter values which are consistent with those applied in recent relevant studies (eg Tsing Yi Duplicate South Bridge; Hong Kong Convention and Exhibition Centre Extension) have been used in the model for this study.

7.103 The diurnal profiles of loading and decay are shown in the Table 7.22 below. Loads varied between about 40% of average around 4:00 am to about 140% around 10:00 am and 8:00 pm, T90 from 40h at night to 4h through the day.

Table 7.22 **Load Variations (expressed as percentage of average load) and T_{90} (hrs), for each ½ hour period, starting at midnight.**

Period (½ hour)	Load (%)	T_{90} (hrs)
1	78.0	40.0
2	62.0	40.0
3	50.0	40.0
4	45.0	40.0
5	40.0	40.0
6	39.0	40.0
7	38.0	40.0
8	38.0	40.0
9	37.0	40.0
10	40.0	40.0
11	42.0	40.0
12	57.0	30.0
13	72.0	20.0
14	81.0	10.0
15	110.0	4.0
16	122.0	4.0
17	134.0	4.0
18	138.0	4.0
19	138.0	4.0
20	141.0	4.0
21	135.0	4.0
22	133.0	4.0
23	130.0	4.0
24	129.0	4.0
25	128.0	4.0
26	120.0	4.0
27	112.0	4.0
28	108.0	4.0
29	105.0	4.0
30	95.0	4.0
31	88.0	4.0

Table 7.22 (continued). Load Variations (expressed as percentage of average load) and T_{90} (hrs), for each ½ hour period, starting at midnight.

Period (½ hour)	Load (%)	T_{90} (hrs)
32	89.0	4.0
33	90.0	4.0
34	94.0	4.0
35	102.0	4.0
36	114.0	4.0
37	130.0	4.0
38	136.0	10.0
39	142.0	20.0
40	141.0	30.0
41	140.0	40.0
42	138.0	40.0
43	135.0	40.0
44	130.0	40.0
45	125.0	40.0
46	113.0	40.0
47	100.0	40.0
48	8[illegible].0	40.0

7.104 The horizontal diffusion coefficient is 5 m^2/s and the vertical diffusion coefficient is 0.003 m^2/s with no restriction of diffusion across the interface between top and bottom layers. The number of particles released is 100,000 and the number of tides in each run is two.

7.105 The release zone for all outfalls during the dry season was taken as the top 40% of the upper layer because the extent of stratification was expected to be small. In the wet season the same zone was used for the short storm outfalls, but for the longer foul discharge (**D** in Table 7.21) it has been assumed that the plume would initially be trapped below the surface, being sited from 40% to 80% of the upper layer below the surface.

Results Output

7.106 The display window has been chosen to contain the plumes generated by the outfalls and thus extends from over 1 km West of Green Island to nearly 1 km East of Shek Tong Tsui.

7.107 The locations for which time history plots are provided are the stations used for comparison of water quality predictions which show some influence from the outfalls in the study area. These are called WM2 and VM8 (EPD monitoring stations), GI_A, GI_B and GI_C (observation stations used in September 1993 to measure existing conditions in the vicinity of Green Island to help calibration of the water quality model) and LOC1 (some 0.5 km off Shek Tong Tsui). In the runs of the bacterial dispersion model, the computational cells are squares of side 100m centred on the stations. The positions and details of these positions are given in Table 7.23.

7.108 The plots are given in Figures 7.9 to 7.12. They show the concentrations for wet season neap tide and dry season spring tide conditions in the upper and lower layers of the water column for each scenario compared with the baseline condition. Figure 7.9 compares the "before" and "after" predictions following the revision of loads described in 7.98, and indicates that the significance of the effect of these alterations is limited.

Table 7.23 - Bacterial Dispersion Modelling Station Identification

No.	ID	Description	Easting	Northing
1	WM2	EPD Monitoring Station	827859	816197
2	VM8	EPD Monitoring Station	830368	817119
3	GI_A	1993 Green I. survey Point A	830490	816050
4	GI_B	1993 Green I. survey Point B	830265	816440
5	GI_C	1993 Green I. survey Point C	829645	815676
6	LOC1	Additional location	831325	816825

7.109 Results are also presented in the form of computer graphics animations. The discs which will allow the results to be viewed for both tides, both layers together with instructions for performing the runs have been submitted separately.

Comparison of predicted values with observed values

7.110 In the context of the very high variability normally experienced with this parameter, the range of concentrations of *E. coli* (No/100 ml) predicted by the model for the Baseline condition and those determined during the intensive water quality surveys at locations GI_A, GI_B and GI_C are broadly in agreement.

Table 7.24 - Summary of predicted and observed *E.coli* values

Season/tide	Location	Survey *E.coli* no/100ml	Model Baseline *E.coli*, no/100ml
Dry Spring	GI_A GI_B GI_C	100 - 1800 36 - 6000 160 - 1200	20 - 6000 1 - 1000 1 - 600
Wet Neap	GI_A GI_B GI_C	260 - 2700 260 - 3000 100 - 1100	10 - 6000 8 - 1200 1 - 1200

Sensitive Receivers

7.111 In the immediate vicinity of the works the only sensitive receiver in relation to bacterial quality for whom a quality objective is defined is the Kennedy Town sea water pumping station. The relevant target limit is a count less than 20,000*E. coli*/100 ml. The two time series locations which can be used to provide information on the predicted concentrations are GI_B and LOC1. The predicted values at these stations do not exceed this target for any of the modelled conditions.

Impact of Construction Activities

Sediment Plume

7.112 The construction of the sea walls could require the removal of a thickness up to 14 m of existing sediments. During their removal some of the finer materials will be lost to the water column and transported out of the immediate works area, forming a plume of increased suspended solids.

7.113 During the peak ebb tide the plume extends for 5,500 m in a south easterly direction along the north side of the East Lamma Channel giving a concentration increase in the upper 10 m thick layer which is almost totally restricted to between 1 and 5 mg/l. The +1mg/l boundary is approximately 250 m off-shore in the region of the proposed seawater intake at Telegraph Bay. In the lower layer concentrations towards the extreme end of the plume increase by between 5 and 10 mg/l.

7.114 At low water slack the plume in the upper layer begins to break up and concentrations to the immediate south west of the dredging area increase by between 10 and 15 mg/l. In the lower layer the concentrations show no further increase but the plume has extended further south-eastward.

7.115 At peak flood the plume is smaller than at peak ebb and is confined to the immediate vicinity of Green Island. At both the Kennedy Town seawater intake and the Telegraph Bay intake the concentrations of suspended solids are predicted not to increase above the background.

7.116 At high water slack the extent of the plume boundary reaches approximately 3km north by north north east of Green Island and shows no movement eastward towards the Kennedy Town seawater intake. The plume in the lower layer shows a similar northward excursion but with some spreading to the eastern side of Green Island. However this still does not reach the vicinity of the Kennedy Town seawater intake.

Impact on Sensitive Receivers

7.117 The sediment plume modelling has indicated that the power station intakes on Tsing Yi Island and the mariculture zones are sufficiently far away from the proposed works area to be unaffected by any plume of suspended solids plume generated during the works operations.

7.118 The WSD have a target value for suspended solids in the sea water to be taken for flushing purposes and it is clear from an examination of the data presented in Table 7.10 that the depth averaged annual mean concentrations reported as part of the EPD routine monitoring programme and the average reported during the Belcher Bay baseline survey meet the objective of 10mg/l. However the maximum values exceed the WQO by at least a factor of 2 and at worst by a factor of almost 7. The sediment plume modelling has predicted that at no time does the plume impinge on either the existing Kennedy Town or the proposed Telegraph Bay intake stations and consequently it will not give rise to increases in the suspended solids at the intakes.

7.119 Data for the chemical oxygen demand of sediments in the vicinity of the Western

Harbour Crossing (Ref. 7.9) and more recently from the EPD sediment quality data base is in the region of 34,500 mgO/kg sediment. Using a similar assumption to that made in the Western Harbour Crossing that the ratio of BOD to COD is 0.5 the total sediment oxygen demand is 51,750 mg/kg (equivalent to 0.05mgO/mg sediment). The sediment plume modelling has shown that, within the main body of the sediment plume, the increase in suspended solids lies within the range 1-5 mg/l. The combined BOD and COD which would be associated with such an increase is between 0.05 and 0.25 mg/l.

7.120 The sediment plume during the dredging phase remains predominantly to the west of Victoria Harbour where values of dissolved oxygen at locations GI_A, GI_B, GI_C, VM8, WH14 and WM1 are generally in excess of 70% saturation (>5mg/l). The additional oxygen demand exerted by the plume is unlikely to have any significant effect on the water quality.

7.121 Sediment-associated ammoniacal nitrogen in the Western Harbour Crossing Report is given as 10 mgN/kg dry sediment. As in the case for sediment COD this is equivalent to $1x10^{-5}$ mgN/mg dry sediment and would give rise to increases of up to $5x10^{-5}$ mgN/l in the main part of the plume. Such an increase will not have any significant effect on the development of phytoplankton.

7.122 There will be temporary deposition of fine sediment resulting from the settling from the plume. The sediment dwelling in-fauna living in the area over which the plume deposits the sediment will be capable of maintaining burrows under the conditions of the predicted rates of sedimentation of between 0.3 and 0.7 mm/day.

7.123 The certainty of the rate of loss of sediment is low and values of 3% and 5%, based on the expected range of losses, have been used in previous similar studies. The concentrations presented in this report assume a 3% loss. As a guide to sensitivity, sediment concentrations would simply have been 1.6 times those reported if the 5% value had been adopted (ie 10 mg/l and 15 mg/l would have become 16 mg/l and 24 mg/l respectively). The extent of impact of the plume is not affected by the choice of loss rate and if the higher concentrations were to be assumed the conclusions of this study would be the same.

Water Quality

7.124 Water depth will be reduced to 8 m for a large part of the Sulphur Channel which will result in alterations in the pattern of flow between Hong Kong Island and Green Island. These changes in flow will affect water quality through changes in the dilution and dispersion of pollutant discharges.

7.125 Figure 7.6 shows the locations of known foul sewer and surface and storm water discharges into the immediate vicinity of the reclamation as identified by the Central, Western and Wan Chai West Sewerage Master Plan Study (Ref 7.16). Where these are to be relocated as part of the Belcher Bay project the new locations were used in the baseline and scenario simulations of the water quality model.

Scenario 1 Dry Season Neap Tide

Dissolved Oxygen

7.126 There are no marked effects on the % saturation of dissolved oxygen. Where differences are discernable on the time history plots at GI_A, GI_B, GI_C and LOC1 they are decreases of less than 1% saturation averaged over the tidal cycle.

BOD

7.127 As in the case of dissolved oxygen there are no major differences. Those departures from the baseline conditions at GI_A, GI_B, GI_C and LOC1 are less than 0.03mg/l.

Ammoniacal Nitrogen

7.128 There are no marked increases in ammoniacal nitrogen at any of the locations; where there are increases shown on the time-history plots they are less than 0.01 mgN/l.

Oxidised Nitrogen

7.129 There are no major increases in the oxidised nitrogen concentrations; where there are increases shown in the time-history plots these are less than 0.01 mgN/l

Organic Nitrogen

7.130 There are no clear departures from the baseline conditions.

Chlorophyll

7.131 There are no changes in the concentration of Chlorophyll_a detectable at any of the locations.

Suspended Solids

7.132 There are small decreases in suspended solids concentrations at the four locations VM8, GI_A, GI_B, GI_C and LOC1 which are those closest to the project area. The greatest tidally averaged decreases are approximately 0.5 mg/l at GI_A and GI_B.

E. coli

7.133 There are small increases in the numbers of *E. coli* at the locations VM8, GI_A, GI_B, GI_C and LOC1 and also at WQ7. The largest increase, 189/100 ml, is at LOC1.

Scenario 1 Dry Season Spring Tide

Dissolved Oxygen

7.134 There are no major effects on the %-saturation of dissolved oxygen; where differences are discernable on the time history plots at VM8, GI_A, GI_B, GI_C and LOC1 they are decreases of less than 1% saturation averaged over the tidal cycle.

BOD

7.135 As in the case of dissolved oxygen there are no marked differences. Those departures from the baseline at GI_A, GI_B, GI_C and LOC1 are less than 0.03 mg/l.

Ammoniacal Nitrogen

7.136 There are no major increases in ammoniacal nitrogen at any of the locations; where there are increases shown on the time-history plots they are less than 0.01 mgN/l.

Oxidised Nitrogen

7.137 There are no marked increases in the oxidised nitrogen concentrations; where there are increases shown in the time-history plots these are less than 0.01 mgN/l

Organic Nitrogen

7.138 There are no clear differences in organic nitrogen at any of the locations.

Chlorophyll

7.139 There are no differences in the concentration of Chlorophyll_a detectable at any of the locations.

Suspended Solids

7.140 There are small decreases in suspended solids concentrations at the five locations VM8, GI_A, GI_B, GI_C and LOC1. The greatest tidally averaged decreases are approximately 1.0mg/l which occur at GI_A and GI_B.

E. coli

7.141 There are no significant changes in the numbers of *E. coli* at any of the locations.

Scenario 1 Wet Season Neap Tide

Dissolved Oxygen

7.142 There are differences discernable on the time history plots at VM8, GI_A, GI_B, GI_C and LOC1. Those in the upper layer are decreases of less than 1% saturation averaged over the tidal cycle. The decreases in the lower layer at VM8, GI_A and GI_B are 1, 3.3 and 3% respectively.

BOD

7.143 As in the case of dissolved oxygen there are some detectable small differences. There are increases above the baseline at VM8 and GI_C of less than 0.03 mg/l while those in the bottom layer at GI_A and GI_B are 0.24 and 0.1 mg/l respectively.

Ammoniacal Nitrogen

7.144 There are no clearly apparent increases in ammoniacal nitrogen at any of the locations other than at GI_A and GI_B, where the increases shown in the lower layer of the time-history plots are 0.01 mgN/l averaged over the tidal cycle.

Oxidised Nitrogen

7.145 There are no discernable increases in the oxidised nitrogen concentrations other than at VM8, GI_A and GI_B. These small increases in the lower layers and are 0.01,0.02 and 0.01 mgN/l.

Organic Nitrogen

7.146 Small increases in organic nitrogen can be seen in the lower layer at VM8, GI_A and in both layers at GI_B. At VM8 the increase is 0.01 mg/l; at GI_A 0.05; and at GI_B 0.01 and 0.03 mg/l in the upper and lower layers respectively.

Chlorophyll

7.147 There are small differences in the concentration of Chlorophyll_a observed in the bottom layers at VM8, GI_A and GI_B; the increases are 0.25, 1.07 and 0.75 mg/m^3 respectively.

Suspended Solids

7.148 There are small differences in suspended solids concentrations at the locations GI_A and GI_B, which are closest to the project area. The greatest tidally averaged decreases are approximately 0.6mg/l at GI_B.

E. coli

7.149 There are small increases in the numbers of *E. coli* at the locations GI_A, GI_B and GI_C. The largest increase, 174/100 ml, is at GI_C.

Scenario 1 Wet Season Spring Tide

Dissolved Oxygen

7.150 There are no marked effects on the %-saturation of dissolved oxygen in the time history plots. The small changes shown at VM8, GI_A and GI_B are increases up to 1.5% saturation in the upper layer when averaged over the tidal cycle.

BOD

7.151 There are no clearly discernable differences from the baseline conditions.

Ammoniacal Nitrogen

7.152 There are no clear increases in ammoniacal nitrogen at any of the locations other than at GI_A and GI_B where the increases shown in the time-history plots are 0.01 mgN/l or less, averaged over the tidal cycle.

Oxidised Nitrogen

7.153 There are no marked changes in the oxidised nitrogen concentrations at any of the locations.

Organic Nitrogen

7.154 There are no major changes in organic nitrogen at any of the locations. The differences at GI_A represent a decrease of less than 0.01 mgN/l averaged over the tidal cycle.

Chlorophyll

7.155 The small change in the concentration of Chlorophyll_a shown in the lower layer at GI_A is approximately 0.15 mg/m^3.

Suspended Solids

7.156 Small decreases in suspended solids concentrations are shown at the two locations GI_A and GI_B. The greatest tidally averaged decrease is approximately 0.8mg/l at GI_B.

E. coli

7.157 There are small changes in the numbers of *E. coli* at the locations VM8, GI_A, GI_B and GI_C. The largest increase is 110/100 ml in the lower layer at GI_B. Small decreases are also shown.

Impact of Scenario I

7.158 Differences between the Scenario I and the baseline conditions are indicated by the Water Quality model and these differences are broadly restricted to the locations in the immediate vicinity of the project area, VM8, GI_A, GI_B, GI_C and LOC1. Dilution results in the water quality at all other locations being unchanged.

7.159 During the construction phase, Scenario 1, when the seawalls are submerged to -8.0mPD the differences are small, as described in the evaluation of the time history plots. These differences are generally less than the limits of detection of the monitoring and analytical methods used to measure the parameters. On no occasion do the predicted values breach the WQO for the Western Buffer or Southern WCZs.

7.160 The nearby Belcher Bay reclamation project is likely to run concurrent with part of the Green Island Public Dump reclamation. It has been assumed for the modelling that the interception and diversion of storm water and outfall discharges associated with the Belcher Bay Reclamation will have been carried out.

Bacterial Dispersion

7.161 For both Dry Spring and Wet Neap simulations there are no significant differences from the baseline conditions at any of the six locations plotted (Figures 7.10a and 7.10b).

Mitigation Measures

7.162 Although the sediment survey undertaken in November 1993 indicated that sediments fell into the EPD "Class C" category based on the level of cadmium and lead contamination, a more recent survey to confirm this finding and investigate the depth of contamination confirmed earlier expectations that the sediments are actually "Class A". Disposal of the sediments may therefore be made in accordance with the requirements of WBTC 22/92 for clean sediment.

7.163 The use of the automatic self monitoring systems will discourage 'short dumping' and the barges should be loaded in such a way as to prevent spillage during transport.

7.164 The proposed interception of the discharges from the surface and storm water outfalls and the diversion of two foul sewer outlets along the Kennedy Town water front proposed in the Belcher Bay Reclamation were reflected in the water quality modelling. Under this configuration there were no significant deteriorations in water quality.

7.165 Following completion of the reclamation, the flows from the five surface and storm water drains discharging directly into the area to be bordered by the two sea walls will need to be diverted. In order to avoid any unacceptable impact on the waters to the north of the temporary seawall, they should be intercepted and diverted to a point to the south of the intersection of the Western sea wall and the existing coastline. Examination of the flow velocities from the 50m hydrodynamic model indicates that current speeds in this area in the upper layer for both ebb and flood tides are in excess of 0.2 m/s.

7.166 Any unsewered discharges from the properties on the hillside above Victoria Road should be intercepted and routed to the nearest functioning sewer.

Impact of Operational Activities

7.167 The material which will be placed in the area between the two sea walls to create the reclamation platform is to be construction waste of particle size less than 250 mm.

7.168 CED has defined the materials which will be accepted in Public Dumps. These materials include:

- earth;
- building debris; and
- broken rock.

In order to comply with the Dumping Licence the material must be free from marine mud, household refuse, plastic, metal, industrial and chemical waste, animal and vegetable matter and any other material considered unsuitable. Limited amounts of timber may be included mixed with otherwise acceptable material. This mixture has the potential to give rise to a localised area of increased suspended solids when placed into the site and may result in floating debris.

7.169 The operation of a rock and debris crushing plant will generate quantities of fine materials depending on the hardness of the material being processed. Due to the nature of the material to be reduced in size, rock, concrete, the material will be inert. During the site construction and the subsequent operation the local water quality may be affected by run off from rainfall from the reclamation area as a whole including the crushing plant and water from plant washing and dust suppression. The most likely pollutants from these sources will be suspended solids, spilled fuel and lubricants from plant.

7.170 During the construction and operation of the site there will be a requirement for workers on the site. Their presence gives rise to a requirement for adequate sewage treatment and disposal. Other solid and liquid waste will be generated during the construction and operation. Solid wastes will be unlikely to be within the definition of the materials to be used in the reclamation and so should not be placed in the site.

Sediment Plume

7.171 The sediment plume model was used to investigate the extent and magnitude of the plume resulting from the dumping of the waste into the site.

7.172 During the peak ebb tide the surface plume resulting from dumping into the site extends, at similar concentrations for the same distance as predicted during the dredging. In the lower layer the peak increase in concentration is higher being between 10 and 15 mg/l (or 16 and 24 mg/l if a 5% loss rate is assumed instead of 3%) but this part of the plume does not extend as far as the proposed Telegraph Bay sea water intake.

7.173 At low water slack the surface water plume is almost totally confined to within 500m of the dumping site and remains at least 250 m westwards of the Kennedy Town seawater intake. The plume in the lower layer remains predominantly to the south east of the site behaving in a similar way to the plume generated during dredging.

7.174 The peak flood tide carries the plume in the upper layer round to the east of Green Island in a northward direction for 1,000 m but the plume is held off-shore of the Kennedy Town waterfront. The plume in the lower layer follows a similar pattern to that in the upper layer in which the concentrations are higher.

7.175 At high water slack the upper layer plume is similarly restricted to the immediate area of dumping as at low water slack. The lower layer plume is generally confined to the dump area with a concentration increase of over 15 mg/l (or 24 mg/l with 5% losses) in the open section of the Sulphur Channel adjacent to Green Island.

Water Quality

7.176 Water quality modelling of the impact of the storm water and sewer discharges was not carried out because the submerged seawall configuration is the same as that assumed for the construction phase.

Bacterial Dispersion

7.177 During Dry Spring tides the low concentrations predicted at GI_B in the baseline immediately prior to midnight are not apparent during this stage of construction. However the predicted concentrations are lower than during the day and remain below the target limit of 20,000/100 ml. At GI_C the concentrations are generally lower than in the baseline and at WM2 they fall to below 1/100 ml (Figure 7.11a).

7.178 During Wet Neap tides the concentrations at GI_B are broadly similar to the baseline condition. Similar to the Dry Spring tide, the concentrations at GI_C are generally lower than the baseline values (Figure 7.11b).

Mitigation Measures

7.179 The surface runoff from the area around the crushing plant should be intercepted and settled. Trapped sediment should be disposed of within a curtained area bounded by the sea walls.

7.180 The sediment plume model indicates that the extent of the dispersion of suspended solids during placement of construction waste does not impact on the identified sensitive receivers and that the increases in concentrations in the plume are small compared with the natural range. However, it has been agreed between CED and EPD that silt curtains will be provided. It has also been agreed that dumping will be restricted to the flood tide.

7.181 An independent auditor should be established on-site whose responsibility will be to supervise the water quality, air and noise compliance monitoring and to report to EPD the results of that monitoring. Condition 7 of the sample Dumping Licence requires that the material for dumping contains no material considered unsuitable by the Dump Supervisor. The Dump Supervisor should authorise the acceptance of each load only if the material is suitable. The independent assessor would at random intervals audit the checks on the material being brought to the site to ensure compliance with the licence before the material was accepted at the site.

7.182 A limited quantity of timber is allowed to be present in the material to be dumped. Other floating material such as plastics, insulation material and packing materials will be present in the waste material. Floating booms with weighted skirts should be placed at a sufficient distance from the active dumping area to contain any floating objects. The area contained by the boom should be cleared on a regular basis by scavenging sampans to prevent accumulation and to protect the boom.

7.183 To minimise the effect of site run off on water quality drainage from the exposed surfaces should be directed through a sediment trap before discharging the settled overflow. The sediment traps should comprise below ground tanks containing baffles to reduce water velocity sufficiently to allow the majority of the solids to settle out. The traps should also include an underflow weir to retain spilled fuel and oils. Adequate provision for regular inspection and digging out of the sumps must be made to maintain the design performance. Sediment removed from the sumps should be disposed of to the upper layers of the reclamation.

7.184 If vehicle washing is to be carried out prior to their leaving the site the washings should also be routed through the sediment traps. Areas where fuel are stored and plant are refuelled should be surrounded by bunds of sufficient capacity to contain losses through spillage or leakage. Fuel storage and handling areas should be founded on an impervious base with a drainage and collection arrangement to minimise contamination in the event of fuel spillages.

7.185 During the construction and operation phase the contractor should provide and maintain adequate portable toilet facilities and arrange regular collection by vehicles/barge as appropriate to an off site disposal facility.

7.186 Covered containers should be provided for the containment of solid wastes generated on site and provision made for their emptying or removal and replacement with disposal of the waste to landfill. Containers for liquid waste, other than sewage, should be provided, waste oil from plant maintenance should be disposed of to dedicated tanks.

Impacts Following Completion

Sediment Plume

7.187 Sediment plume modelling was not required for the post-completion impact assessment.

Water Quality

7.188 The completed reclamation will divert all of the previous flow through the Sulphur Channel around the north and west sides of Green Island giving rise to further modifications of the dilution and dispersion of pollutants.

Full Scenario Dry Season Neap Tide

Dissolved Oxygen

7.189 Differences in the %-saturation of dissolved oxygen are discernable on the time history plots at VM8, GI_A, GI_B, GI_C and LOC1. At GI_C the increase is 1% over the tidal cycle while at the other sites the decreases are between 1.7 and 3.3% saturation.

BOD

7.190 As in the case of dissolved oxygen differences can be seen in the time history plots. Those increases above the baseline at VM8, GI_A, GI_B and LOC1 are less than 0.1mg/l while at GI_C the decrease is 0.05 mg/l.

Ammoniacal Nitrogen

7.191 There are small differences in ammoniacal nitrogen shown for locations VM8, GI_A, GI_B, GI_C and LOC1. These differences are increases of between 0.01 and 0.02 mg/l except at GI_C where a decrease of 0.01 mg/l is shown.

Oxidised Nitrogen

7.192 There are small changes shown in oxidised nitrogen at VM8, GI_A, GI_B, GI_C and LOC1; these are increases of 0.01 mg/l except at GI_C where a decrease of less than 0.01mg/l is shown.

Organic Nitrogen

7.193 There are no marked differences in organic nitrogen concentrations. Where there are discernable differences on the time history plots at VM8, GI_A, GI_B, GI_C and LOC1 they are all less than 0.01 mg/l.

Chlorophyll

7.194 There are no changes in the concentration of Chlorophyll_a detectable at any of the locations.

Suspended Solids

7.195 Decreases in suspended solids concentrations appear at the five locations VM7, VM8, GI_A, GI_B and LOC1. The tidally averaged decreases are up to 3.5 mg/l at VM8 and GI_A. At GI_C a small increase of 0.6 mg/l is shown.

E. coli

7.196 Increases in the numbers of *E. coli* are apparent at locations GI_A, GI_B and a decrease at GI_C. The largest increase is 455/100 ml in the lower layer at GI_B; the decrease at GI_C is 245/100 ml.

Full Scenario Dry Season Spring Tide

Dissolved Oxygen

7.197 There are small decreases in the % saturation of dissolved oxygen shown at VM8, GI_A, GI_B, and LOC1; the decreases are between 3.5 and 5.5% saturation. At GI_C an increase of 1% over the tidal cycle is shown.

BOD

7.198 Small increases in BOD from the baseline at VM8, GI_A, GI_B and LOC1 are indicated where the increases are up to 0.2 mg/l, while at GI_C the decrease is 0.06mg/l.

Ammoniacal Nitrogen

7.199 The increases in ammoniacal nitrogen at VM8, GI_A, GI_B and LOC1 are by up to 0.03 mg/l, while at GI_C the decrease is 0.01 mgN/l.

Oxidised Nitrogen

7.200 Oxidised nitrogen concentrations are shown to increase by up to 0.02 mg/l at VM8, GI_A, GI_B and LOC1, while GI_C shows a decrease of less than 0.01 mg/l.

Organic Nitrogen

7.201 The indicated increases in organic nitrogen concentrations at VM8, GI_A, GI_B and LOC1 are by a maximum of 0.04 mg/l. The decrease shown at GI_C is less than 0.01mg/l.

Chlorophyll

7.202 There are no changes in the concentration of Chlorophyll_a detectable at any of the locations.

Suspended Solids

7.203 Decreases in suspended solids concentrations are shown at the four locations VM_8, GI_A, GI_B, GI_C and LOC1. The greatest tidally averaged decrease is approximately 4.4 mg/l at GI_A.

E. coli

7.204 The numbers of *E. coli* are shown to increase at locations VM8, GI_A, GI_B and LOC1; the greatest increase being at LOC1 where the concentration rises by 452/100ml. At GI_C the concentration decreases by 300/100 ml.

Full Scenario Wet Season Spring Tide

Dissolved Oxygen

7.205 Small differences in the % saturation of dissolved oxygen are apparent in the time history plots at VM8, GI_A, GI_B, GI_C and LOC1 where there are increases up to 4.2% saturation in the surface waters averaged over the tidal cycle.

BOD

7.206 There are no clearly discernable differences from the baseline conditions.

Ammoniacal Nitrogen

7.207 There are no distinctly identifiable differences in ammoniacal nitrogen at any of the locations other than at GI_A, GI_B and GI_C where decreases shown in the time-history plots are 0.01 mgN/l or less, averaged over the tidal cycle.

Oxidised Nitrogen

7.208 There are no clear differences in the oxidised nitrogen concentrations at any of the locations.

Organic Nitrogen

7.209 There are no major changes in organic nitrogen at any of the locations. The change shown at GI_A is less than 0.01 mgN/l over the tidal cycle.

Chlorophyll

7.210 There are small increases in the concentration of Chlorophyll_a shown at VM8, GI_A, GI_B, GI_C and LOC1; the maximum shown is 0.5 mg/m^3 in the upper layer at GI_A.

Suspended Solids

7.211 The time history plots show small decreases in suspended solids concentrations at the two locations GI_A and GI_B. The greatest tidally averaged decrease is 1.8mg/l in the lower layer at GI_B.

E. coli

7.212 Small changes in the numbers of *E. coli* are shown at locations VM8, GI_A, GI_B, GI_C and LOC1. The largest increase is 460/100 ml in the lower layer at GI_A. Small decreases are also shown.

Full Scenario Wet Season Neap Tide

Dissolved Oxygen

7.213 There are differences discernable on the time history plots at VM8, GI_A, GI_B and GI_C. At GI_C the decrease is less than 1% saturation in the upper layer. At the other three sites there is a decrease in the lower layer and an increase in the upper layer. The maximum increase shown is 1.6% saturation while the decreases at GI_A and GI_B are 10.5% and 8.3%

BOD

7.214 As in the case of dissolved oxygen there are some detectable differences. There are small departures from the baseline case at VM8, GI_A, GI_B and GI_C; at GI_C the decreases are less than 0.1 mg/l. The increases in the bottom layer at GI_A and GI_B are 0.35 and 0.25 mg/l respectively and correspond to the lower oxygen saturation identified above.

Ammoniacal Nitrogen

7.215 The increases shown for ammoniacal nitrogen at locations VM8, GI_A and GI_B in the lower layer of the time-history plots are 0.02 mgN/l averaged over the tidal cycle.

Oxidised Nitrogen

7.216 Oxidised nitrogen concentrations at VM8, GI_A and GI_B are shown to increase in the lower layers by 0.01, 0.04 and 0.02 mgN/l and in the surface layer by 0.01, 0.02 and 0.01 mg/l. A decrease at GI_C of less than 0.01 mg/l is indicated.

Organic Nitrogen

7.217 Increases in organic nitrogen can be seen at LOC1 and in both layers at VM8, GI_A and GI_B; at LOC1 the increase is 0.02 mg/l, at VM8 by up to 0.04 mg/l, at GI_A 0.12 and at GI_B 0.09. At GI_C a decrease of 0.02 mg/l is shown.

Chlorophyll

7.218 Small changes in the concentration of Chlorophyll_a are shown at LOC1 as an increase of 0.6 mg/m^3. Other increases are at VM8 by 0.8 mg/m^3; at GI_A 1.6 and 2.6 in the surface and lower layers and at GI_B 1.6 and 1.9 mg/m^3. At GI_C a small decrease of less than 0.5 mg/m^3 is indicated.

Suspended Solids

7.219 Suspended solids concentrations are shown to decrease at the two locations GI_A and GI_B, which are closest to the project area. The greatest tidally averaged decrease is approximately 1.1 mg/l in the bottom layer at GI_B.

E. coli

7.220 Small increases in the numbers of *E. coli* at the locations GI_A, GI_B and the lower layer at GI_C are indicated. The largest increase, 421/100 ml, is in the bottom layer at GI_A.

Impact of the Completion - Full Scenario

7.221 Following completion of the reclamation (the Full Scenario) when the Sulphur Channel is completely closed the differences predicted by the water quality model are greater at the time of partial closure. At location GI_C the changes show improvement in water quality; however these changes are small and it is unlikely that they would be detectable by a marine water monitoring programme or result in a significant improvement in the marine environment.

7.222 The most marked effect which can be seen is that on dissolved oxygen during both wet and dry seasons and for both tide types. The changes in oxygen %-saturation with respect to the baseline conditions at the four locations where changes can be seen in the time history plots are summarised in Table 7.25. The brackish surface layer covers the entire water depth at LOC1 and so only surface layer results are present.

7.223 During the dry season the differences in % saturation are all negative but at no time will they bring about changes which would breach the WQO for the Southern and Western Buffer WCZs. During the wet season the differences indicate that for both neap and spring tides the level of saturation in the upper layer and also the spring tide lower layer would tend to be increased, albeit by small amounts. During neap tides, however, the saturation level at GI_A and GI_B is reduced to approximately 50%. Even at the ambient temperature and salinity, 25°C and 30 ppt, at a saturation concentration of 7.9 mg/l the predicted concentration (3.5 mg/l) is higher than that required to meet the WQO at 2 m above the bed.

Table 7.25 : Dissolved Oxygen % saturation changes predicted by Water Quality Model.

	Dry Season				Wet Season			
Station	Neap Tide		Spring Tide		Neap Tide		Spring Tide	
Layer	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower
VM8	-1.8	-1.8	-3.2	-3.3	+0.3	-2.4	+1.6	+1.2
GI_A	-3.1	-3.3	-5.5	-5.8	+2.2	-10.5	+4.3	+1.9
GI_B	-3.0	-3.2	-5.1	-5.4	+1.7	-8.3	+3.4	+0.9
LOC1	-2.0		-3.6	-3.6	+0.2		+2.0	

7.224 Taking all the water quality parameters into account it is unlikely that any of the changes which are predicted by the model will result in deterioration of water quality which is either detectable visually or by analysis with the exception of dissolved oxygen. The effect on DO concentrations could be detected by instruments but it is unlikely to have any discernable effect on broader environmental quality because a similar magnitude decrease does not occur for all tides and both seasons.

7.225 It has been suggested that the reclamation and Green Island be eventually developed to include domestic dwellings and associated support and recreational facilities. These will require urban drainage networks to dispose of surface and foul drainage. The disposal of the sewage should be investigated in detail as part of the development plan when the final configuration of the overall reclamation and the population density have been established.

Bacterial Dispersion

7.226 The pattern during the Dry Spring tide is similar to that seen for Scenario 2; the decline in baseline values at GI_B leading up to midnight is not apparent and a further decrease relative to the baseline can be observed at GI_C (Figure 12a).

7.227 During Wet Neap tides the pattern is similar to the partial closure of the channel but with a greater decrease in values apparent at GI_C (Figure 12b).

Mitigation Measures

7.228 The water quality modelling has indicated that the reduction of dilution and dispersion in the region of Belcher Bay gives rise to a deterioration in the water quality during dry season neap tides. The magnitude is such that the WQO is not breached and the reduction in dissolved oxygen is of short duration. It is not therefore necessary at this stage to make specific provision for interception of the outfalls; this will be required as part of the further development of the Green Island Reclamation.

7.229 It is recommended that adequate provisions are made for the collection and disposal of foul sewage be made at the planning stage of the development and that these be developed in line with the drainage plan for the whole Green Island Reclamation.

7.230 The surface drainage network should include drainage interceptors to retain fuel spillages resulting from motor vehicle accidents.

Cumulative Impacts

7.231 The water quality modelling which was carried out simulating the full scenario included all the known changes in land form which were expected to be in place at the time of the project together with the discharge of sewage through the outfall from Stonecutter Island. Thus the water quality predictions for the full scenario represent the cumulative impact of this and all other projects which will result in hydrodynamic or storm and foul water load changes.

7.232 The sediment plume modelling only predicted the increases in concentration which could result from the dredging and operation of the works area. The further development of the Green Island Reclamation into Belcher Bay will be subsequent to the completion of dredging and construction of this phase and there will be no cumulative impact of the dredging activities.

7.233 An area for the dredging of marine sands has been identified immediately to the west of the location of the project area and it is expected that dredging will take place over a two and a half year period commencing mid 1995. This latter project will clearly interact with the Green Island project which is also proposed to commence mid 1995. Consideration will need to be made of the possible impact of the dredging activity taking place for the removal of the overlying sediments and the loss of fines from the marine sands being extracted.

Marine Barging Point

Assessment of Marine Water Quality Impact

Present Water and Sediment Quality

7.234 The project area lies within the Victoria Harbour WCZ and the water quality in the open harbour represented by monitoring stations VM7 and 8 (see Figure 7.3) is summarised in Table 7.8. The water quality within the basin will be lower than in the more open and better flushed waters of the Harbour because of the presence of the two stormwater outfalls EE and FF, accumulated sediments and the restricted flushing imposed by the partially obstructive structure of the China Merchant's Wharf.

7.235 The closest sediment sampling location in Victoria Harbour is VS6 for which data are presented in Table 7.14. Results for November 1992 indicate that the sediment quality at that location fell within EPD Class C with respect to lead, Class B for chromium, copper and zinc and Class A for cadmium, mercury and nickel. It is likely that the sediments within the basin are of lower quality considering the presence of the two outfalls and an ash handling facility (adjacent to which soundings indicate that the water depth is considerably reduced, suggesting that ash has been dropped into the water).

Construction of Marine Access

Potential Impacts

7.236 Soundings for the water depth in the basin adjacent to the loading area taken in 1984 and updated in 1994 show that there is insufficient depth for barge access immediately adjacent to the seawall. However, it is considered that the need for dredging can be avoided by the use of an extended loading ramp or use of a lighter barge and it has been stipulated by CED that the construction contract for the site will not allow dredging. Marine water quality construction impacts are therefore expected to be negligible.

Marine Transport of Dump Material

Potential Impacts

7.237 Final placing of the public dump materials at the Green Island site may be either below or above water level requiring bottom dumping barges for the former while conventional derrick barges will be suitable foı the latter.

7.238 During transport, material may be lost overboard from both types of barge or from between the doors of the bottom dumping barges. Assuming that the loaded material complies with the public dump licence requirements, lost material will not be contaminated.

7.239 Following dumping and closure of the bottom doors the barge will contain sea water which will require pumping out prior to refilling at the Marine Barging Point.

7.240 Tne impact of all of these activities will be one of a suspended solids increase either as point sources or as a continuous loss during transit.

Mitigation Measures

7.241 The material should be loaded in such a way as to prevent material falling overboard during movement from the basin to the Green Island site.

7.242 Losses through leakage from the bottom should be controlled by ensuring that the bottom doors are fully closed following dumping and prior to loading.

7.243 Water retained in the barge following closure of the doors should be discharged according to current guidelines.

Site Operation

Potential Impacts

7.244 It has been assumed that, during the demolition of the incinerator, any contaminated material or ground will have been removed from the site or rehabilitated prior to hand over.

7.245 It is anticipated that loading of the barges will be from trucks reversing up ramps and tipping into barges moored below using a facility similar to that already in operation at the Aldrich Bay Public Dump Reclamation. There is potential for the public dump material to miss the barge and for material to fall from the barge into the basin; this may produce a localised temporary increase in suspended solids and, if sufficient material is lost to cause shallowing of the basin, a requirement for maintenance dredging. This additional dredging would give rise to increases in suspended solids as in the case of the original access dredging.

7.246 Material falling from the trucks on to the loading ramp and other paved and unpaved surfaces could be washed off into the harbour during the rainy seasons, either directly or via the surface water drainage network.

7.247 If, as anticipated, wheel and underbody washing facilities are recommended at the exit from the site, the washwater will be high in suspended solids which will give rise to local increases in suspended solids if allowed to run off directly into the basin. Similar results may be expected if the washwater is channelled to the existing drainage network; these also discharge to the basin although there may be some retention of solids within the system.

7.248 There will be no stockpiling of "as received" material; unacceptable material for the public dump such as reinforcement bar, steelwork and timber will be sorted from the waste and stored temporarily on the site. This material is unlikely to have any impact on water quality while being stored prior to its alternative disposal.

7.249 There will be no grading or other plant based on site and consequently no requirement for fuel storage or maintenance facilities which could give rise to run-off containing fuel or lubricant hydrocarbons.

7.250 A site office with toilet and washing facilities will be required for the site operatives which will give rise to a polluting discharge.

Mitigation Measures

7.251 Losses occurring during loading of the barges should be controlled by appropriate design of the loading ramps to ensure that material is tipped onto the mid-line of the barge, allowing even distribution. Loading of the barge should be controlled so as to prevent the mound forming in such a way as to allow material to fall overboard either within the basin or during movement.

7.252 Material dropped onto the ramp should be cleared and transferred to the barge before delivery of the next load. Rain and surface wash water should be intercepted and settled before discharge to the harbour through the surface water drains.

7.253 The site has a surface water drainage system designed to drain the present structure which discharges into the harbour although no details of the layout of the proposed site are available. It is recommended that a surface water drainage system be provided with sufficient capacity to allow for settling of solids washed into it and that the settlement chambers be emptied regularly to retain efficiency.

7.254 Discharge from the site office should be linked into the nearest available sewer.

Environmental Monitoring

Marine Transport of Materials

7.255 Checks on compliance with the recommended working practice by the barge operators through random inspections should be implemented to minimise water quality impact.

Site Operation

7.256 Checks on compliance with the recommended working practice by the site operators through random inspections should be implemented to minimise water quality impact.

Conclusions and Recommendations

Public Dump

7.257 WQOs have been identified for the gazetted Western Buffer and Southern WCZs. Parts of the Victoria Harbour WCZ have now also been gazetted in 1995, but the area around Green Island is not expected to be gazetted until 1996, when appropriate WQOs will be applied.

7.258 With the exception of the phytoplankton, nutrients and total inorganic nitrogen (TIN) there is compliance with the WQOs of the Southern and Western Buffer WCZs.

7.259 In Victoria Harbour TIN and dissolved oxygen in the bottom water would not comply with the WQOs if the same objectives as for the Southern and Western Buffer WCZs were applied to the Victoria Harbour WCZ.

7.260 There are no sensitive receivers in the immediate works area. The nearest sensitive receiver which could be impacted by the works is the Kennedy Town salt water pumping station.

7.261 The maximum suspended solids concentrations in Victoria Harbour exceed the target guidelines for water to be taken for flushing purposes (10 mg/l) but are below the guideline value for pump wear (140 mg/l). Concentration maxima currently reach 57mg/l.

7.262 Sediment plume modelling has shown that the mariculture zones at Ma Wan, Sok Kwu Wan and Lo Tik Wan, and the power station intakes at Tsing Yi and Lamma Island lie outside the +1mg/l suspended solids increase plume contour. The proposed sea water pumping station at Telegraph Bay, the existing stations in West Kowloon and along the north shore of Hong Kong Island are similarly outside that contour. Based on these results, the suspended solids elevation will not be detectable and will have no impact on them.

7.263 The environmental impacts on adjacent water bodies are considered to be minimal and acceptable based on the results of the modelling work. Nevertheless, after the modelling work had been completed, and in order to mitigate as far as possible any environmental impacts which might result from the occasional encroachment of the plume on the eastern shore of Green Island or in the East Lamma Channel, it was agreed between CED and EPD that the western seawall would be built as early as possible in the programme, and that dumping operations would take place only on a rising or slack tide.

7.264 The latest sediment surveys of the area, which investigated the depth of contamination using triplicate samples, confirmed that the samples were within the "Class A" category. As a result no special measures will be required during transport and disposal.

7.265 It is predicted that the suspended solids concentration at the Kennedy Town salt water pumping station will not increase above background levels. However, increases of a few mg/l may be expected a short distance offshore from the intake. It is recommended that precautionary provision be made that, should the measured flood difference concentration of suspended solids at the monitoring station offshore of the Kennedy Town salt water pumping station increase by more than 10mg/l above the baseline flood difference as a result of the works, then a silt screen should be installed around the station intake.

7.266 Predicted sediment deposition rates of 0.3-0.7mm/d will not significantly affect the sediment benthic in fauna beneath the plume.

7.267 The additional oxygen demand imposed on the water column by dispersed sediment resulting from dredging will range between 0.05 and 0.25 mg/l. Existing oxygen demand levels are in the range 1-2 mg/l and this increase is unlikely to have any significant effect on water quality.

7.268 The construction, operation and completion of the public dump reclamation give rise to no significant or unacceptable deteriorations in bacteriological quality of the marine waters in the immediate vicinity of the works and hence further afield. No mitigation measures are therefore necessary.

7.269 Floating booms with skirts should be used to retain floating timber, insulation material and plastics adjacent to the dumping area. Accumulated material should be removed daily.

7.270 The construction of the submerged seawalls and the subsequent filling will not give rise to measurable deterioration in water quality due to the storm and foul sewer discharges into the harbour.

7.271 The present surface water discharges into the works area from Victoria Road should be diverted to the south of the western seawall where currents exceed 0.2 m/s.

7.272 Sewage derived from residential blocks built on the final reclamation should be treated at the Strategic Sewage Treatment works at Mount Davis.

Marine Barging Point

7.273 Soundings for the water depth in the basin adjacent to the loading area taken in 1984 and updated in 1994 show that there is insufficient depth for barge access immediately adjacent to the seawall. However, it is considered that the need for dredging can be avoided by the use of an extended loading ramp or use of a lighter barge and it has been stipulated by CED that the construction contract for the site will not allow dredging. Marine water quality construction impacts are therefore expected to be negligible.

References

7.1 Marine Water Quality in Hong Kong. Results from the EPD marine water quality monitoring programme for 1988. Marine Section, Water Policy Group. EPD Hong Kong Government, 1989.

7.2 Marine Water Quality in Hong Kong. Results from the EPD marine water quality monitoring programme for 1989. Marine Section, Water Policy Group. EPD Hong Kong Government, 1990.

7.3 Marine Water Quality in Hong Kong. Results from the EPD marine water quality monitoring programme for 1990. Marine Section, Water Policy Group. EPD Hong Kong Government, 1991.

7.4 Marine Water Quality in Hong Kong. Results from the EPD marine water quality monitoring programme for 1991. Marine Section, Water Policy Group. EPD Hong Kong Government, 1993.

7.5 Baseline Water Quality Report Belcher Bay Link. Highways Department. August 1993.

7.6 Green Island Reclamation Model Validation Field Measurement. Green Island Reclamation (Part) Public Dump, Draft Final Report EIA, December 1993.

7.7 Green Island Link Preliminary Feasibility Study Volume 4. PAPM Consultants.

7.8 Analytical Results of Sediment Sampling Exercise. Green Island Reclamation (Part) Public Dump, Draft Final Report EIA, December 1993.

7.9 Western Harbour Crossing Study Volume 5, Environmental Assessment. Western harbour Crossing Consultants. Highways Department Hong Kong Government.

7.10 Sewage Strategy Study, Working Paper 2, Water Quality Objectives. Watson Hawksley. EPD Hong Kong Government.

7.11 Assessment of the Environmental Impact of Marine Fish Culture in Hong Kong. Ove Arup & Partners, Final Report. EPD Hong Kong Government. 1991.

7.12 Hong Kong Government, EPD. 1992. Technical Circular No (TC) No 1-1-92, Classification of Dredged Sediments for Marine Disposal.

7.13 Not used.

7.14 Works Branch Technical Circular No.22/92 Marine Disposal of Dredged Mud. Ref WB(W)209/32/96(92) Pt.II. 1992.

7.15 Disposal of Spoil at South Tsing Yi, An Assessment of the Stability and Losses of Dumped Spoil. Hydraulics and Water Research (Asia) Ltd Report HWR 064, May 1993. The sediment plume simulation for the operational phase modelled the losses

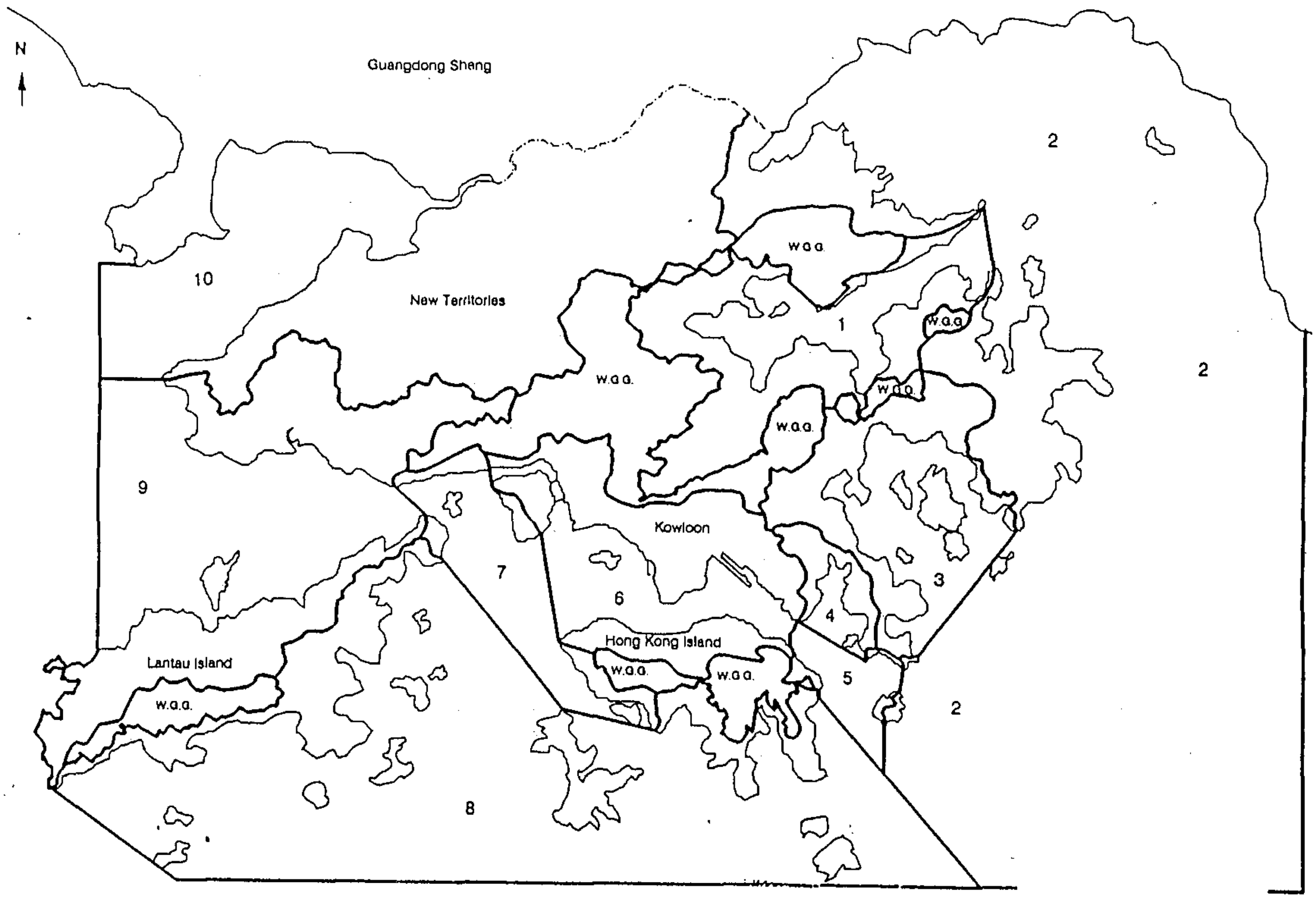
7.16 Central, Western and Wan Chai West Sewerage Master Plan Study. Balfours International (Asia) Final Report. EPD, Hong Kong Government, 1991.

7.17 Green Island Link Preliminary Feasibility Studies. An Assessment of Bed Stability. Hydraulics and Water Research (Asia) Ltd Report HRA 026, July 1991.

7.18 Green Island Link Preliminary Feasibility Studies. An Assessment of Scour, Deposition and Stability of Rock Armour. Hydraulics and Water Research (Asia) Ltd Report HRA 033, November 1991

7.19 Estuarine Muds Manual, HR Wallingford Report SR 309, May 1992.

7.20 Green Island Sediment Analysis - April 1994 Survey. Interim Report. Severn Trent Laboratories, April 1994.



Legend

Water Control Zones

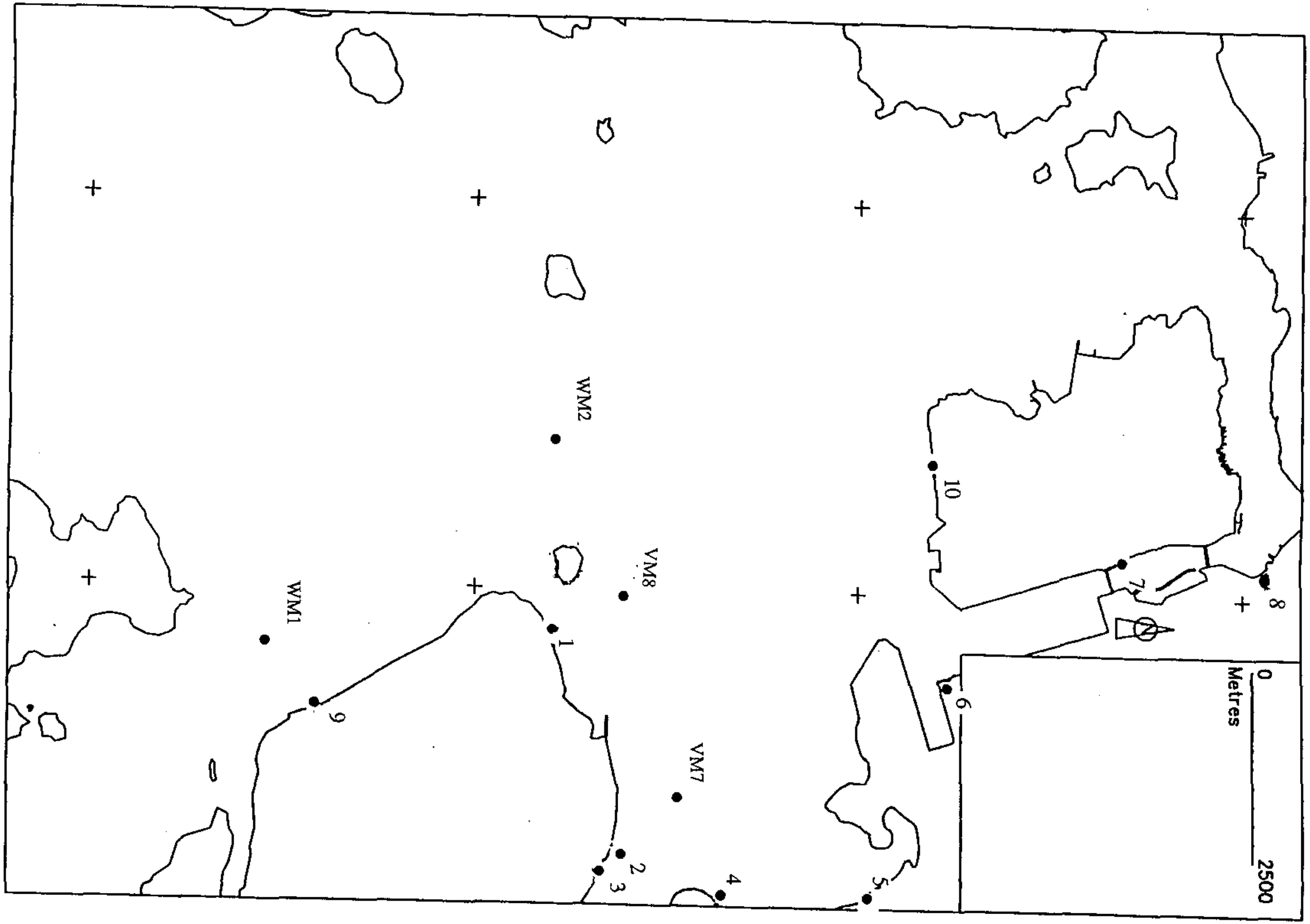
1 Tolo: 1987
2 Mirs Bay: 1990
3 Port Shelter: 1989
4 Junk Bay: 1989
5 Eastern Buffer: 1993/94
6 Victoria Harbour: 1995
7 Western Buffer: 1995
8 Southern Waters: 1988
9 North Western Waters: 1991
10 Deep Bay: 1990
W.G.G. Water Gathering Ground

0 5 10km

GREEN ISLAND RECLAMATION
(PART) -PUBLIC DUMP
FINAL REPORT (EIA)

Figure No. 7.1

Gazetted Water Control Zones



Legend:

●

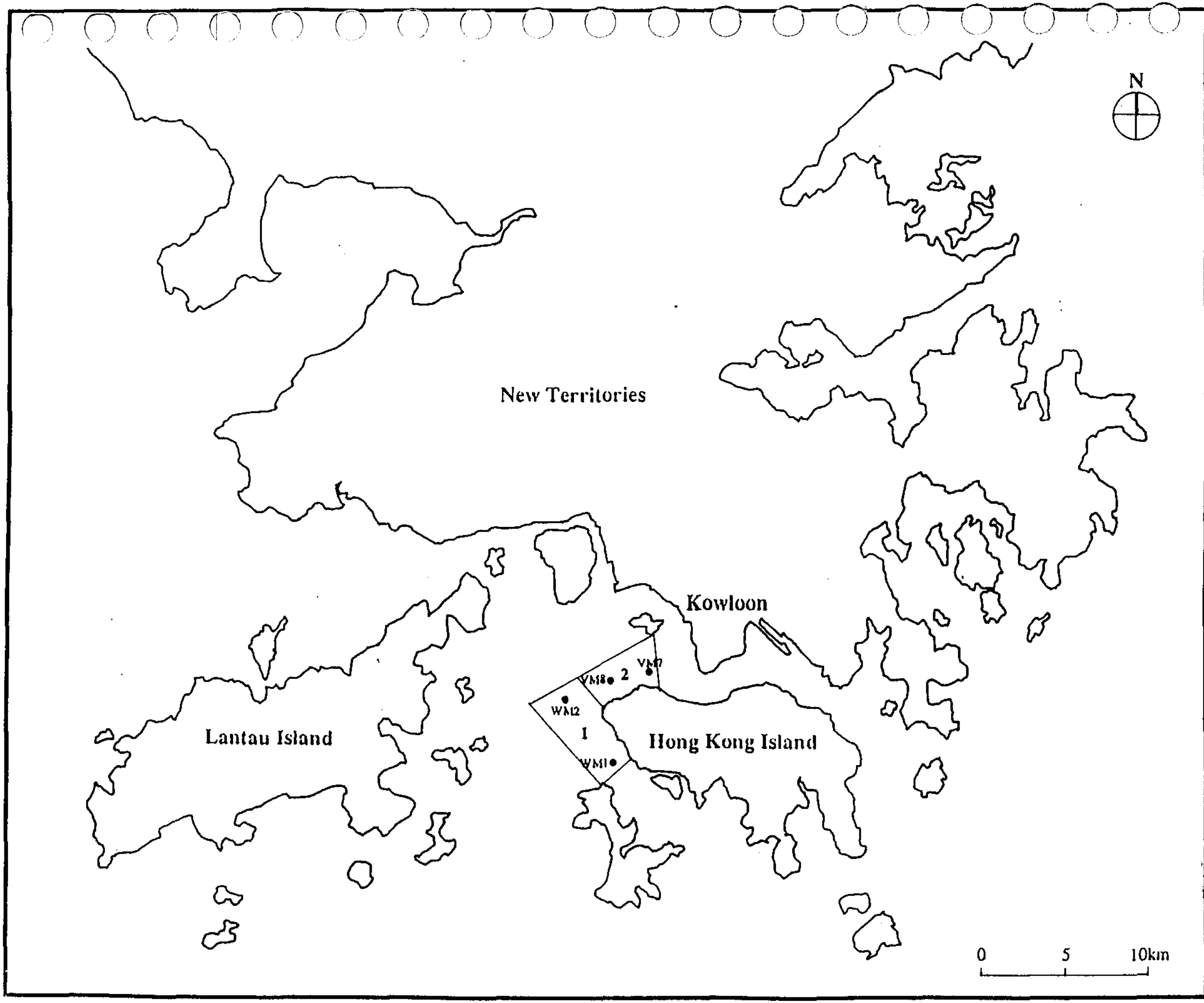
1 Kennedy Town SW P/S
2 Prince Philip Dental Hospital SW P/S
3 Wing On Centre & WSD SW P/S
4 Kowloon South SW P/S
5 Cheung Sha Wan SW P/S
6 SW P/S
7 Tsing Yi SW P/S
8 Tsuen Wan SW P/S
9 Proposed YTelegraph Bay SW P/S
10 Tsing Yi Power Station P/S

VM7, VM8, WM1, WM2 - EPD Sediment Sampling Locations

GREEN ISLAND RECLAMATION (PART) - PUBLIC DUMP FINAL REPORT (EIA)

Figure No. 7.2

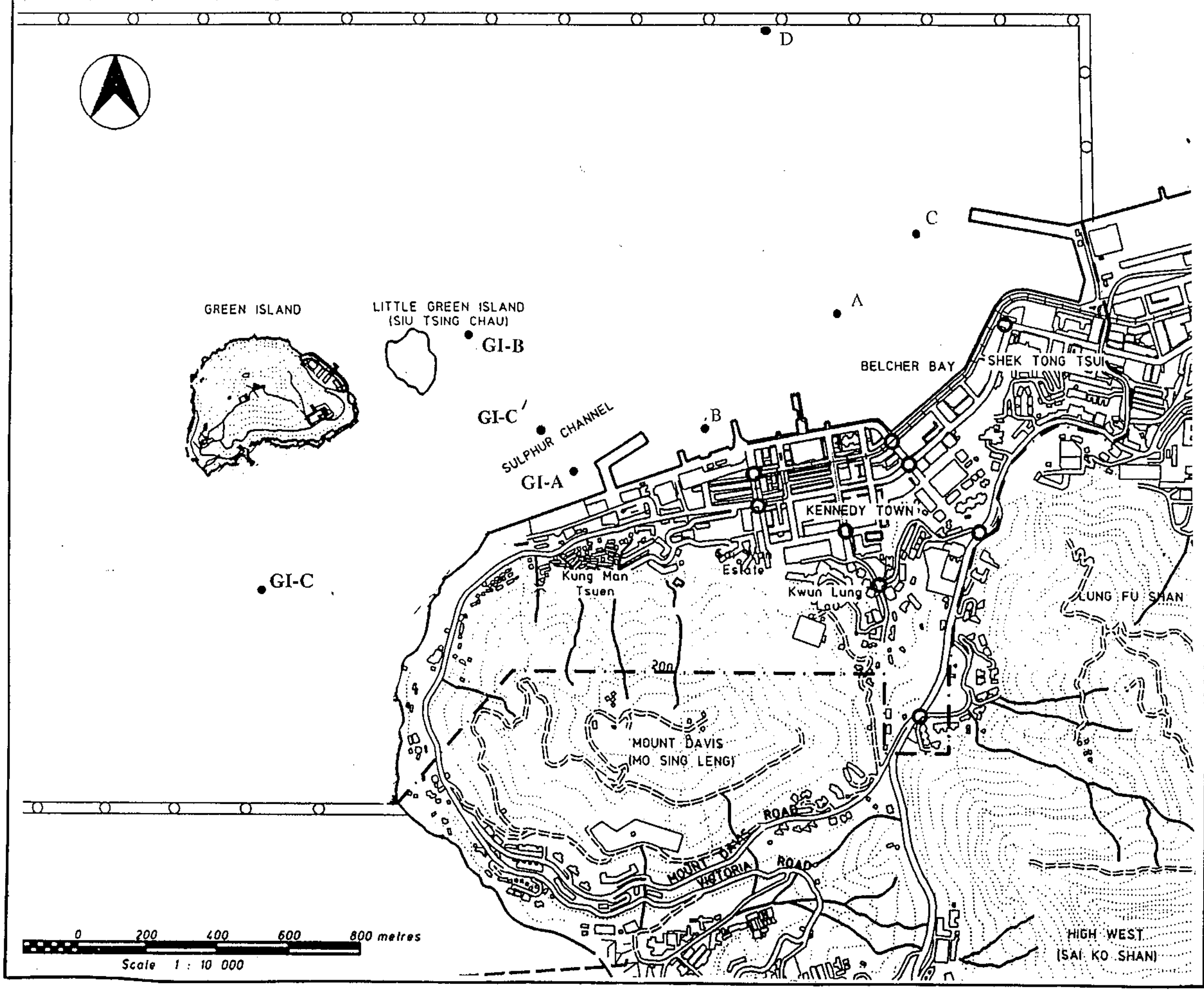
Locations of Marine Water Intakes and EPD Marine Water Monitoring Stations



GREEN ISLAND RECLAMATION (PART) - PUBLIC DUMP FINAL REPORT (EIA)

Figure No. 7.3

EPD Water Quality Sampling Locations



Legend:

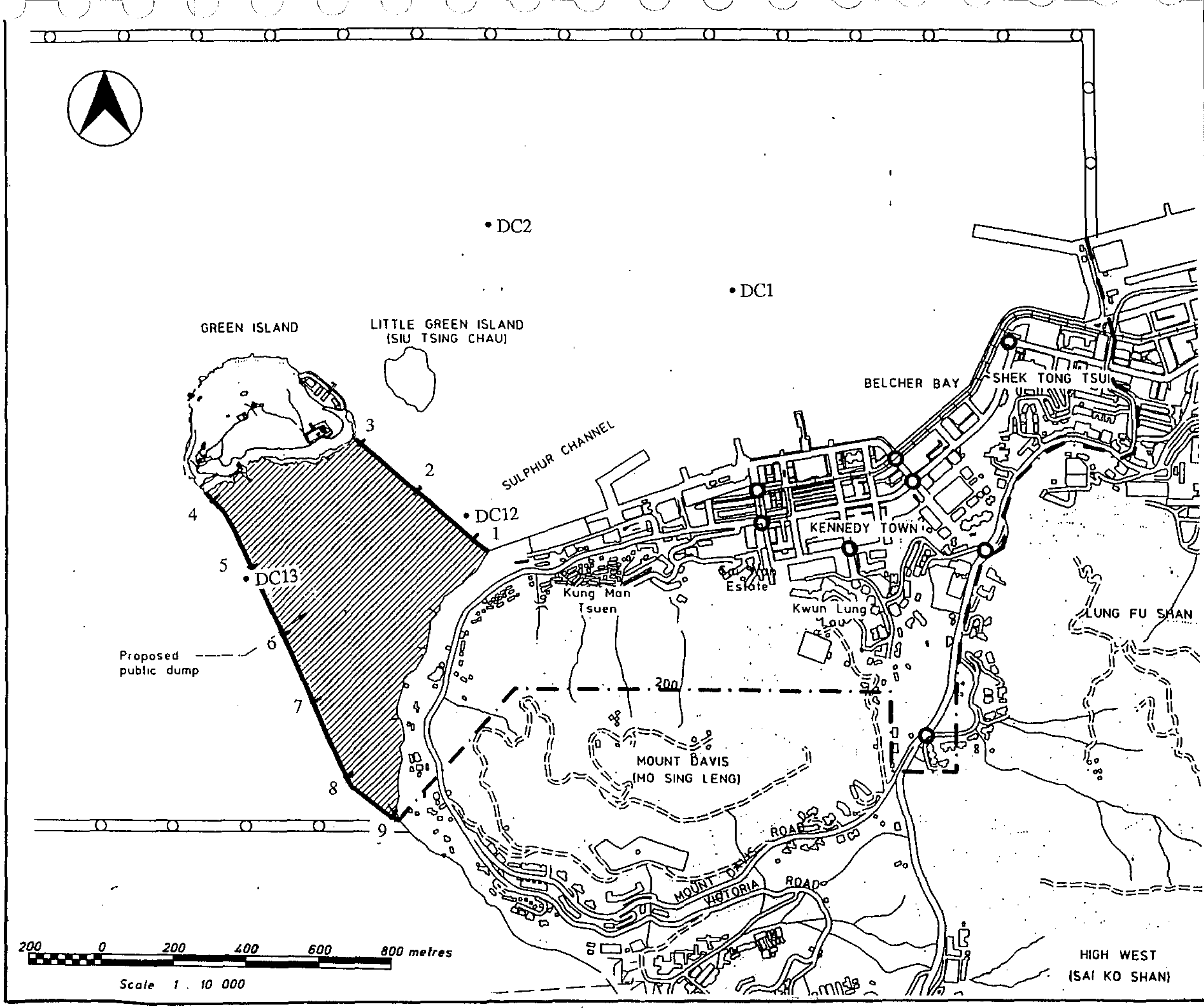
A, B, C, D
Belcher Bay

GI-A, GI-B, GI-C
Green Island

GREEN ISLAND RECLAMATION (PART) -PUBLIC DUMP FINAL REPORT (EIA)

Figure No. 7.4

Belcher Bay and Green Island Survey - Water Quality Sampling Locations



Legend:

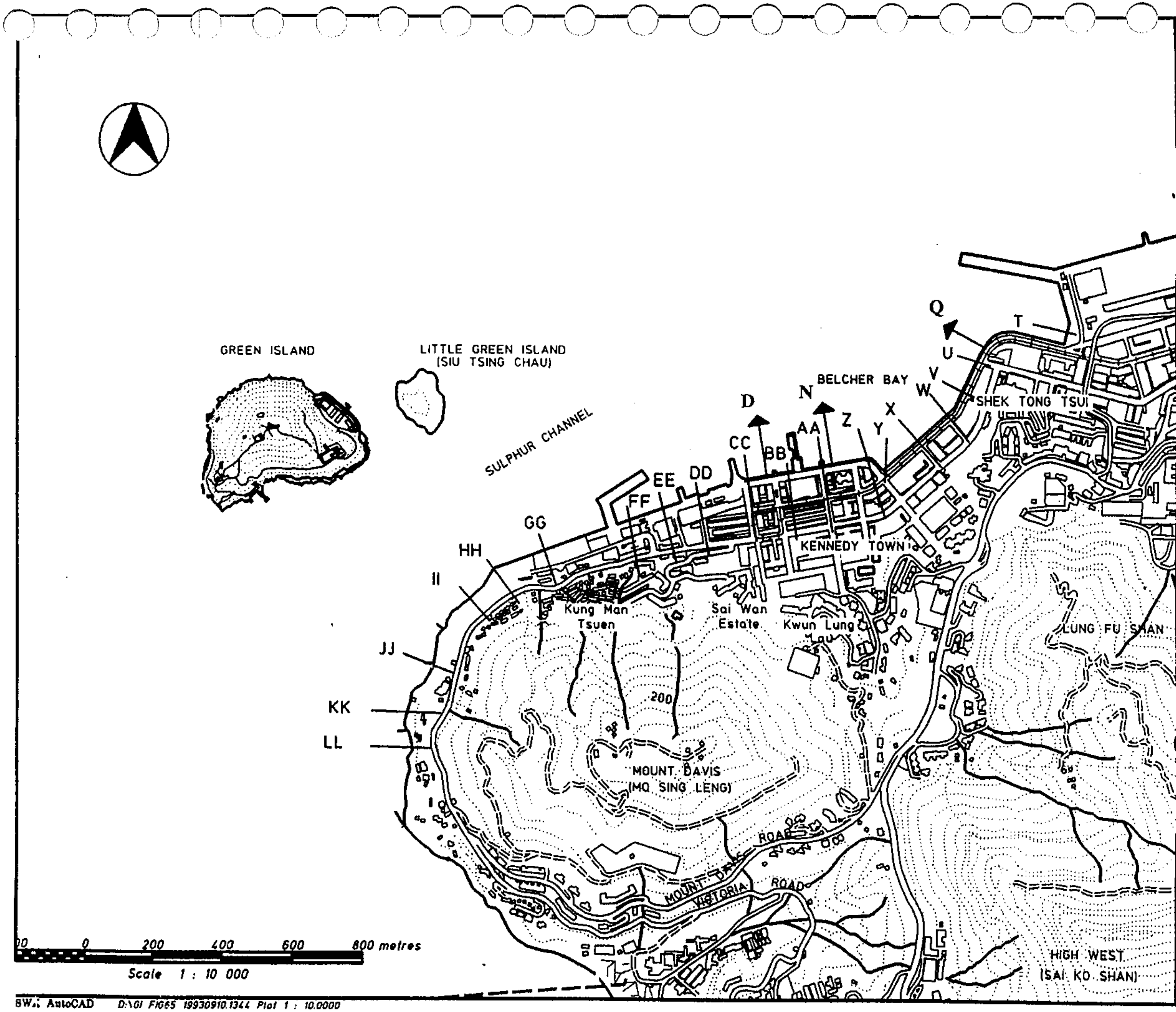
1, 2, 3, 4, 5, 6, 7, 8, 9
Green Island Reclamation (Part) Public Dump EIA

• DC1, DC2, DC12, DC13
Green Island Feasibility Study

GREEN ISLAND RECLAMATION (PART) -PUBLIC DUMP FINAL REPORT (EIA)

Figure No 7.5

Sediment Sampling Locations



Legend

Foul Sewer Outlet

Stormwater Outlet

Note:

1. Letter codes shown for stormwater outlet are those given in Central, Western and Wanchai Sewerage Master Plan.

Foul Sewers:

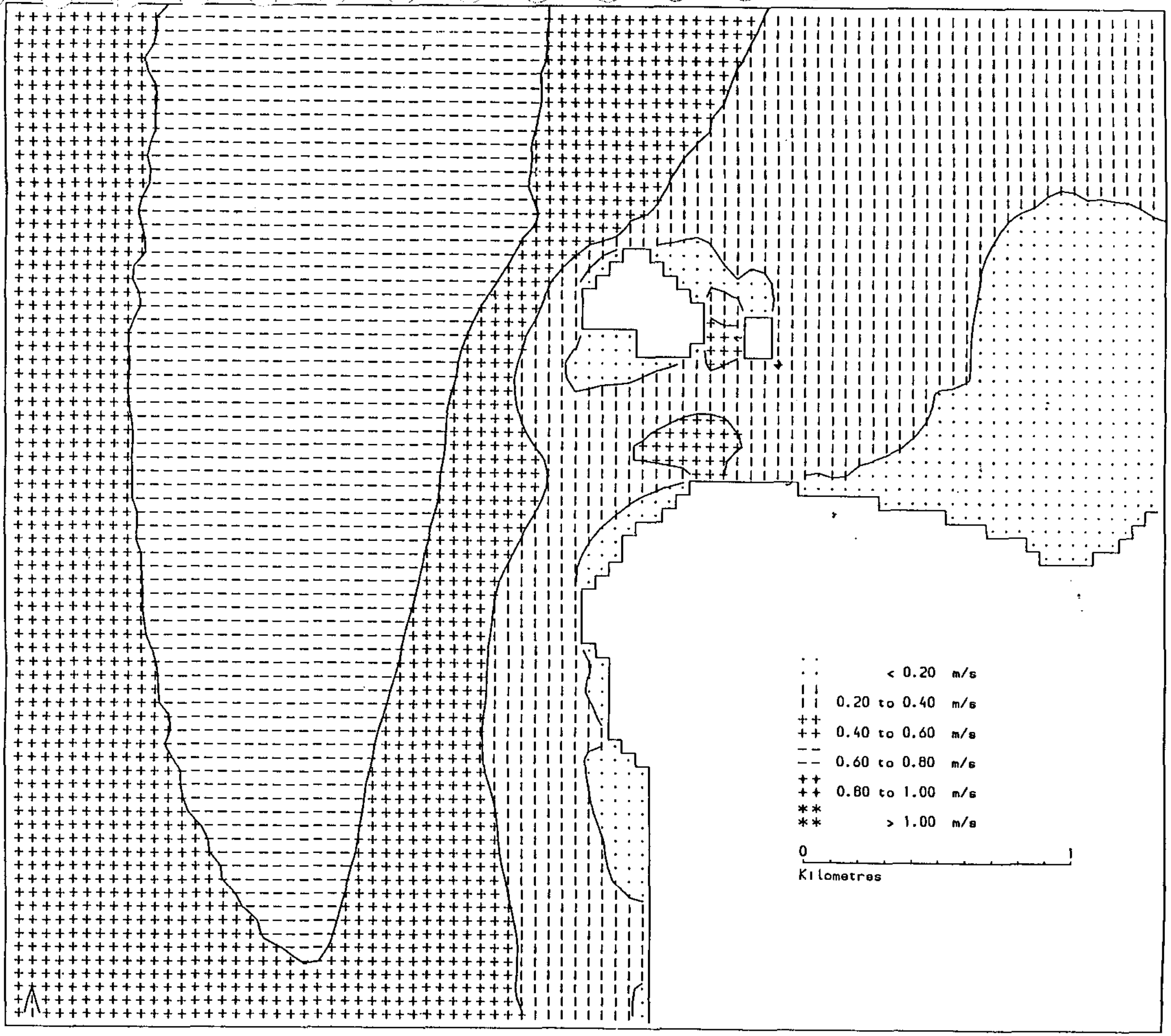
D = Davis St
N = North St
Q = Queens Road East

GREEN ISLAND RECLAMATION (PART) - PUBLIC DUMP
FINAL REPORT (EIA)

Figure No. 7.6

Foul Sewer and Stormwater Outlets

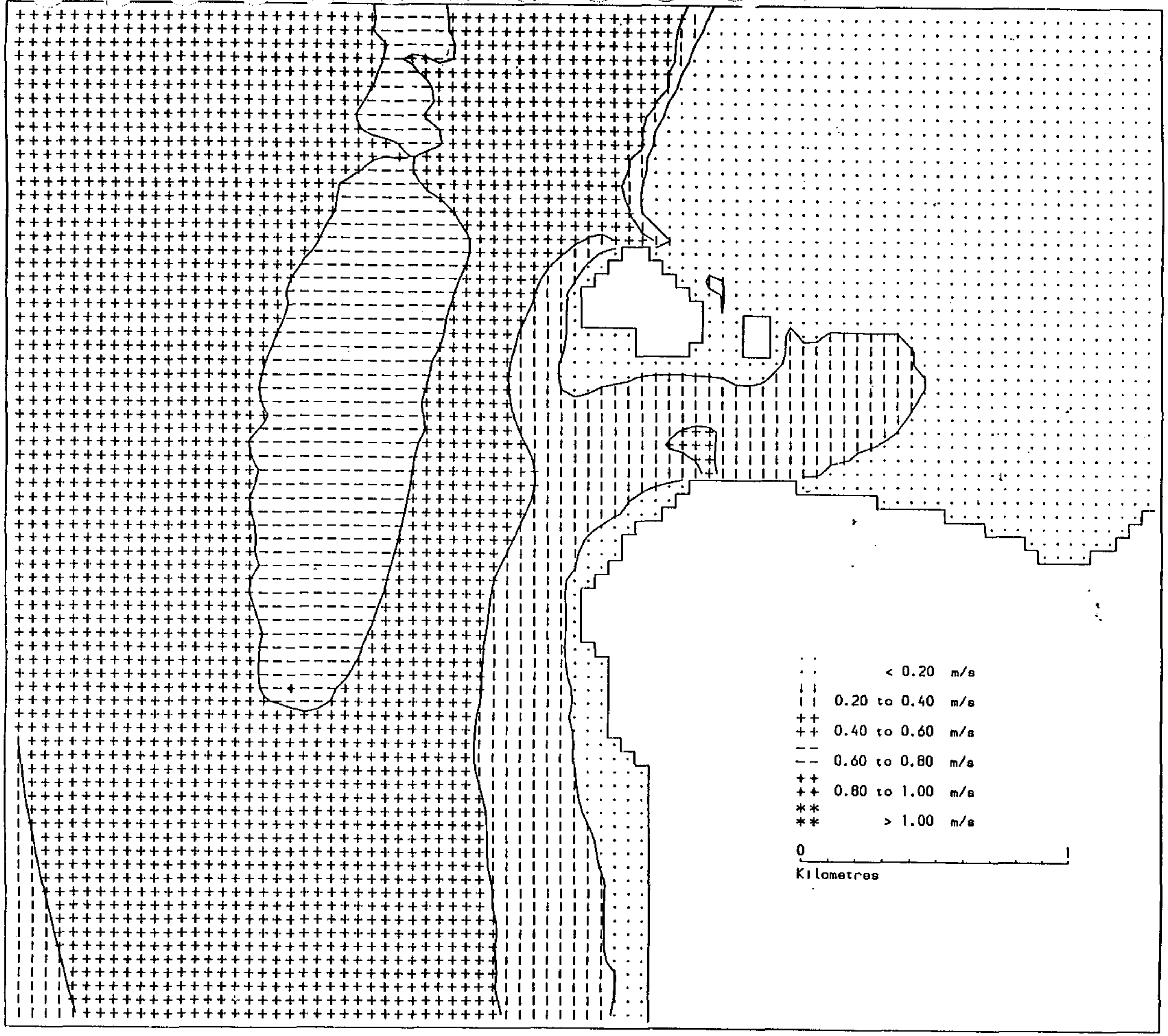
SW.: AutoCAD D:\GI FIGES 19930910.1344 Plot 1 : 10.0000



GREEN ISLAND RECLAMATION (PART) - PUBLIC DUMP FINAL REPORT (EIA)

Figure No.	7.7a

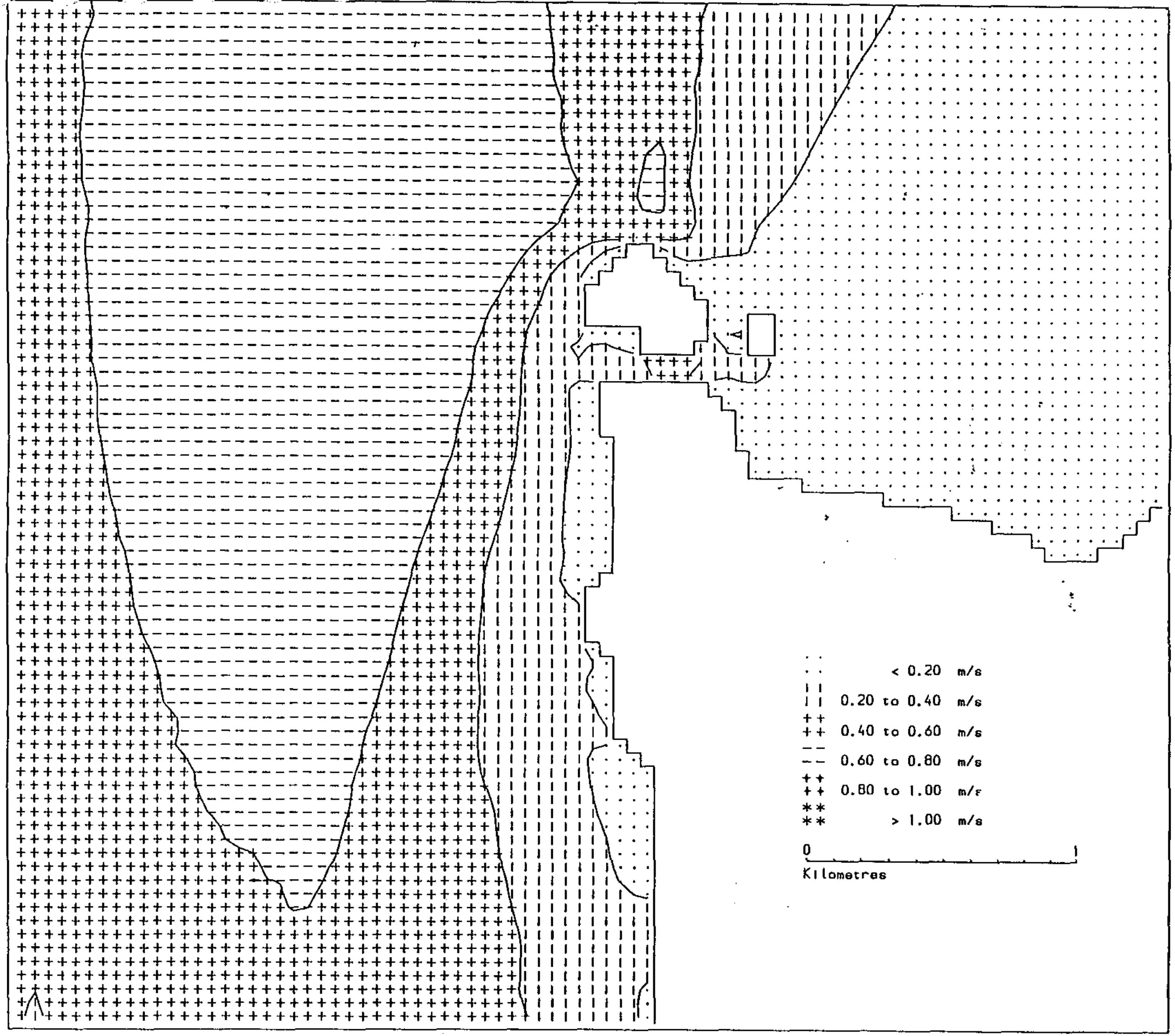
(50m Grid Model) - Upper Dry Season Spring Peak Speed - Case 1



GREEN ISLAND RECLAMATION (PART) -PUBLIC DUMP FINAL REPORT (EIA)

Figure No.	7.7b

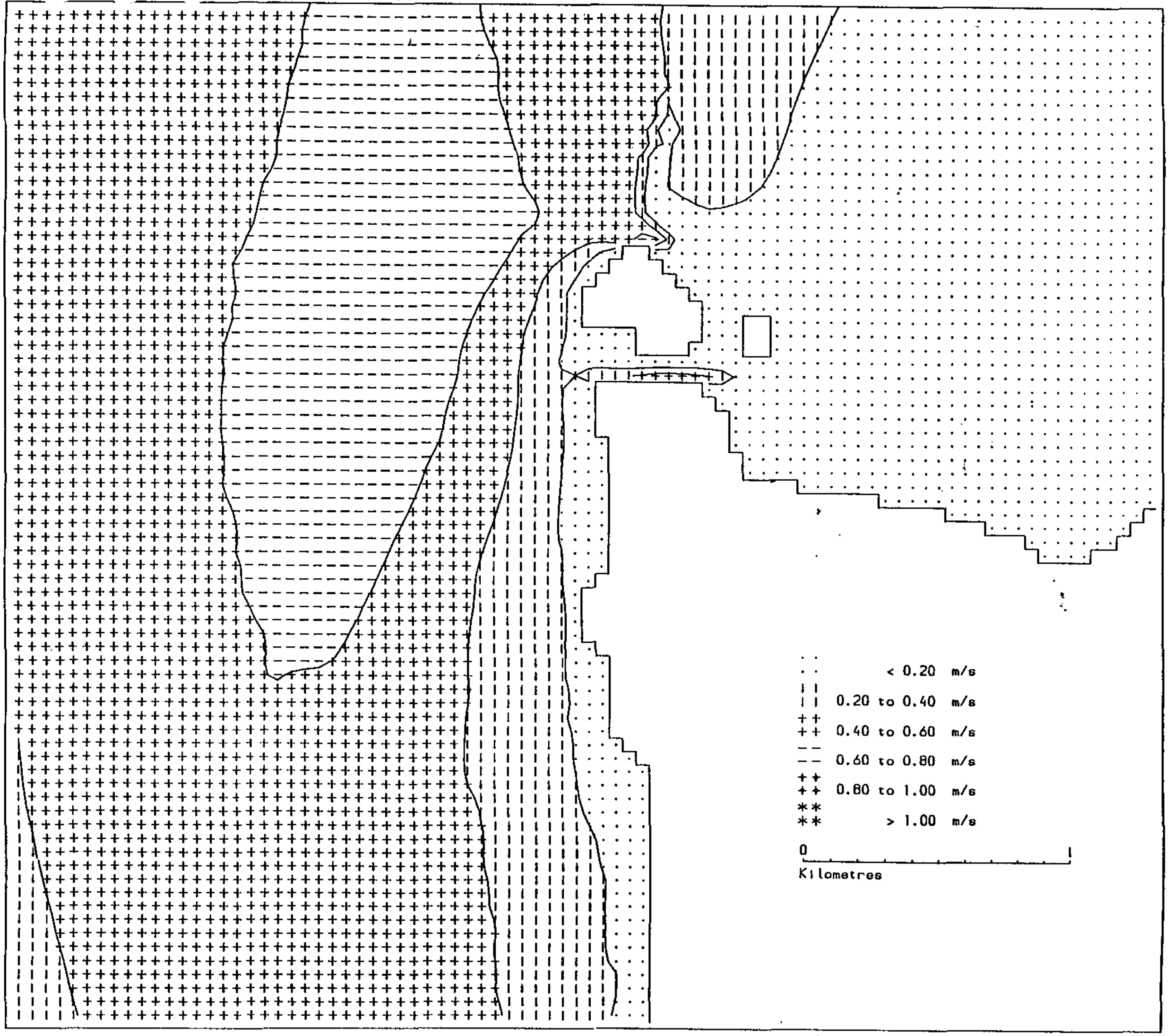
(50m Grid Model) - Lower Dry Season Spring Peak Speed - Case 1



GREEN ISLAND RECLAMATION (PART) - PUBLIC DUMP FINAL REPORT (EIA)

Figure No.	7.8a

(50m Grid Model) - Upper Dry Season Spring Peak Speed - Case 4



GREEN ISLAND RECLAMATION (PART) - PUBLIC DUMP FINAL REPORT (EIA)

Figure No. 7.8b

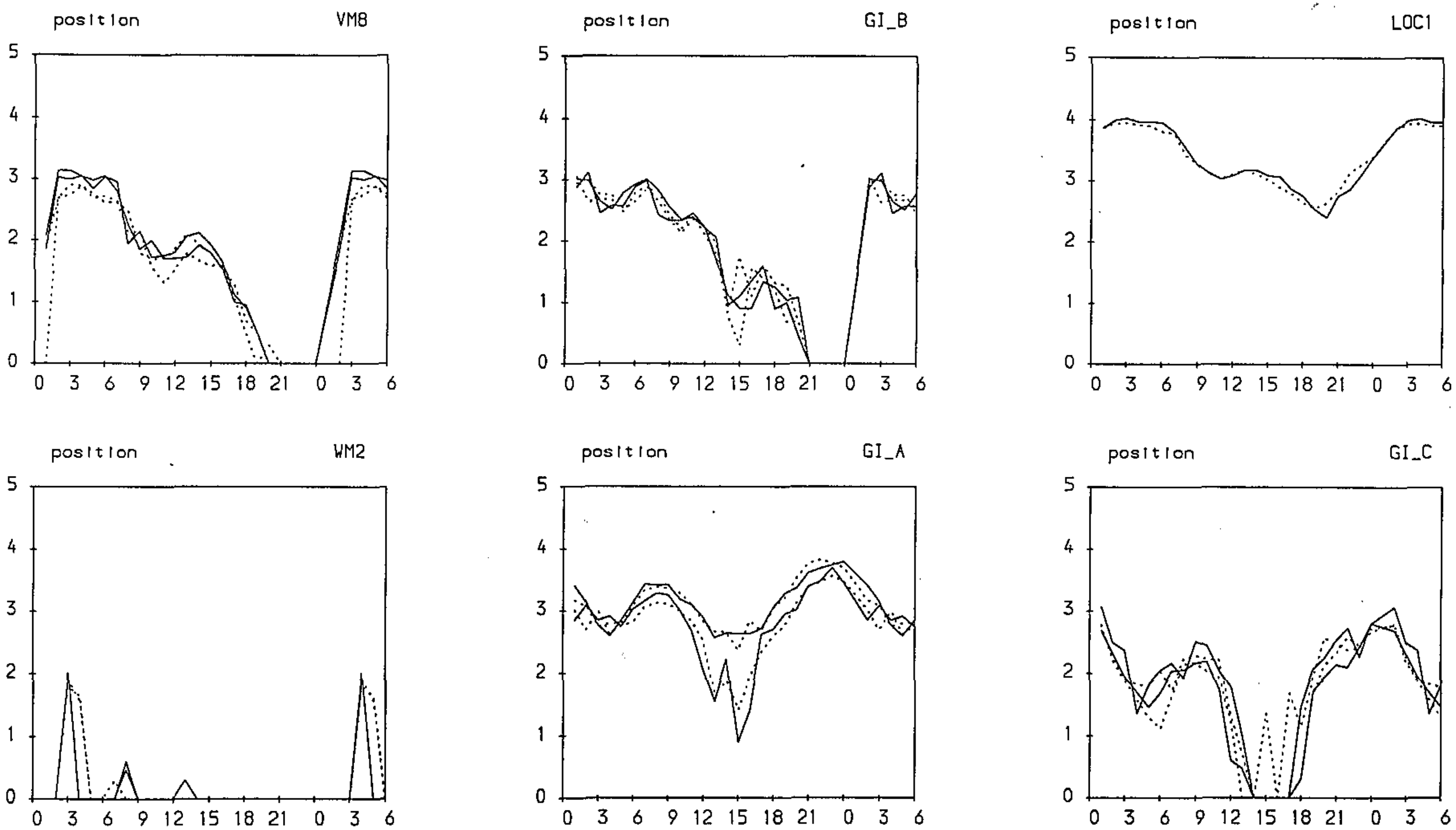
(50m Grid Model) - Lower Dry Season Spring Peak Speed - Case 4

Green Island Dry Spring Old and New baseline (Case 2)

E.Coli (no/100ml) against time (log to base 10 on y-axis)

2 Layer, 50m grid 15 April 1994 —— New base .... Old base

Observed symbols: * Upper layer, ▵ Lower layer



GREEN ISLAND RECLAMATION
(PART) - PUBLIC DUMP
FINAL REPORT (EIA)

Figure No. 7.9

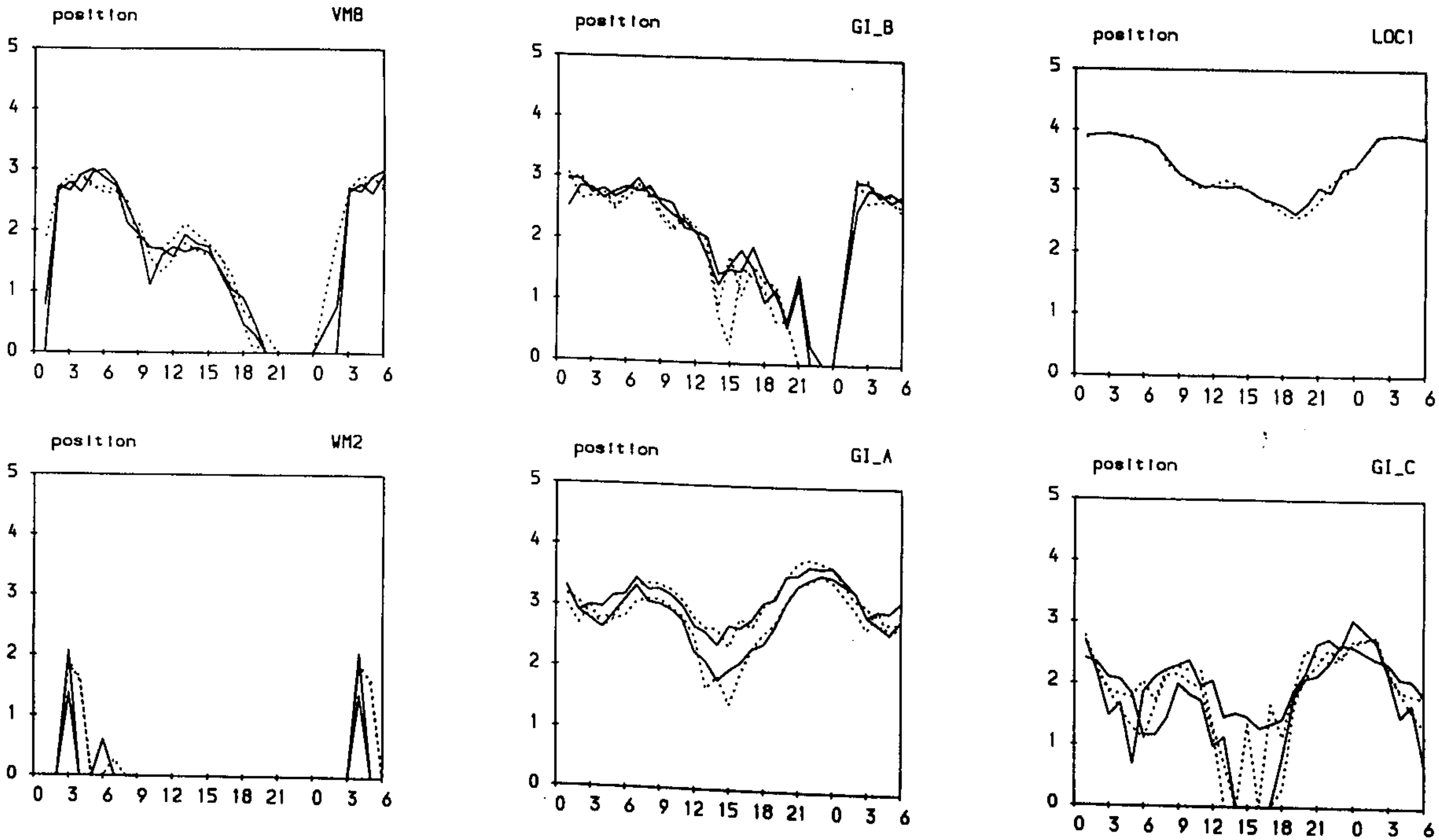
Bacterial Dispersion
Model Results

Green Island Dry Spring Scenario 1 (Case 3)

E.Coli (no/100ml) against time (log to base 10 on y-axis)

2 Layer, 50m grid 21 Dec 1993 —— Scen. 1 .... Baseline

Observed symbols: * Upper layer, ▵ Lower layer



GREEN ISLAND RECLAMATION (PART) - PUBLIC DUMP FINAL REPORT (EIA)

Figure No.	7.10A

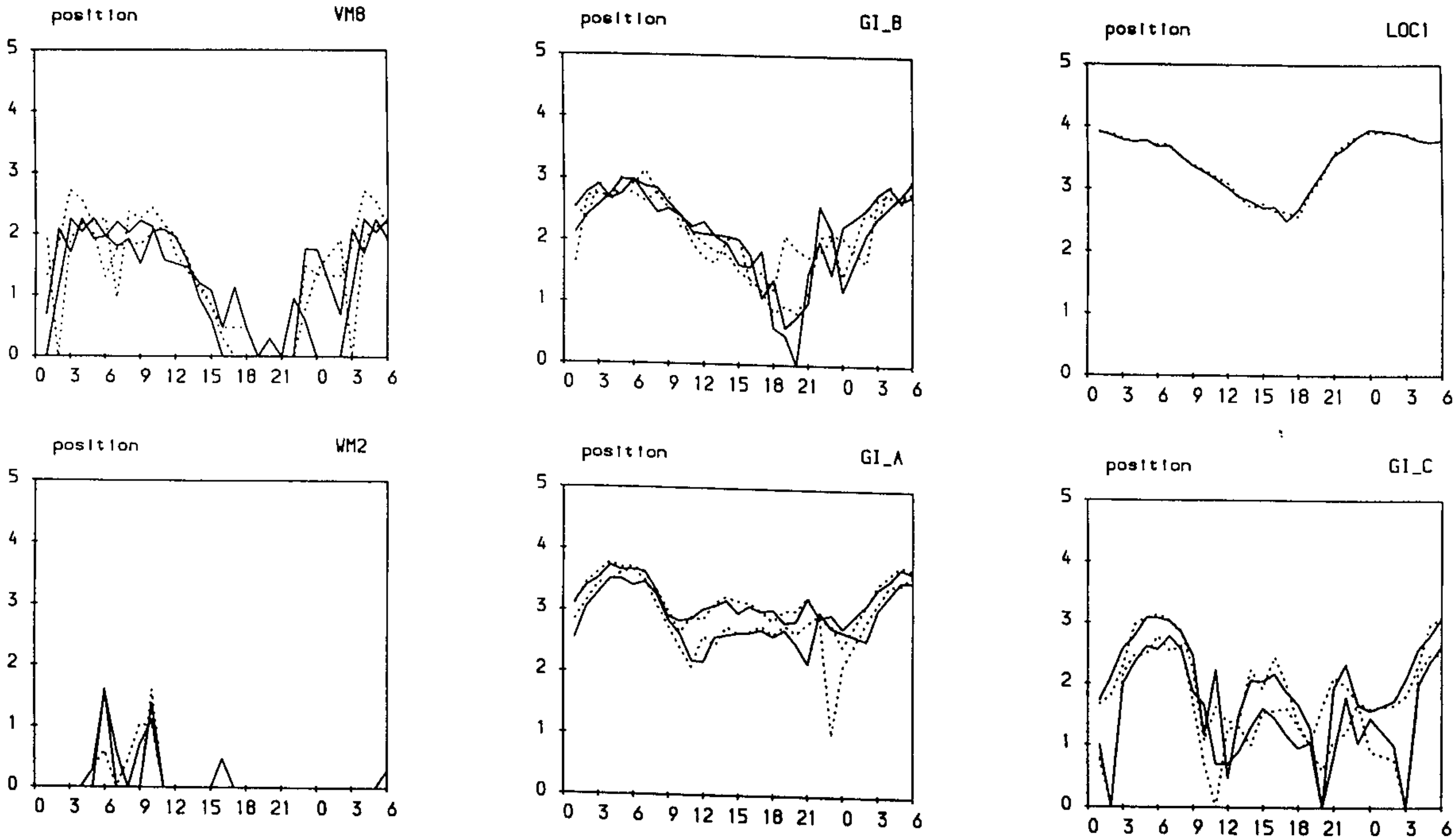
Bacterial Dispersion Model Results

Green Island Wet Neap Scenario 1 (Case 3)

E.Coli (no/100ml) against time (log to base 10 on y-axis)

2 Layer, 50m grid 22 Dec 1993 —— Scen. 1 .... Baseline

Observed symbols: * Upper layer, ▵ Lower layer



GREEN ISLAND RECLAMATION (PART) - PUBLIC DUMP FINAL REPORT (EIA)

Figure No.	7.10B

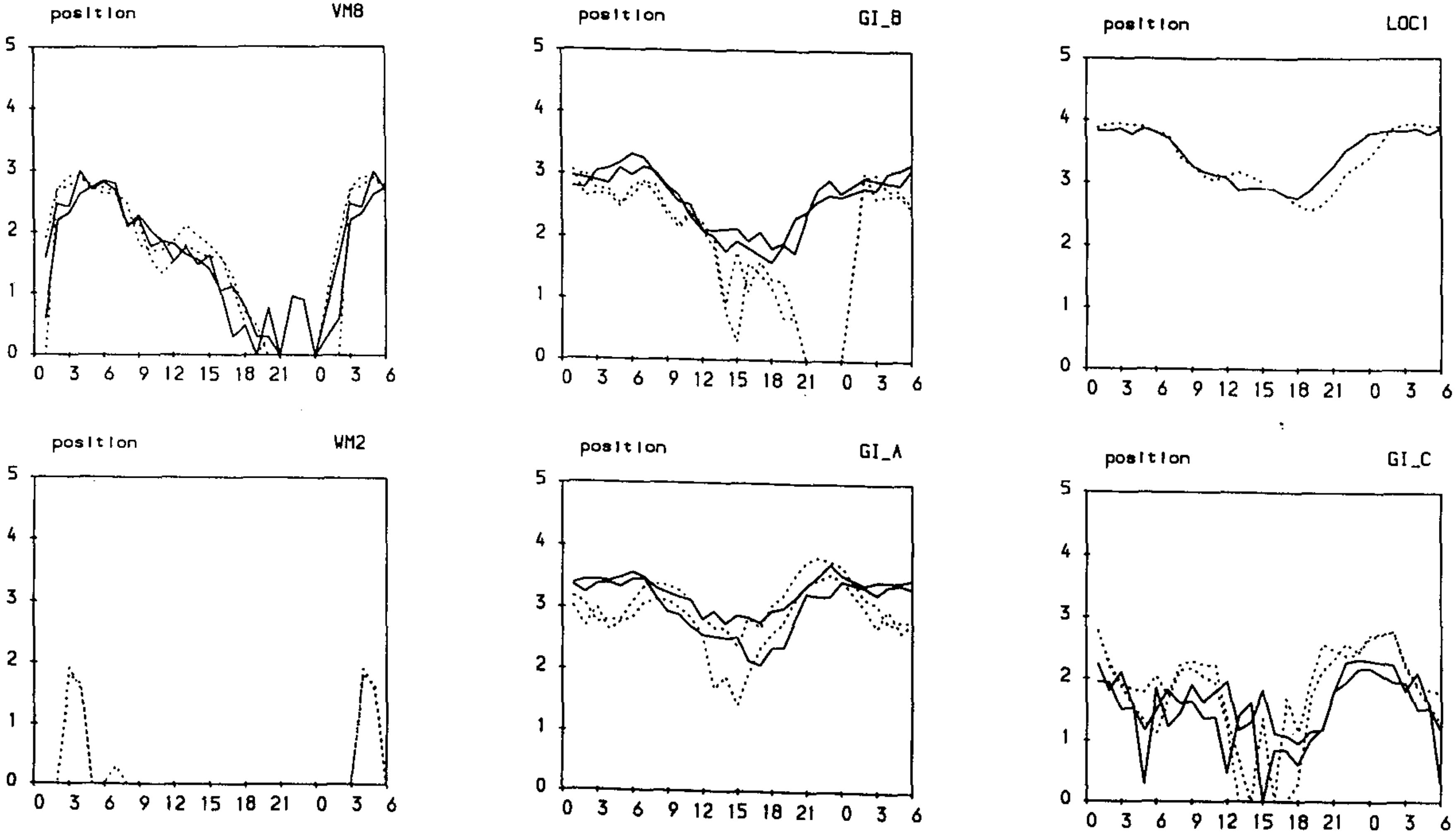
Bacterial Dispersion Model Results

Green Island Dry Spring Scenario 2 (Case 4)

E.Coli (no/100ml) against time (log to base 10 on y-axis)

2 Layer, 50m grid 22 Dec 1993 —— Scen. 2 ········ Baseline

Observed symbols: * Upper layer, △ Lower layer



GREEN ISLAND RECLAMATION (PART) - PUBLIC DUMP FINAL REPORT (EIA)

Figure No. 7.11A

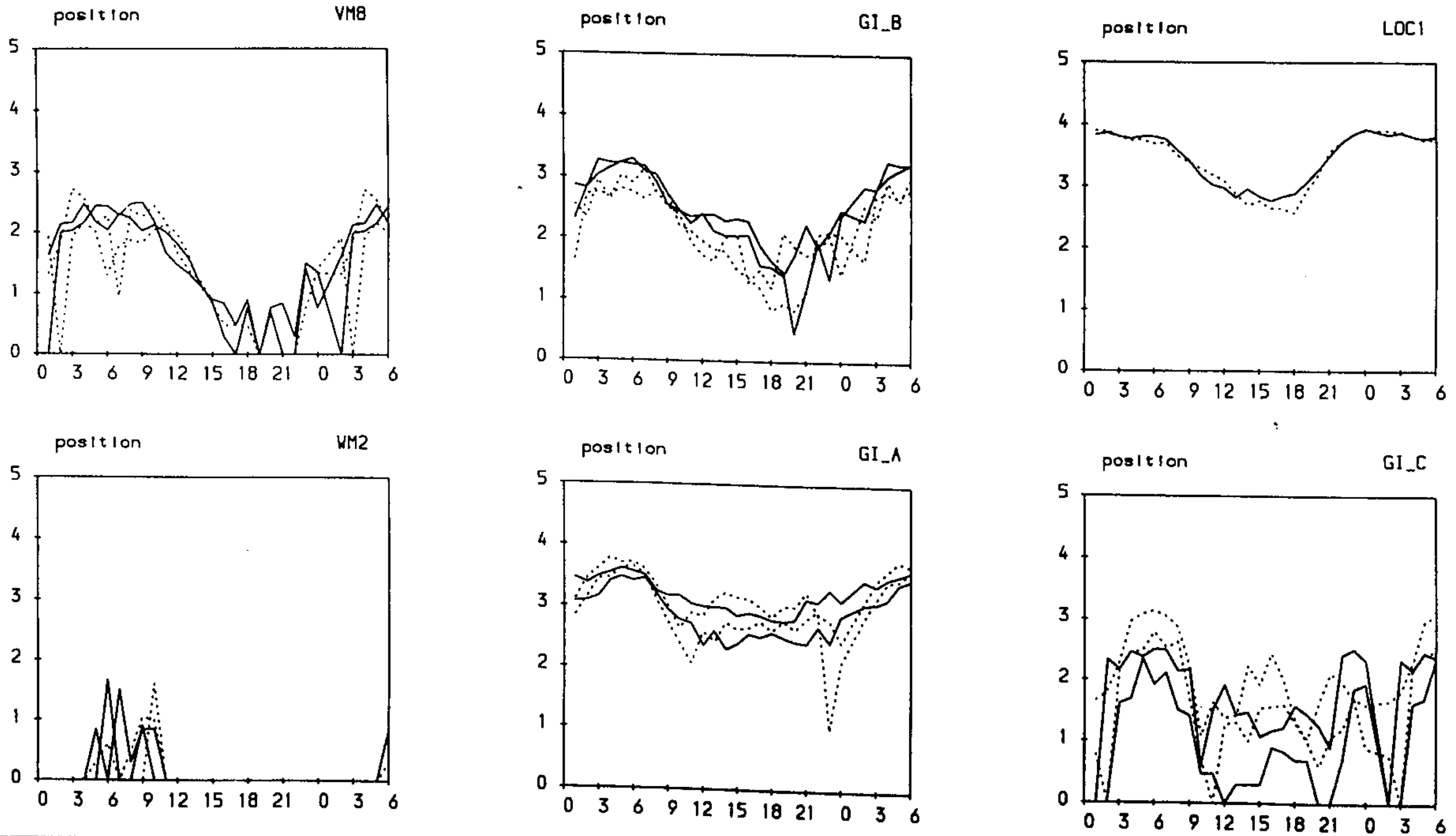
Bacterial Dispersion Model Results

Green Island Wet Neap Scenario 2 (Case 4)

E.Coli (no/100ml) against time (log to base 10 on y-axis)

2 Layer, 50m grid 22 Dec 1993 —— Scen. 2 ········ Baseline

Observed symbols: * Upper layer, △ Lower layer



GREEN ISLAND RECLAMATION
(PART) - PUBLIC DUMP
FINAL REPORT (EIA)

Figure No.	7.11B

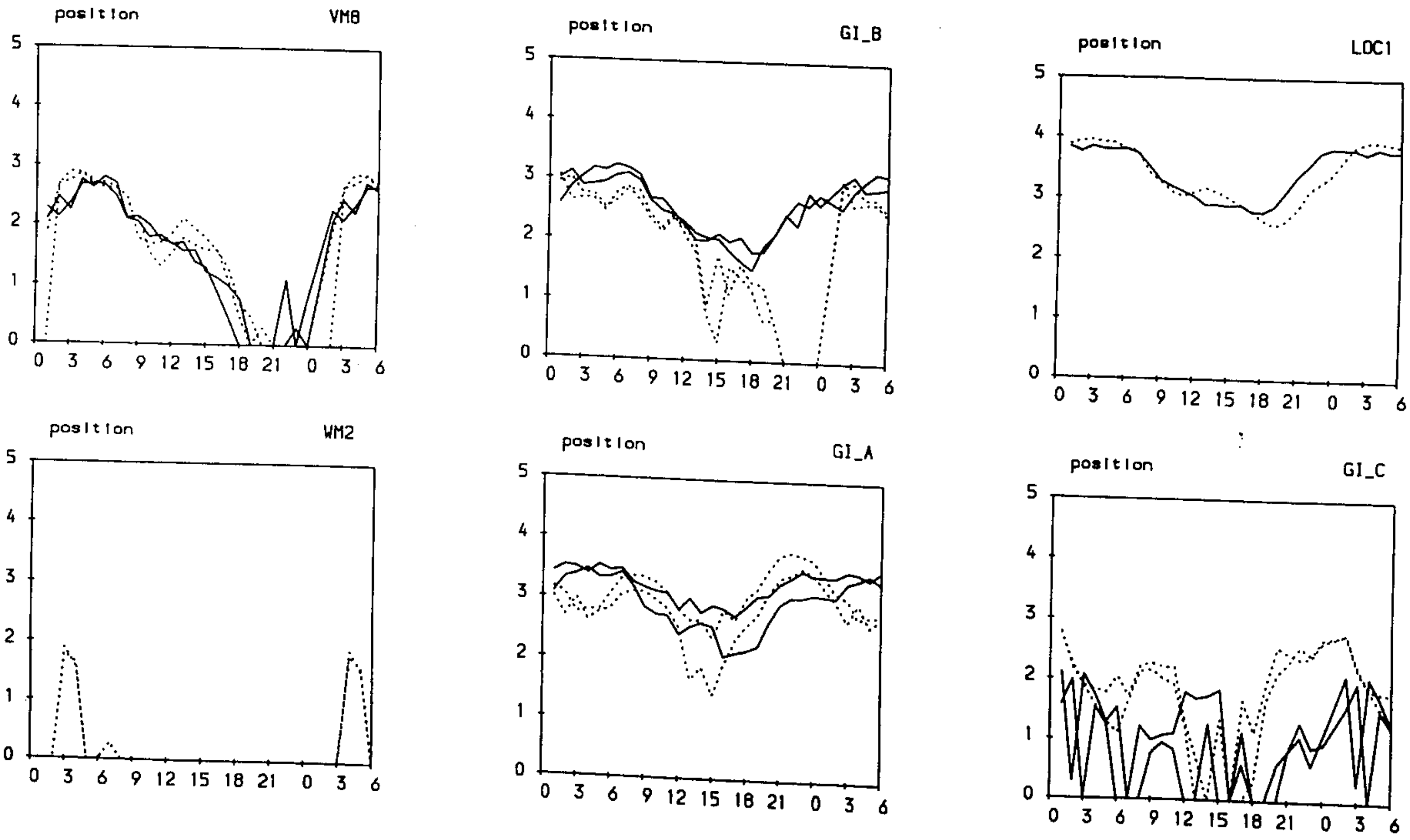
Bacterial Dispersion
Model Results

Green Island Dry Spring Full Scenario (Case 5)

E.Coli (no/100ml) against time (log to base 10 on y-axis)

2 Layer, 50m grid 22 Dec 1993 —— Full Scen. ········ Baseline

Observed symbols: * Upper layer, ▵ Lower layer



GREEN ISLAND RECLAMATION
(PART) - PUBLIC DUMP
FINAL REPORT (EIA)

Figure No. 7.12A

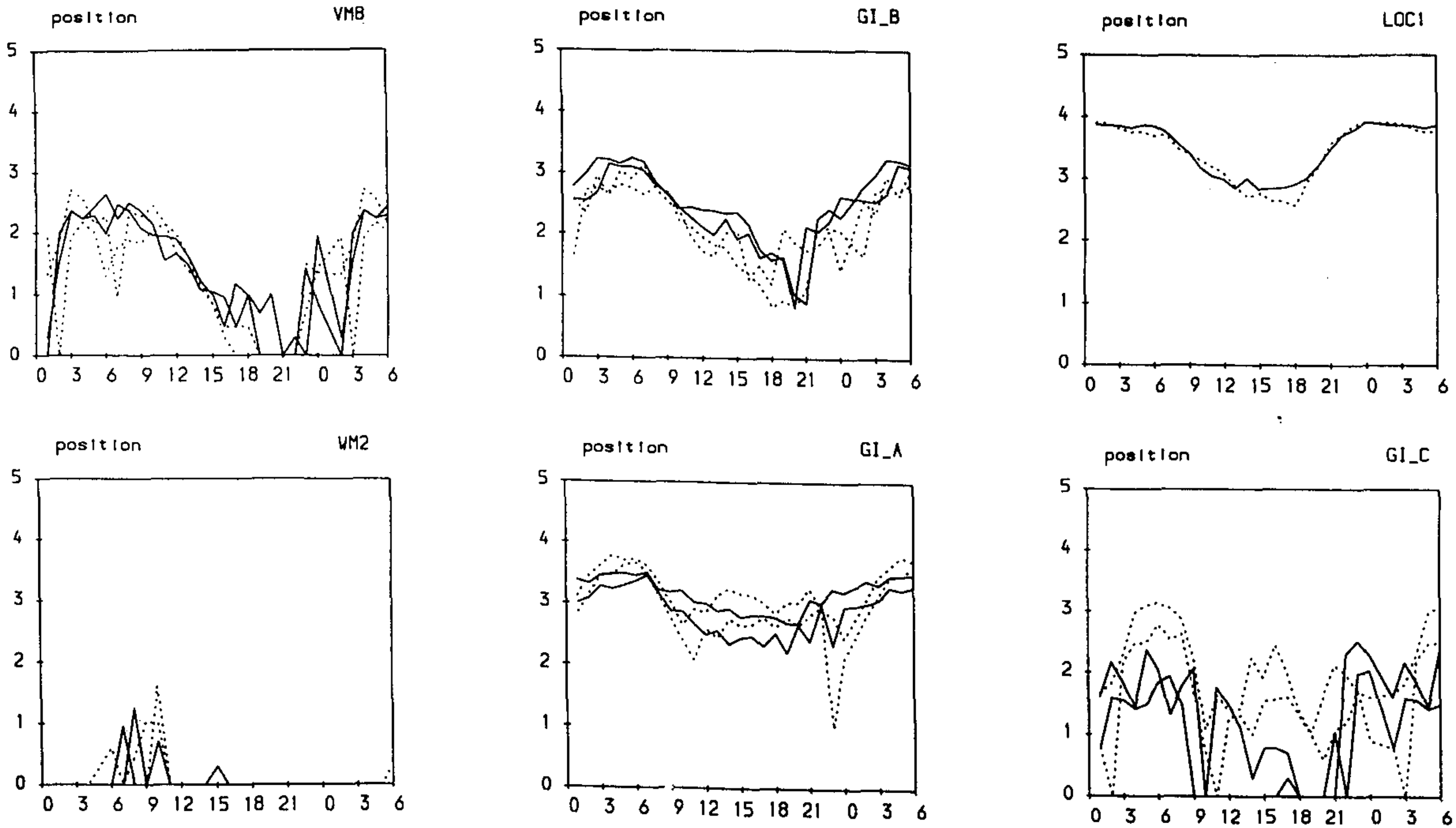
Bacterial Dispersion
Model Results

Green Island Wet Neap Full Scenario (Case 5)

E.Coli (no/100ml) against time (log to base 10 on y-axis)

2 Layer, 50m grid 22 Dec 1993 ——Full Scen ········ Baseline

Observed symbols: * Upper layer, ▵ Lower layer



GREEN ISLAND RECLAMATION (PART) - PUBLIC DUMP FINAL REPORT (EIA)

Figure No.	7.12B

Bacterial Dispersion Model Results

8. MARINE ECOLOGY

Introduction

8.1 Green Island is one of the few remaining natural islands in Victoria Harbour. With the reclamation of Rambler's Channel which has resulted in the joining of Stonecutter's Island with western Kowloon, Green Island has become the largest island within Victoria Harbour. From previous studies of the sediment stratigraphy of Victoria Harbour, it is known that the Harbour originally housed a rich fauna including corals (W.S. Yim, personal comm.) typical of a rocky bottom environment. The remaining islands within Victoria Harbour, with the protection accorded to them because of security reasons, are therefore likely to be areas of biological importance in this pollution-laiden and heavily altered environment.

8.2 This assessment considers the marine ecology of the intertidal areas and the maritime community at the back of the shore on Green Island, and that part of the shoreline on Hong Kong Island to be affected by the construction and operation of the public dump. A survey of the subtidal benthos of Hong Kong waters including the Sulphur Channel has been commissioned by CED under a separate contract and is therefore not covered by this study. Marine ecological impacts associated with the development of the Marine Barging Point at the former KTIP site are not assessed in this chapter, as the urban foreshore and immediate marine environment are not considered to retain any significant ecological value.

8.3 This Chapter summarizes the findings of the baseline surveys, conducted as part of this study, of the marine ecology of the communities to be affected by the Green Island Reclamation (Public Dump) project. Quantitative data on the abundance of the important shore fauna and flora as well as other features of biological interest are reported upon.

Standards and Guidelines

8.4 Any assessment of impacts on wildlife and biological communities would have to be based on an ecological currency. There are, however, no set standards for the assessment of the biological value of communities other than for the protection of locally (e.g. mangroves, corals) or globally endangered species and habitats. In the following assessment, the criteria adopted considered only the biological aspects, such as:

- the impact, whether beneficial or harmful, on the biological communities originally associated with the impact area; in particular, the loss or reduction of endangered species through direct habitat destruction or other consequences of habitat alteration; in this respect, assessment of whether the impact will bring about disturbance resulting in non-viable populations was carried out;

- the present importance of the existing communities in terms of their values for conservation, education or scientific research both on local and global scales. In this respect, factors such as the uniqueness of the community, ease of rehabilitation and ecological value in maintaining a healthy ecosystem were considered.

Background Information and Survey Data

8.5 The amount of biological information on the natural communities in Victoria Harbour is scarce. There are earlier reports on some taxonomic groups and the species occurrence at sites along Victoria Harbour, e.g. the crab fauna (Shen 1940 - Ref 8.1). The occurrence of animal artifacts also provides an indication of the state of the community before large scale alteration of the shores and seabed began. The available information suggests that Victoria Harbour housed a fauna and flora typical of sub-tropical, protected rocky shores, including the presence of a coral community. More recently Thompson and Shin (1983 - Ref 8.2) have investigated the relationship between sewage pollution and macrobenthos distribution and have concluded that the structure of the macrobenthic community in Victoria Harbour is largely dictated by organic pollution from sewage discharge.

8.6 Information on biological communities on boulder and rocky shores in Hong Kong can be found in Morton & Morton (1983 - Ref 8.3) and Hill et al. (1978 - Ref 8.4) where the common faunal and floral assemblages on local shores are documented. Studies have also been carried out dealing with specific aspects of habitat types in Victoria Harbour on the macrobenthos (Shin 1977 - Ref 8.5), on the fouling community (Hon 1978 - Ref 8.6), on reclaimed shores (Yip 1979 - Ref 8.7) and on dominant components of the fauna (Lee 1985/6 Refs 8.8 & 8.9). The existing communities on Green Island and the northwestern shores of Hong Kong to be affected by the project have been evaluated in the light of this information.

8.7 Baseline surveys were conducted at low tide for the two shores and the occurrence of all maritime and intertidal plants and animals were recorded. As an initial survey conducted as part of this study suggested that this area, and in particular Green Island, housed a fauna characterized by a large body size and the occurrence of some taxa rarely recorded in similar habitats elsewhere in Hong Kong, features such as size distribution, abundance levels and the occurrence of rare species were addressed in subsequent surveys. A complete list of shore organisms recorded from the site is given in Table 1 of Appendix 2.

The North-Western Shore of Hong Kong Island (Western)

8.8 This shoreline comprises typically steep and narrow stretches of rocky outcrops with occasional areas of coarse sand, stones and boulders (Plate 1). Due to the steep gradient, the horizontal stretch of the intertidal area is usually limited to about 10 m, with many surfaces having near vertical aspects. The heavy sea traffic in Sulphur Channel creates frequent artificial waves on the shore which has resulted in a community typical of semi-exposed rocky substrata. The biological community on this shore probably experiences relatively little disturbance from human activities because of the difficulty of access and exposure. There are, however, a few exceptions where parts of the shore have been used as bathing beaches in the past.

8.9 Some species of animals attain considerably high densities on these shores. Random quadrats were placed on the shore and the number of animals present in them counted. The limpets *Patelloida saccharina* and *P. pgymaea* are the numerical dominants on the shore, attaining densities of 368 ± 216 and 115.2 ± 33.6 individuals m-z respectively (Plate 2). The density of other species of limpets are presented in Table 8.1. Other species which are numerically important include the barnacle *Tetraclita squamosa* and the gastropods *Monodonta labio* and *Thais clavigera.*

8.10 Encrusting algae are common on the rock surface. Common genera include *Hildenbrandtia*, Ralfsia and the pink *Corallina*.

Green Island

8.11 The northern shores of Green Island offer a greater variety of habitats than the southern shores. The shores just northwards of the Green Island Detention Centre include a short stretch of sand-cobble shore as well as a gentle, though narrow, boulder shore before transforming into a steep landscape dominated by large rocky outcrops. These gentler sandy and boulder shores house the richest intertidal fauna on the island. The two sides of the island are, however, very similar in their assemblages of marine animals.

Table 8.1: Density (+ S.D.) of Limpet Species on the Shores of Western.

Species	Density + S.D. (no. per metre square)
Patelloida saccharina	368.0 +/-216.0
Patelloida pgymaea	115.2 +/- 33.6
Notoacmea sp.	25.6 +/- 16.0
Cellana toreuma	16.0 +/- 14.4
Cellana grata	<3

8.12 The shores of Green Island are similar to those natural shores on Hong Kong Island in their physical and biological characteristics. As expected, the shores on the two sides of Sulphur Channel share most of their fauna (Table 1, Appendix 2). Nevertheless, Green Island has a generally richer maritime floral community, probably because of the presence of a more gentle and less disturbed back of shore area at some sites, e.g. the boulder-coarse sand shore to the north of the Quarantine Centre of the Correctional Services Department (Table 2, Appendix 2). The community is again typical of moderately exposed rocky beaches, with *Pandanus tectorius, Cerbera manghas, Clerodendron inerme* and *Scaevola sericea* as the dominant species (Plate 3).

8.13 The shores to be affected by the reclamation project share many species with similar communities elsewhere in Hong Kong, however, Green Island has some characteristics which are not typical of other areas in Hong Kong. These differences are:

- the occurrence of a few species which, as a result of human disturbance, are becoming rare in Hong Kong, e.g. *Nerita undata*;
- some species dominant in the rest of Victoria Harbour, e.g. the green mussel *Perna viridis* (Ref 8.5 and 8.6) do not appear to be abundant at all on Green Island; and
- the average body size of the animals found on Green Island are significantly larger than those attained by their conspecifics elsewhere in Hong Kong, including that part of the Hong Kong Island shoreline surveyed in this study. This is especially noticeable for the gastropods *Monodonta labio* (up to 18mm aperture width), *Nodilittorina trochoides* (8mm shell height), the limpets *Liolophura japonica* (75mm body length) and *Cellana grata* (64mm shell length). Average adult body size of three of these grazing gastropods, i.e. *Monodonta labio, Cellana grata* and *Liolophura japonica* all attain significantly larger sizes than their

counterparts on the Hong Kong Island site (t-test, P<0.001;Table 8.2; Plate 4a, 4b)

8.14 Similar sizes of marine fauna have been recorded previously from Stonecutters Island and from more remote sites such as Sam Ah Chung in Starling Inlet for *Monodonta* (S.Y. Lee, unpublished data). Although the Green Island and Hong Kong shores share a common fauna, growth conditions associated with the two sites are probably distinctly different. The larger average body size of shore animals is especially apparent on the eastern shores of Green Island.

Table 8.2: Comparison of the Average Body Size Attained by Intertidal Macroinvertebrate Fauna at the Two Sites.

Species	Green Island	Western	t	P
Monodonta labio (aperture diameter, mm)	15.7±1.4	11.5+±1.1	10.1	< 0.001
Liolophura japonica (body length, mm)	62.7±8.6	27.1±3.6	14.7	< 0.001
Cellana grata (shell length, mm)	47.9±6.1	25.6±6.6	9.53	< 0.001

8.15 Large body size is thought to result from the combined effects of low levels of human disturbance and the enriching effects of a eutrophic water on the primary producers and thus increased food availability. This feature is not shared by most other easily accessible shores in Hong Kong. It is considered to be of academic interest and hence worthy of further study to understand the reasons for the large body size of species.

8.16 Green Island houses a more diverse algal community than the site on Hong Kong Island. Although the survey was carried out early in the algal season, extensive beds of *Porphyra* and *Ulva, Gelidium* and cyanobacteria ("blue-green" algae) could be found in the mid-intertidal zone around the island, especially on the boulder shores and in small rock pools formed on eroded boulders (Plate 5). This abundance of algae may account for the large individual sizes of the grazers, and indicates the importance of these shores in providing habitats which are no longer common in other parts of Victoria Harbour.

8.17 There is a general lack of information on the benthic community in Sulphur Channel and as such it is difficult to predict the possible impact of the Public Dump on the subtidal community not directly eliminated by the Public Dump itself. The survey by Thompson & Shin (1983 - Ref 8.2) suggested that the whole of Victoria Harbour was dominated by either abiotic mud or local patches of opportunistic, generally small animals (polychaetes such as *Capitella*). Relative to the intertidal fauna, it is unlikely that the subtidal areas will house a unique and particularly valuable assemblage compared with the rest of Victoria Harbour, as the low disturbance characteristic of the shores on Green Island is not shared by the subtidal communities.

8.18 The study carried out by Fill Management Committe of CED indicated that removal of sea bed habitat due to the construction of the Public Dump will result in the loss of a relativly undisturbed macrobenthic community across the Sulphur Channel. The importance of this community however is relatively small. Potential impacts on the local coral community in the vicinity of the West of Sulphur Channel Marine Borrow Area and those in East Lamma Channel are likely to be restricted to potential impacts from increased sedimentation of the sea bed as a result of dredging operations, rather than a direct loss of habitat. The actual degree of impact however is dependent on the resuspension and redistribution of sediments caused by storm events throughout the duration of works. No toxicological impacts on the benthic fauna on the adjacent sea bed and in Sulphur Channel are expected since additional site investigation and laboratory testing recently undertaken have confirmed that sediments are not contaminated with heavy metals according to EPD criteria (Ref 8.10).

Impact of Construction Activities

Stage I

8.19 The formation of the seawalls extending towards Green Island from Hong Kong Island is expected to significantly alter the hydrography of the remnant Sulphur Channel and will lead to:

- an increase in flow velocity due to the narrowing of the channel;
- an increase in suspended matter in the water due to the dispersion of dredged materials.

8.20 These impacts will mainly affect the southern side of Green Island. The shores on Hong Kong Island will also face a dramatic change in hydrography; the seawalls will effectively stop existing current flow which will result in a stagnant embayment. Fauna and flora in this area will likely be destroyed by this construction early in the schedule.

Stage II

8.21 As access to mainstream water in the channel is progressively closed off the communities on the shores of Hong Kong Island will be lost. The marine community on the southern shores of Green Island is expected to be further detrimentally affected as a result of increases in suspended matter in the water column caused by the construction works.

Stage III

8.22 Stage III will completely seal off Sulphur Channel, thereby killing all marine life on the southern shores of Green Island. The northern shores of the island are also likely to be affected by proximity to the construction work and their related water quality impacts, such as increases in suspended matter in the water column.

8.23 Increases in suspended matter will present physical problems such as clogging of the feeding and respiratory apparatus of shore animals, especially the filter-feeders which are the dominant feeding group on the shores. The presence of suspended matter derived from dredged materials used for the construction of the seawalls may also give rise to a potential problem of intoxication due to the toxic materials associated with the sediment (metals, adsorbed organics).

Impact of Operational Activities

8.24 The operation of the reclamation works may not affect the marine communities to the same extent as the construction phase. This is because most of the operational activities will take place on already reclaimed land and the impacts will be contained by the seawalls. The possible impacts associated with the operational phase may include the discharge of undesirable materials from the site such as wastewater and fill materials.

These can be largely prevented however, through good site management practices and adherence to regulations governing such operations.

Impact Following Completion

8.25 Following completion of the Green Island Public Dump, the southern rocky shoreline of the island community will be lost.

8.26 Further impacts will arise as the reclaimed land area is developed following a standing period. Effects will include the provision of access and service facilities and related stresses. For example, increased human activity can be expected to lead to a greater traffic flow resulting in higher noise and air emission levels and an increased waste stream. However, the provision of an appropriate sewerage system and the restriction of direct marine discharges from the site will limit the marine impacts associated with its afteruse, provided stormwater discharges can be suitably accommodated. Gradual colonization of the exposed surfaces of the seawalls can be expected by marine flora and fauna.

Cumulative Impacts

8.27 The proposed Green Island Public Dump Project will primarily encroach the southern shores of the Island. However, the Green Island reclamation project as a whole will encroach on almost all of Green Island. with the exception of the north-west shores. This will then become one of the last remaining natural shorelines in Victoria Harbour.

8.28 The development of the reclaimed area can be expected to instigate further adjacent development to the site, where increased human disturbance to the whole area may lead to significant changes in the volume and quality of stormwater flow discharged into the surrounding marine environment. Careful planning and restriction of marine waste water discharges will be required to avoid any long term deleterious effects on the remnant marine community.

8.29 The generally fast tidal current in the main Victoria Harbour channel and the impending improved sewage treatment strategy for the Harbour may allow the community to survive the water quality disturbance. Therefore, it is considered that the greatest threat to the small remnant community at the north-west corner of Green Island is likely to come from increased human disturbance resulting from improved accessibility.

Conclusions and Recommendations

8.30 The public dump will result in the destruction of a significant part of Victoria Harbour's last stretch of natural rocky shores. These shores house the remnants of the biological community, in particular the intertidal fauna, which pre-date development in the harbour. The species on these shores are generally much larger in size than their counterparts in other shores in Hong Kong. For example, individuals of the limpet *Cellana grata* found in the mid- to high intertidal are about double the average size of their conspecifics elsewhere in Hong Kong. Similarly, the chiton *Liolophura japonica* is about 30-40% larger than their counterparts elsewhere in Hong Kong. The reasons for these large species size are not fully understood, therefore this habitat is of interest to scientists keen to understand the factors which have promoted such growth in species size.

8.31 Protection of the remnants of the shore life on Green Island and the Hong Kong Island site may be enhanced by minimizing disturbance to the north-west shoreline of Green Island. This shoreline may be afforded some natural protection as a result of its inaccessibility, however additional measures are considered necessary to safeguard this area in the future. During the construction phase restrictions should be applied to prevent these shores being used as storage areas for construction materials or temporary stockpiling areas for construction or other wastes. In addition, the recommendation of the Final Report of the Green Island Reclamation Feasibility Study (Ref 8.11) to create an Urban Fringe Park on Green Island is endorsed by this study. It is further proposed that within the proposed Urban Fringe Park that access to the foreshore is restricted.

8.32 The amount of suspended matter in the water resulting from the construction activities should be effectively reduced by the use of suitable mitigation measures as described in Chapter 7. These include ensuring that barges are loaded in such a way as to prevent spillage during transport; the use of automatic self monitoring systems to discourage 'short dumping'; and ensuring that direct discharges from surface and storm water outfalls and unsewered discharges are intercepted prior to discharge. These will reduce the direct impact of the construction phase on the biological community and permit time for rehabilitation and mitigation measures to be implemented.

8.33 The translocation of a representative community of fauna from the affected shores to the north-western quarter of the island is recommended, preferably during Stage I or Stage II of the work. Species such as *Liolophura japonica* and *Cellana grata* have long life-spans in undisturbed environments and may therefore benefit from the translocation. Translocation also increases the local density of these species and may assist survival of these populations following the destruction of their other habitats on Green Island. The translocation is unlikely to be effective, however, unless the area is accorded some protection to ensure the proposed development, together with the accompanied stresses (eg. human disturbance) do not offset the translocation effort. The steep gradient of the northern shores of Green Island should provide some natural protection to the translocated populations.

8.34 Further quantification of the occurrence and distribution of species within the affected area will be required before detailed proposals can be made for translocating and monitoring of the marine community. A pre-construction phase study to determine the potential success of translocating fauna is therefore recommended. The proposed scope of further investigations is presented in Table 3 of Appendix 2. The transfer of fauna to the north-western shores is regarded as the only feasible mitigation measure due to the entire loss of the shoreline habitat on other parts of Green Island.

8.35 The subtidal community of Sulphur Channel will be destroyed by construction of the Public Dump. However, the results of the study by Fill Management Committee of CED have shown that the importance of this community is small.

References

8.1 Shen, C.J. The Brachyuran fauna of Hong Kong. Journal of the Hong Kong Fisheries Research Station 1:211-242,1940.

8.2 Thompson, G.B. & Shin, P.K.S. Sewage pollution and the infaunal macrobenthos of Victoria Harbour, Hong Kong. Journal of Experimental Marine Biology and Ecology 67:279-299,1983.

8.3 Morton, B.S. and Morton, J. The Sea Shore Ecology of Hong Kong. Hong Kong University Press, Hong Kong, 1983.

8.4 Hill, D.S., Gott, B., Morton, B.S. & Hodgkiss, I.J. Hong Kong Ecological Habitats: Flora and fauna. Second Edition. Department of Zoology, University of Hong Kong, Occasional Publication No.2. 189pp, 1978.

8.5 Shin, P.K.S. A quantitative and qualitative survey of the benthic fauna of the territorial waters of Hong Kong. M.Phil. Thesis, The University of Hong Kong, Hong Kong, 1977.

8.6 Hon, S.S.L. Aspects of marine fouling and anti-fouling in Victoria Harbour, Hong Kong. M.Phil. Thesis, The University of Hong Kong. 480pp, 1978.

8.7 Yip, S.S.Y. The ecology of coastal reclamation in Hong Kong. M.Phil. Thesis, University of Hong Kong, 1979.

8.8 Lee, S.Y. Population dynamics of the green mussel *Perna viridis* in Victoria Harbour, Hong Kong: dominance in a polluted environment. Asian Marine Biology 2:107-118, 1985.

8.9 Lee, S.Y. Growth and reproduction of the green mussel *Perna viridis* (Bivalvia: Mytilacea) in contrasting environments in Hong Kong. Asian Marine Biology 3:111-127, 1986.

8.10 Scott Wilson Kirkpatrick (1994). West of Sulphur Channel Marine Borrow Area. Focused Environmental Impact Assessment - Draft Final Report

8.11 Green Island Reclamation Feasibility Study (H197) Technical Paper No 13. Urban Design and Landscape Guidelines. Ove Arup & Partners, Peter Y.S. PUN & Associates. Territory Development Department, Urban Area Development Office, 1989.

Plate 1:
Rocky shore west of Kennedy Town: the intertidal area is typically steep and narrow

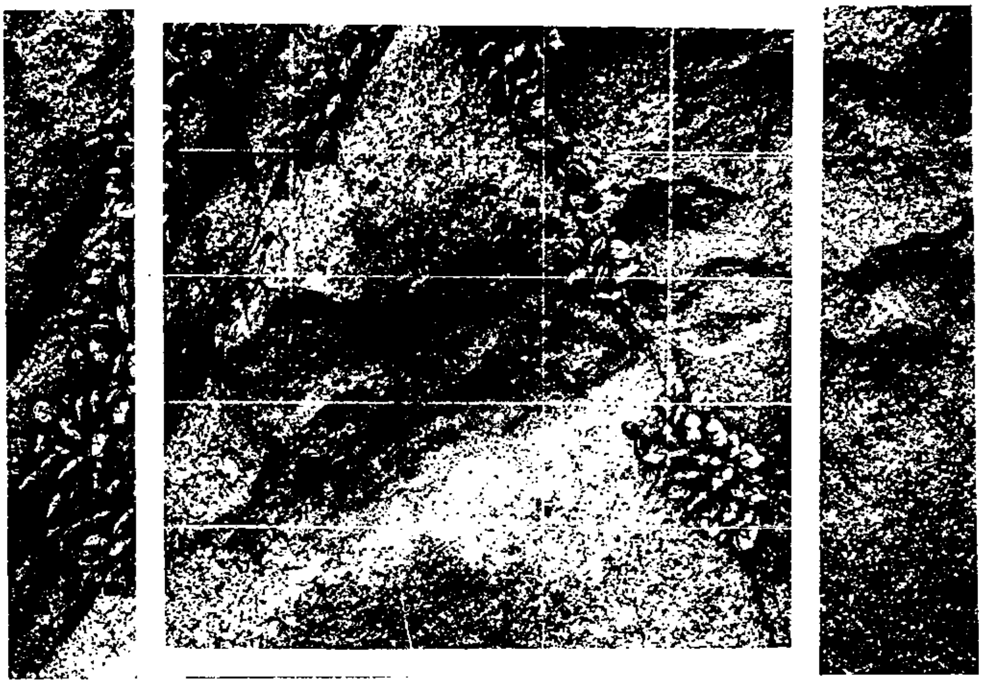


Plate 2:
Limpets such as *Patelloida saccharina* and *P. pgymaea* are very abundant on the steep rocky surfaces of the shore west of Kennedy Town. The acorn barnacle *Tetraclita squamosa* and the stalked barnacle *Capitulum mitella* are also featured in the quadrat.

Plate 3:
Back-of-beach plants on Green Island. *Scaevola* in the foreground and *Macaranga* in the background.

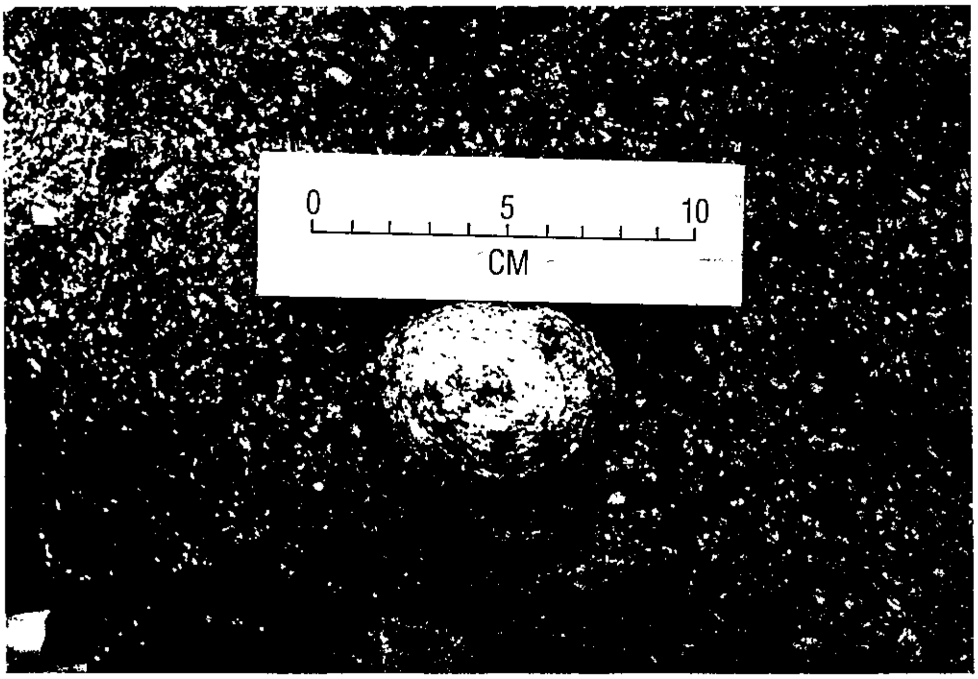


Plate 4a:
The limpet *Cellana grata* commonly attains shell lengths greater than 50mm on the shores of Green Island.

Plate 4b:
Large body size is also demonstrated by the chiton *Liolophura japonica*. The coin has a diameter of 25 mm.

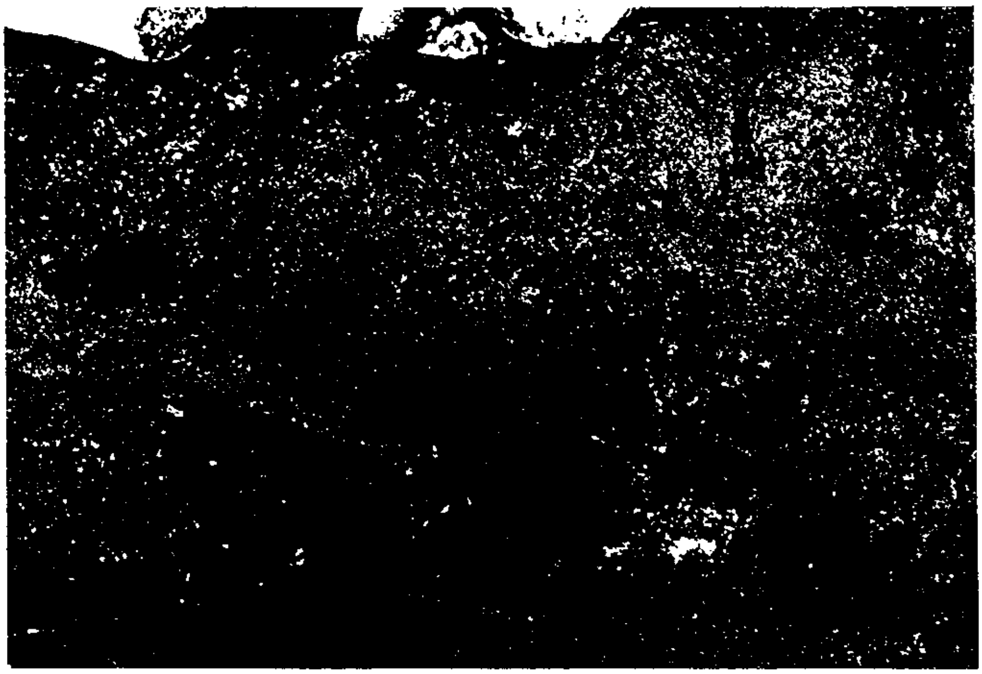


Plate 5:
Algal primary producers such as *Porphyra* and *Ulva* are common on the boulder shores on Green Island.

9. TERRESTRIAL ECOLOGY

Introduction

9.1 This chapter presents the findings of the baseline survey work undertaken for the Final IAR which described the terrestrial flora and fauna of Green Island, and reports upon the additional survey work undertaken on the proposed access road options to the site. The potential impacts of the proposed reclamation works on the ecology of the island and access routes have been assessed. Recommendations for further monitoring work during the construction, operational and post-completion stages of the development are provided in Chapter 11.

9.2 Terrestrial ecological impacts associated with the development of the Marine Barging Point at the former KTIP site are not assessed in this chapter, as the site does not have any natural habitats and is not considered to retain any significant ecological value.

Standards and Guidelines

9.3 As stated in Chapter 8, there are no set standards for the assessment of the biological communities other than for the protection of local or internationally endangered species. The criteria adopted for the assessment of terrestrial ecology have included:

- the impact, whether beneficial or harmful, on the biological communities originally associated with the impact area; in particular, the loss or reduction of endangered species through direct habitat destruction or other consequences of habitat alteration; in this respect, it has been important to assess whether the impact will bring about disturbance resulting in non-viable populations;

- the present importance of the existing communities in terms of their values for conservation, education or scientific research both on local and global scales. In this respect, factors such as the uniqueness of the community, ease of rehabilitation and ecological value in maintaining a healthy ecosystem were considered.

Background Information and Survey Data

Published Information

9.4 There appears to be little information available on the terrestrial ecology of Green Island. No published material appears to exist. The restricted access to the island has limited the accumulation of natural history observation. David Melville of World Wide Fund for Nature, Hong Kong reports nesting by Black-eared Kites (*Milvus lineatus*) on both Green Island and Little Green Island (para 9.19). Staff interviewed at the Police Recreation Centre as part of the baseline survey on 30th August 1993 did not report having seen large wild animals on Green Island in recent times, with the exception of one large snake of unknown species. The presence of a cobra (snake) species was also reported to the survey team.

Baseline Survey of Terrestrial Flora

9.5 A botanical survey of the island was undertaken. Due to the size, topography and accessibility of the island the survey focused on vegetation bordering the concrete footpaths.

9.6 The island is an isolated and restricted area and as such has been free from human disturbance (such as fuel wood collection, medicinal herb collection and hill fire) for a long time - probably since World War II. No evidence of hill fire could be observed on the island except for a small patch of shrubland on the eastern side. It is considered likely that the island has been free from fire for over 20 years thereby allowing a luxurious vegetation to develop.

Characteristics of the Vegetation

9.7 The whole island is densely covered with woodland and tall scrub. The height of the trees on the southern side of the island is around three to eight metres with some individuals reaching 10 m or more. The vegetation is characterized by trees and climbers with high species richness and high density. The most common tree species include *Microcos paniculata, Mallotus paniculatus, Pterospermum heterophyllum, Ficus superba var. japonica, Cratoxylum ligustrinum, Schefflera octophylla* and *Sterculia lanceolata*. Common climbers include *Smilax* spp., *Strychnos angustiflora, Uvaria* spp. and species in the family *Menispermaceae*. Common shrubs include *Ilex* spp., *Lantana camara* and *Litsea rotundifolia var. oblongifolia*, but no species dominates. Grasses and herbs are less important in terms of diversity and biomass.

9.8 On the coast and behind the beach, typical seashore plants include *Scaevola sericea, Fimbristylis* sp., *Cerbera manghas, Clerodendrum inerme, Hibiscus tiliaceus,* and *Pandanus tectoris*.

9.9 The total number of plant species recorded was 150, which is considered very high for such a small island and the limited area surveyed. The flora is also characterized by a high proportion of native species. Exotic species and weeds were insignificant both in number and in species diversity. Table 1 in Appendix 3 lists the plant species recorded in the survey.

Rare and Protected Species

9.10 Certain species are of particular interest. A few individuals of *Pavetta hongkongensis* were found. This tree is protected under the Forests and Countryside Ordinance (Chap. 96), Section 3. Three clumps of the formerly protected Lady Palm *(Rhapis excelsa)* were found in the ravines; the largest colony occupied an area of approximately 45 square metres. Many other species were recorded including the herbs *Amorphophallus variabilis* and *Zephranthes candida*, the shrub *Grewia biloba* and the trees *Cudrania tricuspidata, Bridelia balansae* and *Celtis philippinensis.*

Significance of the Flora

9.11 The vegetation of Green Island was found to be very species-rich, with an advanced succession comprising many woodland species. This is thought to reflect a lack of disturbance by fire and other factors. The Green Island habitat provides an opportunity to study plant succession, while the high species diversity indicates that it would merit more detailed botanical exploration. The flora is also thought to provide valuable habitat for fauna such as butterflies and other invertebrates as described below.

Characteristics of Terrestrial Fauna

9.12 The Island was also surveyed for reptiles and amphibians and observations were made on terrestrial invertebrates and mammals. A clockwise transect was followed which ran from the north-west shoreline along the shore in a eastward direction and along the main path to the south-west side of the Island; and an inland trail which led to the highest point in the centre of the Island was surveyed. The northern inland part of the island was not covered due to its inaccessibility. Reptiles and amphibians were recorded through direct sighting and active searches. In addition, a dip-net was used to sample the freshwater for tadpoles. The secretive nature of the subject animals and the dense vegetation precluded any measurement of population density.

9.13 Three species of reptile were found during the survey and these are listed in Table 2, Appendix 3. No amphibians were found during the survey. The sole wetland area on Green Island is a seepage pool on the southern side. It is just over one square metre and is in an exposed position near the coast. It is likely that the Island supports no amphibian fauna because of its small size and limited available breeding sites.

9.14 The three species of reptile found are common and widespread throughout the Territory. *Ptyas mucosus* is a protected species (Animals and Plants (Protection of Endangered Species) Ordinance (Replacement of Schedules) Order 1990) but it is not under threat locally and has an extensive distribution in China and Southeast Asia.

9.15 During the field survey no signs of large mammals were observed. However, it is considered unlikely that an island of this size could support viable populations of Civets, Leopard Cats, Barking Deer or Wild Boar. Scats of rodents (probably *Rattus* sp.) were seen, but the abundance and diversity of small mammals was not assessed. The abandoned buildings at the centre of the island did not contain signs of bat roosting; the ceilings and walls are considered too smooth to attract bats. Certain of the tree species on the island, including *Schefflera octophylla, Ficus superba* and *F. microcarpa* are known to be dispersed by Hong Kong's two fruit bats *Rousettus leschenaulti* and *Cynopterus sphinx* while another tree species recorded, *Livistona chinensis*, is the main roosting site for *C. sphinx*.

9.16 A large variety of butterflies were observed on the Island. This diversity was considered to be related in part to the plant species assemblage on the Island. One ant species not previously found elsewhere in Hong Kong, *Acropyga sp*, was found on Green Island. It is thought to be a new observation (M. Terayama, pers. comm.), although the genus has previously been recorded in Macao and Taipo (Ref 9.1).

Birds

9.17 A survey of the bird fauna also took place during August, 1993. Birds were recorded as they were seen foraging, roosting or heard calling along the same clockwise transect as surveyed for fauna (para 9.12).

9.18 All birds are protected in Hong Kong under the Wild Animals Protection Ordinance. 21 species were recorded as listed in Table 3, Appendix 3. (Ref 9.1). Most of the birds recorded have a widespread distribution in Hong Kong. The Brown Shrike *Lanius cristatus*, although a regular visitor to Hong Kong, is quite scarce.

9.19 The areas surveyed provide ideal woodland and scrub habitats for seasonal visitors such as passage migrants and winter visitors (in particular warblers and flycatchers). Many areas on Green Island are inaccessible due to the steepness of the slopes and thickness of vegetation cover. This inaccessibility provides natural protection to the bird life. One species known to nest on both Green Island and Little Green Island is the Black-eared Kite *Milvus lineatus* (David Melville, pers. comm.). In addition, in 1989 and 1991 a pair of White-bellied Sea Eagles, *Haliaeetus leucogaster* was frequently seen flying from the Island. (George Walthew, pers. comm.)

9.20 There is a sandy beach and rocky shore on the northern coastline where the only wader species (Common Sandpiper) was seen. Several large rocks in this area potentially provide roosting sites for Cormorants (*Phalacrocorax carbo*) which are winter visitors; in addition visiting waders may forage amongst the rocks on a seasonal basis. Reef Egrets (*Egretta sacra*) use the natural shoreline of Green Island as a foraging ground.

9.21 The Reef Egret, *Egretta sacra*, is listed as Resident in Hong Kong and most other coastal Asian countries, but not listed in China, which suggested that the Hong Kong population is of regional importance (Ref 9.3); other observations suggest, however, that it is not uncommon (although localised) on outlying islands of Hong Kong and southern China (K Wilson, pers. comm., M Lau, personal observation). Within Hong Kong it breeds on islands with low disturbance, probably including parts of the southern coast of Hong Kong Island; it is also thought to breed on Lantau and in the northern New Territories (Ref 9.1). If it breeds on Green Island it is unlikely to constitute a large porportion of the Hong Kong breeding population (K Wilson pers comm).

Impacts of Construction and Operational Activities and Recommendations for Mitigation Measures

9.22 The direct impacts on the ecology of Green Island as a result of the construction and then operation of the public dump will relate to clearance and damage to vegetation. Construction activities will directly impact on the southern shoreline of Green Island. However, it will not be until Stage III of the Sequence of Works that the final link with Green Island is made by the reclamation (as shown in Fig 3.1)

9.23 The 5mPD encroachment of Green Island will almost certainly result in the loss of some trees at the back of the shore. It is likely that a compensatory landscape scheme will be required by Government to recompense for the loss of trees as part of the development. It is therefore recommended that before the reclamation commences a tree survey is carried out to determine the exact number of trees which will be lost. Following completion of the reclamation and in line with future plans for the Green Island reclamation as a whole a replanting programme should be undertaken as a mitigatory measure.

9.24 The use of Green Island for the storage of construction materials and other waste materials should not be permitted so as to avoid damage or disruption to those parts of the Island not directly affected by the reclamation. If materials do need to be stored on the Island they should be contained within the area of direct impact.

9.25 Existing fauna and flora are likely to be tolerant of air pollution to some extent and the main impact of construction is likely to be of settled particulate matter. Dust from construction activities can be expected to reduce photosynthetic capability of terrestrial plants, and may have deleterious effects on sensitive animal species. In this context, it is recommended that the dust mitigation measures specified in Chapter 5 which include surface damping, control of vehicle speeds and movements, and coverage of loose materials are rigourously applied.

9.26 Green Island has largely escaped fire in recent years, however increased activity within the works area in the future will increase the risk of fire. Precautionary measures should be included in the contract to mitigate fire hazards. Open fires, the storage of flammable materials and smoking should be prohibited on the Island once the public dump is operational. In addition, adequate buffer distances between site activities and natural vegetation should be maintained as far as possible.

Impacts Following Completion and Recommendations for Mitigation Measures

9.27 On completion of the public dump Green Island will effectively become a part of Hong Kong Island and will no longer be an Island habitat. The accessibility afforded by this reclamation may lead directly to a number of potential ecological impacts. Perhaps the most severe risk to the existing animal and plant community will be hill fire. Visitors would pose a greatly increased fire hazard. Short shrubs readily catch fire in the winter months, and although the present taller vegetation cover on the island is very thick and unlikely to catch fire under normal conditions, hill fire could occur in woodlands under extreme dry weather conditions. Once fire has occurred the landscape will become susceptible to recurrent fires in subsequent years.

9.28 Precautionary measures to prevent fire will depend on the nature of future activities carried out on the Island. However, if the Urban Fringe Park, as proposed by the Green Island Reclamation Feasibility Study is developed then fire breaks should be established between barbeque areas and areas of natural vegetation, clear signage to alert visitors to fire hazards should be provided, and Park staff should be given responsibility for identifying such hazards.

9.29 As well as opening the Island up to potential adverse impacts from increased human activity, the completion of the Public Dump may expose some aspects of the Green Island biota to invasion from other species. This could include predators, however increased invasion probability is too difficult to assess.

9.30 Under the proposed development plans much of the shoreline of Green Island will be lost with the exception of the north-western shores of the Island. This means the Reef Egret, and other wader species which frequent Green Island, will lose these shores as a foraging ground. The overall importance of Green Island as a foraging ground to the Reef Egret is not known and hence the impact of the loss of this habitat on local populations cannot be assessed. It is possible that the Reef Egret will seek new foraging grounds on the Outlying Islands or return to the north-western shores of Green Island once the public dump is completed, but this cannot be predicted with certainty as the relationship between disturbance and the presence or absence of a species is not understood. Mitigation measures are considered in the conclusions to this assessment (para 9.43).

9.31 Following the Stonecutter's Island Reclamation, Green Island and little Green Island represent the last remaining islands in Victoria Harbour. This has repercussions for fauna relying on such islands as breeding and feeding sites. One species that may be particularly affected is the Black-eared Kite, which has limited suitable breeding sites due to development and human disturbance. The Stonecutter's Island population has bred in 1993 following careful protection measures which involved sealing off the island and prohibiting human access and further disturbance to the Island. The future uses proposed for Green Island under the Green Island Reclamation Feasibility Study include an Urban Fringe Park. In this regard, the management authority of the proposed Urban Fringe Park should consider restricting human access to the breeding sites on the Island. Furthermore, it is also important to ensure that other island breeding sites in Hong Kong, such as Sunshine Island are not lost and are protected from development and human disturbance. Protection of Sunshine Island, in particular, from development is also very important as the island might be an alternative nesting site for the White-bellied Sea Eagle.

Access Road Options: Botanical Survey

9.32 In addition to the baseline ecological survey of Green Island a botanical survey of the two proposed access road options to the Green Island Reclamation (Public Dump) was undertaken. The purpose of this survey was to assess the floral diversity and rarity of plants along the alternative access routes.

IWTS Access Road Option (Figure 3.4)

9.33 The upper (southern) part of this site is on a slope between the western end of Sai Ning Street and Victoria Road. The lower (northern) part of this proposed access road is on the existing USD Kennedy Town Vehicle Depot and on the proposed reclamation site. Since there is no vegetation cover on the lower part of the site, the survey concentrated on the upper part only.

9.34 The site is about 20m x 40m in area. The site is on an abandoned squatter area and there are still ruins of derelict houses. It is adjoined by a three-storey building (an old people's home) to the north, a new thirty-storey residential block (Serene Court) 10m to the east on Sai Ning Street, and a squatter area to the south.

9.35 The site is completely vegetated. There are a number of tall trees, attaining heights up to 18 m. These include *Aleurites moluccana, Michelia alba, Ficus variegata* var. *chlorocarpa,* and *Ficus elastica*. Other trees at the mid-canopy levels (5 to 10 m) include *Macaranga tanarius, Ficus hispida, Ficus microcarpa* and *Schefflera octophylla*. There are few shrubs or herbs on the ground; *Alocasia macrorrhiza* is the only dominant ground species. Some of the tree canopies are covered by tangling climbers such as *Ipomoea* spp. and *Mikania micrantha*. An uncommon plant (*Cudrania* sp.,*Moraceae*, which occurs also on Green Island) was found at the western end of this site but, it is safe from the proposed construction activities. A list of plants occurring on the site is given in Table 4, Appendix 3.

9.36 The site is not very interesting botanically since it is dominated by exotic and artificially planted trees. No plants protected under the Forests and Countryside Ordinance (Cap. 96) Forestry (Amendment) Regulation 1993 or the Animals and Plants (Protection of Endangered Species) Ordinance (Cap. 187) were found on the site. The existing vegetation may, however, be of aesthetic value to the nearby residents.

Disused Track Access Road Option (Figure 3.4)

9.37 The disused track is on a steep slope between Victoria Road and the sea shore. It is a concrete vehicular track two to three metres wide. There are many derelict structures on both sides of the track. Plant species occurring within 5 to 10m (depending on local topography and accessibility) of both sides of the track were surveyed.

9.38 The area is a well-grown secondary woodland composed of natural (spontaneous) and planted (native or exotic) tree species. The most abundant tree species are *Macaranga tanarius, Broussonetia papyrifera* and *Ficus* spp. Other trees such as *Leucaena leucocephala, Sterculia lanceolata* and bamboos (*Bambusa* spp.) are also commonly found. The understorey is only sparsely covered with shrubs and herbs since the tree canopy is dense and closed. No shrub species is dominant in the area and native (spontaneous), planted and exotic species are present. *Alocasia macrorrhiza, Liriope spicata and Cyperus alternifolius* are the most common species on the ground below the canopy. On exposed sites with more light penetration, weeds and exotic species such as *Ipomoea cairica, Mikania micrantha* and *Panicum maximum* are more commonly found. A list of plants occurring on the site is given in Table 5, Appendix 3.

9.39 No plant protected under the Forests and Countryside Ordinance (Cap. 96) Forestry (Amendment) Regulation 1993 or the Animals and Plants (Protection of Endangered Species) Ordinance (Cap. 187) was found.

9.40 The plants immediately adjacent to the track and derelict structures are mostly planted, while those further (5 to 10m) from the track are naturally occurring. All now constitute a stable semi-natural secondary woodland, providing habitat for various animal groups.

Conclusions and Recommendations

Green Island Survey

9.41 The flora of Green Island was found to be very species-rich, with an advanced succession comprising many woodland species. This is thought to reflect a lack of disturbance by fire and other factors. One protected plant species, *Pavetta hongkongensis*, was found. A full four season survey of bird fauna was not undertaken, but is not expected that many rare species are present. No large native mammals are present on the island. The invertebrate fauna were not surveyed in detail but may be of interest due to the high plant diversity, lack of disturbance and the dispersal barrier presented by the sea.

9.42 The direct impacts resulting from construction activities and the operation of the Public Dump will be a loss of vegetation along the southern shores of Green Island. Indirect effects following completion of the Public Dump will result from disturbance due to increased human access to the 'Island', the risk of fire, and the risk of invasion by predatory and exotic species. Proposed mitigation measures include prohibiting open fires, smoking and the storage of flammable materials on-site during the construction and operational phases; to prohibit the storage of construction materials and other wastes on Green Island other than within the works area; and a tree survey should be carried out by the contractor prior to the commencement of any works. Replacement planting of damaged or destroyed vegetation should be carried out by the project proponent on both Green Island and along the Hong Kong Island shoreline and should be consistent with the recommendations for landscape works proposed in Chapter 10.

9.43 On Stonecutters Island proposed mitigation for the loss of coastal habitat to reclamation involved construction of an artificial boulder shore for the displaced Reef Egrets and Night Herons. However, in view of access problems and the threat to other habitats this proposal has been changed to provision of pontoon-bridge rafts, from which the birds are expected to fish. Breeding takes place on large-boulder shores, with nests located at the foot of large (greater than 2 m) boulders on flat surfaces above sea level. Thus unless disturbance increases, adverse impacts on the Green Island population could be compensated, in the long term, by provision of an equivalent area of large-boulder shore on the reclamation. This would also benefit rocky shore invertebrate species displaced from southern Green Island. The constructed rocky shore should be fenced off to prevent animal-collectors and other human disturbance. In addition it is suggested that perches, such as floating rafts or buoys, are provided near the shore as foraging posts.

9.44 Following completion of public dumping activities public access to Green Island will increase with the proposed development of an Urban Fringe Park. The public therefore will need to be alerted to the risk of fire and the illegal exploitation of plant and animal species.

Access Routes

9.45 From a botanical and ecological point of view, the IWTS Access road option would cause less detrimental impact to the environment than the Disused Track option. The latter represents a well-grown secondary woodland habitat composed of native and exotic tree species and is likely to provide a suitable habitat for various animal groups.

9.46 If the Disused Track option is adopted, special care must be taken to minimize the damage to the natural woodland down-slope of the track (i.e. between the track and the shoreline) when engineering work is carried out. Consideration should also be given, where possible, to limit the potential alteration in plant species composition as a result of increased light penetration or changes in the water table, for example. This can only be achieved by careful selection of the road alignment to avoid ecologically sensitive species.

9.47 Any trees destroyed during development should be replaced with native species, with the provision of nursing/pioneer species as appropriate, to assist in the succession to woodland coverage. A compensatory landscape scheme will be required by Government at the detailed design stage to recompense for the loss of trees. Aesthetically and ecologically important shrubs and trees should be fenced off for protection if they are exposed by the clearance of adjacent vegetation.

9.48 It is recommended that the ecological effects of all construction and operational activities be monitored. Monitoring and audit requirements are given in Chapter 11 of this report.

References

9.1 Wheeler, W.M. A List of the Known Chinese Ants, Peking Natural History Bulletin 5(I), 53-81, 1931.

9.2 Chalmers, M.L. Annotated Checklist of the Birds of Hong Kong, 4th edition. The Hong Kong Bird Watching Society, Hong Kong, 1986.

9.3 Sonobe, K. and Usui, S. (eds.) A Field Guide to the Waterbirds of Asia. Wild Bird Society of Japan, Tokyo, 1993.

10. VISUAL IMPACT

Introduction

10.1 This chapter assesses and evaluates the visual impacts of the construction and operational activities associated with the proposed Green Island Public Dump and the Marine Barging Point at the former KTIP site. The assessment is based on the study brief as well as the other outputs prepared as part of this consultancy. It develops on the initial assessment and the update of information presented in the Summary of Key Findings.

10.2 The relevant environmental standards and guidelines are reviewed and a visual assessment methodology outlined. The existing visual context of the site is described in order to establish baseline visual conditions against which the impact of the proposed Green Island Public Dump and Marine Barging Point can be assessed. Key viewpoints are identified and their visual sensitivity assessed.

10.3 Based on the preliminary implementation programme and scope of construction work outlined in Chapter 3, an assessment is made of the probable visual changes resulting from the construction and operation of the Public Dump and Marine Barging Point. Cumulative visual impacts and impacts following completion are also considered. The visual impact of these changes from key viewpoints will be assessed. In conclusion, the key concerns are identified and recommendations made to reduce and mitigate significant impacts in the design and programming of the project. Areas for further visual assessment and detailed consideration during the tender design and construction stages are also recommended.

Environmental Standards and Legislation

10.4 Currently in Hong Kong, there is no specific legislation governing visual impact or offering guidelines on visual assessment methodologies. The Government White Paper on "Pollution in Hong Kong - A Time to Act" (Ref 10.1) offers general policy objectives that are applicable to visual impacts, as well as specific environmental issues relating to, for example air and water quality. This white paper states that new environmental problems should be avoided by considering the environmental impacts in the early stages of the development process.

10.5 The "Environmental Guidelines for Planning in Hong Kong" (Ref 10.2) (containing extracts from the Hong Kong Planning Standards and Guidelines) make no specific reference to visual impacts in their "guidelines on environmental matters which should be considered in planning and development activities in Hong Kong".

10.6 The only directive from the Hong Kong Environmental Protection Department (EPD) is published in an advice note (Ref 10.3) which offers guidelines on the environmental impact process for major private sector projects. This recognises visual impact as an issue of concern.

10.7 Clearly, these general statements offer little guidance on criteria for visual evaluation or methodologies for assessing visual impacts and acceptable standards. In the absence of formal guidelines, recognised visual assessment methodologies from overseas have been adapted to the particular Hong Kong conditions. These are methodologies currently in use in the USA and UK.

10.8 The recent (July 1993) Hong Kong Government Works Branch Technical Circular entitled "Control of Visual Impact of Slopes" (Ref 10.4) is relevant to this project. This document outlines a policy that design of new, man-made slopes should give due consideration to minimising adverse visual impacts. It states that where possible, project layout should be amended to avoid or reduce in size large slopes which are difficult to satisfactorily blend with the environment. In addition, wherever possible, existing vegetation should be preserved.

Background Information

10.9 Chapter 2 gives a general description of the study area and therefore this section examines the existing visual context and identifies key viewpoints to the proposed Green Island Public Dump. This area of Hong Kong Island will, nevertheless, be the focus of considerable change in the years up to and beyond the turn of the century. The future visual context is therefore also considered.

Existing Visual Context

10.10 The proposed public dump will reclaim the harbour area between the shoreline of Mount Davis and Green Island. Both Mount Davis and Green Island are distinctive landforms, with steep vegetated slopes down to a rocky shoreline. These two landscape features create a distinctive marine "entrance" to Hong Kong from the busy Lamma shipping channel. The Metroplan Landscape Strategy for Urban Fringe and Coastal Areas (Metroplan) (Ref 10.5) emphasises their visual importance noting that they mark the "western limit of Hong Kong's major ridgeline". Although close to the dense urban area, they remain essentially unspoilt, natural features on the visually prominent, northwest corner of Hong Kong Island.

10.11 Mount Davis forms a distinctive landmark, especially visible on seaward approaches to Hong Kong from the south and west. Its conical landform effectively screens views of the built skyline. The slopes of Mount Davis, adjacent to the project area, represent the only undeveloped section of Victoria Harbour and Hong Kong's northern shoreline. This is especially noticeable along its waterfront edge; contrasting with the active and densely developed Kennedy Town frontage.

10.12 The hillside has a uniform and natural appearance with a few low-rise developments on the hillside above Victoria Road. Ruins on the slopes below Victoria Road indicate previous military structures and developments. It is suggested that stability issues have limited further development in this area. These slopes, below Victoria Road, are zoned Green Belt and residential (RB) on the Kennedy Town OZP. Metroplan identifies these residential sites as "Development Areas with High Landscape Value" and recommends specific development control policies to protect and conserve the existing landscape features. These include protection of existing woodland and careful control to ensure compatible development.

10.13 Although smaller in scale and mass, Green Island creates an important visual element in the land and sea-scape. While its northeastern shoreline has been altered and low buildings constructed, most of its shoreline remains undisturbed. The slopes are vegetated and appear predominantly natural with only a lighthouse on the western side and mast on the summit.

10.14 The MLS designates Mount Davis and Green Island as Landscape Protection Areas. The strategy states that Mount Davis shall be retained as a natural backdrop and developed as an urban fringe park to provide active and passive recreation for the urban population. Green Island is also proposed as an urban fringe park.

10.15 To the east of the project area, lies Kennedy Town. This older, mixed use and densely developed community is concentrated on the flatter land, adjacent to the harbour.

Community life is still closely connected to its waterfront location. Godowns industrial uses and cargo handling areas line the waterfront edge with mixed residential, commercial and retail activities supporting these land uses.

10.16 The area around the former KTIP site is flat to the north at Victoria Road. It is characterised by an active zone of waterfront related uses as well as a mortuary and abattoir in large scale, medium-rise buildings which effectively obscure views of the waterfront from the immediate vicinity. A large low-rise market also dominates this bustling area. To the south of Victoria Road, the land rises forming the lower slopes of Mount Davis. This hillside is intensively developed; dominated by medium-rise schools and medium to high-rise residential blocks.

10.17 Currently, the decommissioned Kennedy Town Incineration Plant and its chimneys form a dominant element in the view from the surrounding areas. The existing plant and structures will be demolished by mid-1995, effectively removing a significant "eye-sore" from the area and generally improving views to the waterfront. The baseline condition for the visual assessment is therefore considered to be the vacant KTIP site.

Identification of Key Viewpoints

10.18 Key viewpoints to the project area within the defined visual envelope are identified and their sensitivity assessed. These are described below, located on the plan (Figure 10.1) and illustrated in Figures 10.2 to 10.6:

- Mount Davis Cottage Area (Kung Man Tseun) is located above Victoria Road and consists of low-rise, low-density village-type houses. The western section would appear, on plan, to overlook the project area however, the topography and vegetation on the slopes below Victoria Road effectively screen the shoreline and approximately 50% of the project area. From the adjacent Caritas School more of the project area will be visible from the upper floors. From both these sensitive viewpoints, Green Island and part of the Sulphur Channel are clearly visible. Views of the project area from the main, eastern section of Kung Man Tseun are screened by a minor ridgeline and its associated vegetation.

- The Kennedy Town Temporary Recreation Ground, providing hard-surfaced ball pitches and sitting area, gives public access to the waterfront. From here, the eastern edge of the project area is less than 100 metres away and from the seawall there are clear views of Green Island and part of the Sulphur Channel. From the sitting area, climbers growing on the chain link fence along the boundary with the Refuse Collection Point, effectively screen the entire project area. This area is zoned for future use as a cargo handling area, commercial/godown or bus terminus.

- A low-rise residential building (Old Folks Home) is located on low land to the south of the Temporary Recreation Ground, at the end of Sai Ning Street. The main building facade is orientated to the north. There will be oblique views of the project area from windows on this side and direct views from the western side of the building. The south west corner of the project area will be completely screened by the lower slopes of Mount Davis. This is one of the nearest highly sensitive view points to the development.

- Serene Court is a high-rise residential tower on Sai Ning Street, on the western edge of Kennedy Town, 200 metres from the edge of the reclamation. Most of the project area is screened from the lower floors by the topography and vegetation on the lower slopes of Mount Davis, as well as the form of the shoreline. The upper floors, with windows on the north and west side are sensitive viewpoints and currently enjoy uninterrupted views of all but the southwestern shoreline of the project area. From the north facing windows there are also extensive views to Kowloon.

- The former paths and building platforms in the area below Victoria Road, on the lower slopes of Mount Davis, are used for recreational purposes in the early morning by elderly people. From here, there are clear and uninterrupted views of the Sulphur Channel and Green Island. The landform, however, obscures views of the shoreline area. While this is a sensitive viewpoint, it is used by relatively few people.

- There are few open views out towards Green Island from the recreational paths on the northern slopes of Mount Davis; dense vegetation effectively screens views from the footpath network.

- From Victoria Road, views out to Green Island are screened in most places, by the vegetation along the road side; trees and shrubs as well as existing climbers on the chain link fence. The only viewpoints are created where the vegetation has been cleared for slope stabilisation work.

- The Kennedy Town waterfront is a busy public cargo working area, lined with industrial buildings and godowns. Intense activity along the shoreline currently impedes extensive sea views and, in addition, viewpoints from such areas are not considered "sensitive".

- The residential towers in Shek Tong Tsui, on Kennedy Town Praya have oblique views of the Sulphur Channel and Green Island, including approximately 60% of the project area. While this is considered a sensitive viewpoint, its significance will be reduced by distance (approximately 1500 metres from the project area) and the alternative, high quality sea views to the north. At ground level and the lower floors, this view is essentially obscured by the activity along the Kennedy Town waterfront.

- From the seaward side, the entire project area will be extremely visible by marine traffic; most significantly the busy passenger ferries from Lamma and Cheung Chau, currently using the Sulphur Channel. A ferry would not usually be considered a sensitive viewpoint, however, in this case most passengers commute daily and will be particularly sensitive to changes in the existing high quality view.

- There are distant views of the project area from the Outlying Islands; illustrated in Figure 10.6. From strategic viewpoints on Lamma, 4 kilometers away, there are views of the western side of the project area. Mount Davis, however, dominates the view and screens part of the project area. The project area is not visible from the main residential areas on the island. On a clear day, the project area is visible from the eastern side of Cheung Chau, more than 12 kilometers away. From Lantau (approximately the same distance away), the view to the project area is interrupted by smaller islands, including Green Island. The project area also forms part of the high quality view from the Outlying Islands. However, as a relatively small component of the overall view, this can be completely obscured by a container ship in the foreground.

10.19 Several key viewpoints to the KTIP area are identified and their sensitivity assessed. These are described below and also illustrated on Figure 10.1.

- There are several schools with views of the KTIP area:

    - Kennedy Town Government Secondary School

- Lui Ming Choi Memorial Primary School
- St. Lukes Settlement

These will all have views from the higher ground to the KTIP area, which is less than 100 m away. While schools are considered to be moderately sensitive viewpoints, they look out onto a dynamic waterfront and market area. Within this overall context, changes on the KTIP site would not be significant.

- Several residential buildings have views to the KTIP area. These include :

    - Low-rise dwellings on the eastern side of the Mount Davis Cottage Area (Kung Man Tsuen)
    - The upper floors of the medium rise Block C of the Sai Wan Estate
    - Direct views from the north facing windows of the medium-rise residential blocks at 29 and 33 Ka Wai Man Road.
    - Partial views from the medium-rise North and West Terrace Territories of the Sai Wan Estate.
    - Views from the west facing windows of the upper floors of the high-rise Centenary mansion and the adjacent block.

    The general view from these blocks is of the busy Kennedy Town waterfront area; of which the of vacant KTIP site would form a relatively small component. These properties will also get good harbour views and distant views over to Kowloon. Changes on the KTIP site would therefore have a minimal impact.

- The KTIP site is not visible to pedestrians on Victoria Road but would be extremely visible from the workshop on the adjacent site to the south. The workers in this building would, however, be classified as moderate to low visual sensitivity viewpoints.

Future Visual Context

10.20 The visual environment in the Green Island area will experience a considerable change as a result of the proposed progressive development of the Green Island and Belcher Bay reclamation as well as the related built developments and the construction of Route 7 and the Green Island Link. In addition, changes will ensue as a result of the IWTS, Sewage Master Plan and other public utility developments.

10.21 The Green Island Reclamation is the subject of a Government feasibility study which is currently in the draft final report stage. As part of the Green Island Reclamation Feasibility Study (GIRFS)(Ref 10.6), a Recommended Outline Development Plan (RODP) has been drawn up in full consultation with Government. This document is also accompanied by Master Landscape Plan.

10.22 The design principles for the future development on the reclamation are set out in the GIRFS. Metroplan recommendations were adopted as the basis for the future visual character of the area. The distinctive visual character of the natural features of Green Island, Little Green Island and Mount Davis gave rise to the urban design form and landscape strategy for the reclamation. This is summarised below :

- The vegetated backdrop provided by Green Island and Mount Davis was considered to be important as a natural element, contrasting with the high rise development; an image that characterises Hong Kong. GIRFS Technical Paper No. 13 (GIRFS TP13) (Ref 10.7) states: "views from the reclaimed area will have high interest and scenic value." To support this recommendation, visual improvements were identified for the slopes in Kennedy Town and Mount Davis.

- These natural landforms were considered visually important in juxtaposition to the tower blocks on the reclamation. These natural features will still dominate the landscape and the height and spacing of the blocks will maintain the natural skyline.

- The urban design established a system of visual corridors through the development; from the waterfront to Mount Davis and Green Island, as well as forming connections with Kennedy Town. On the RODP, the visual corridors are designated as open space.

- The GIRFS proposed that both Green Island and Mount Davis should form key elements in the landscape framework for the reclamation and the focus of recreational activity by preserving the island and designating it, and the surrounding area, as an Urban Fringe Park on the RODP.

10.23 According to the RODP, the majority of the study area, once reclaimed, will be developed for residential and open space use. An informal waterfront promenade will be developed along the western shoreline.

10.24 The GIRFS shows Route 7 and its associated slip roads located on the reclamation at the base of Mount Davis. In the east of the project area, the roads will be on embankment, with the slip roads at +12.8mPD and the main alignment at +9.2mPD, gradually falling towards a major roundabout and the western seawall. Ultimately, the Route 7 link to Aberdeen will continue along the shoreline at the bottom of Mount Davis; constructed on a vertical retaining structure. A drainage "fairway"(200 year flood channel) is indicated between Mount Davis and Route 7. This is designated an Amenity Area, to be planted with grass and trees for informal recreation.

10.25 While the base of Mount Davis will be dominated by a major highway, it is not intended to encroach on the lower slopes of Mount Davis. The road is relatively low lying and, as it is constructed on embankment, its visual impact will be reduced by trees and shrubs planted to reflect the natural slopes of Mount Davis. The continuation of Route 7, around the base of Mount Davis will result in the loss of natural shoreline in this area.

10.26 In summary, the view from the sea is probably the most significant viewpoint of the project area as it is currently the only unobscured view of the entire area. This is especially relevant in the context of the future development on the reclamation. From other key viewpoints, the area at the base of Mount Davis is obscured by landform or existing foreground vegetation. Part of the Sulphur Channel and Green Island are visible from most viewpoints. From more distant viewpoints, foreground activity and alternative sea views assist in partially screening the project area.

Visual Assessment Methodology

10.27 Visual evaluation and assessment is a subjective, and sometimes emotive, subject; it is based on a human response and opinion so the results can be as varied as the individuals involved. While the concept of human 'preference' has been researched for natural landscapes in Europe and the U.S., few studies have been undertaken in Asia or in developed urban settings, such as those found in Hong Kong.

10.28 In order to establish a more solid scientific base for visual evaluation, several assessment methodologies have been devised which attempt to quantify visual elements. Complex mathematical strategies for their ranking and evaluation are then proposed. As this type of approach is ultimately based on subjective judgments, the end result inevitably endorses the initial subjective response. The procedure (while of some value in comparing several visual impacts) is, in most cases, unnecessarily complex.

10.29 Some methodologies define a visual "envelope" indicating on plan, an area affected by the proposed development. This approach is considered a useful visual assessment methodology where each location on a plan represents one viewpoint; for example in rural areas. In the densely developed, urban areas of Hong Kong, this can be misleading and over simplistic approach. For example, a high-rise residential building will have a range of views, from different floors and from different facades, within a building. On plan, such a building would fall within the "visual envelope, however, it is likely that some flats would actually not be affected by the development in question. In addition, high-rise buildings in the foreground, can screen views of more distant view points from some floors and not others.

10.30 For the purpose of this study, visual evaluation and assessment is based on the following methodology which is considered most appropriate in this case. It is based on the methodology usually adopted for the assessment of other environmental impacts, such as noise and air quality. Sensitive users or "receivers" are identified and the impacts assessed.

10.31 Key viewpoints (receivers) to the development are identified. These viewpoints are considered to have varying degrees of "sensitivity" to changes in the view. Sensitivity is based on the land use at each viewpoint. The Environmental Guidelines (Ref 10.2) define sensitive users as "land uses which, by virtue of the nature of the activities thereon .... are susceptible to the influence of residuals or physical changes generated by polluting uses". Visual impacts will not result in physical changes to the users in the area, as would possible damage to health from the effects of air pollution. Visual impact is therefore assessed in terms of the impacts on the "quality of life" of the users at the key view points.

10.32 Quality of life, like visual impact is a subjective term. for the purpose of this study, it is generally assumed that :

- Residential viewpoints are considered highly sensitive as the users (the residents) will be particularly aware of any visual changes. Residents are likely to care about the views from their homes as this is where they are likely to spend their leisure time. Visual impacts will have the most significant effect on the overall quality of life from a residential area. In addition, residents are likely to have a financial interest in the property (either ownership or rental) and a change in the visual quality of views or the surroundings could have significant financial implications due to changes in property values.

- Views from commercial developments, school and public open spaces are considered moderately sensitive. In the case of schools and offices, while users may be at these viewpoints regularly, they are primarily there for another reason i.e. for study or work. In the case of open spaces, these are likely to be visited for shorter periods of time and there will be an element of control or choice in their use. A change in the view from these land uses will have a less significant effect on the overall quality of life of the user.

- View points from industrial areas and transport corridors are considered to have low sensitivity. In industrial areas, users expectations of visual quality are low and the users are there primarily for another reason i.e. to work. Users of transport corridors are subject to changes in a view for a relative short period of time. A change in the view will therefore have an insignificant effect on the overall quality of life from such view points.

10.33 As stated, the "sensitivity" of each viewpoint is based on the land use at each location. In addition to this general classification of sensitivity, also of importance are :

- the distance between the viewpoint and the new development,

- the number of people at each of the viewpoints,

- the number of times people will look at the view while at this viewpoint,

- what the viewer will be doing at the time (for example, sleeping, morning exercises),

- light, air and general weather conditions will affect the view (hazy conditions, which prevail in Hong Kong during the summer months, reduce contrasts within the visual environment),

- the size of the development in relation to the overall view (the impact will be less significant if part of a wide or panoramic view),

- the overall quality of the existing view; this will be influenced by the extent and type of existing man-made development.

10.34 Having established the sensitivity of the viewpoints to the new development (a factual exercise), the overall visual impact can be assessed. This is based on objective professional experience, with consideration of the following:

- visual obstruction; the extent to which the development will block a view,

- visual intrusion; the incompatibility of the development within the existing view. This is created by the introduction of contrasting and incongruous forms, textures and colours,

- visual quality; a judgment of the effect of the development on the existing visual quality of the area.

Impact of Construction Activities

10.35 Construction impacts are those resulting from work related to the construction of the temporary and permanent seawalls to contain the dumped materials. This will include dredging, sea wall construction, laying of the sand blanket and associated drainage works. The impacts of the construction of the access road are also included in this section.

10.36 As vehicular access to the site will not be achievable until early 1996 (Ref 10.8), construction activities will be carried out by marine vessels. These will include grab dredgers and trailer dredgers to fill the underwater trenches with materials transported by barge. This type of activity is extremely common in the waters around Hong Kong, where several large scale projects of this nature are in progress. In addition, there is also considerable marine activity along the adjacent Kennedy Town waterfront. This marine activity will be most noticeable from the seaward side however, within this context, it is not considered to be a visual intrusion.

10.37 Visual impacts could result from siltation due to dredging operations. From elevated viewpoints, such as Victoria Road and the nearby residential towers, this would create an obvious and unnatural visual intrusion. The use of a silt curtain around dredging equipment would minimise the visual, as well as other environmental, impacts.

10.38 The Preliminary Implementation Programme (Fig. 3.3) indicates that construction activity will be concentrated in the early stages of the project (1995 to 1996) when the Stage I Advance Works in Area 1 will be in progress as well as the seawall construction in Area 2. Construction activities will resume once public dumping in Area 1 is nearing completion (1997 - 1998) and again, in the last year of dumping in Area 2 (2000).

10.39 Most of the construction work will take place below sea level. The sea wall will only be visible once it is nearing completion and will form a relatively minor visual feature within the context of the project as a whole. The final design of the permanent seawall is, however, an important issue and will be referred to under completion impacts.

10.40 The most visible part of the construction activities will be the reclamation for the barging platform in Area 1. The Summary of Key Findings (SKF) (Ref 10.8) also suggests that it may be necessary to construct part of the Advance Works reclamation to accommodate the rock crushing plant. A 100 metre by 50 metre reclaimed area is required.

10.41 As illustrated in Figure 10.7, Area 1 is the least visible part of the project area when viewed from Hong Kong Island. In this location, the topography of the lower slopes of Mount Davis would screen the rock crushing plant from the sensitive receivers and would therefore have no visual impact.

10.42 Construction activities will, however, be visible from the sea. The Traffic Impact Assessment (Marine) (Ref 10.9) states that work associated with Stage 1 will have no effect an marine traffic. Passenger on ferries, considered sensitive receivers in this case, will therefore be aware of construction activities in this area. The visual impact of this work will be heightened as this represents the first stage of reclamation and future development, along this currently unspoilt and relatively natural part of the Hong Kong Island shoreline.

10.43 The Technical Note (TN) on Sequence of Works (Ref 10.10) suggests that Area 1 Advance Works should become the permanent location for the rock crushing plant for the duration of operations. As this is the least visible part of the Public dumps area when viewed from the land, this suggestion is supported from a visual standpoint. Visual mitigation measures should, however, be considered to screen views from the ferry routes, These could include constructing hoardings around the plant area (painted shades of blue/mauve/grey/blue green) or advance planting of appropriate trees and shrubs along the western seawall. This would be undertaken as part of the early construction activities in this area.

10.44 From viewpoints on land, the Stage II construction works will only have an impact once they have extended well into the Sulphur Channel, towards Green Island. Most of the construction activities for Stage II will be visible from the passenger ferries as the Sulphur Channel routes will not be relocated until after Stage II work has commenced (Ref 10.9). Stage II construction will be taking place concurrently with public dumping operations in Area 2. Within this context, the visual impact of the construction activities will be minimal.

10.45 As the Sulphur Channel will be closed to all marine traffic once work on Stage III commences, this will have no visual impact from the passenger ferries. All Stage III construction works will be visible from the sensitive viewpoints on Hong Kong Island. Within the context of public dumping operations that will be taking place simultaneously in Areas 3 and 4 (Preliminary Implementation Programme, Ref 10.8), the visual impact of construction activities will be minimal.

10.46 It has been suggested (Ref 10.10) that the existing USD depot could be used as a combined Works Area for the IWTS and Public Dump Contractors. If this is pursued, visual mitigation measures should be undertaken along the boundary with the adjacent Kennedy Town Temporary Recreation Ground, to screen the activities. A hoarding combined with screening plant material would be appropriate in the area next to the seating area.

Impact of Access Options

10.47 The Traffic Impact Assessment (Land) initially identified two possible vehicular access routes to the Public Dump, known as the IWTS Option and the Disused Track Option. A third option known as the KTIP Barging Point Option is also considered (Ref 10.10).

IWTS Option

10.48 This option involves shared use of the IWTS access road as well as construction of a section of the Route 7 distributor road which would require reclamation along the shoreline. A 10 metre wide access road, intersecting with Victoria Road at 25 mPD, would be constructed on structure, approximately 35 metres to the east of the proposed IWTS access road. The road is then aligned parallel with the IWTS access, through the USD Depot onto the future reclaimed area. The length of road required is approximately 250 metres. The slope area required for construction is zoned "Open Space" on the OZP and is currently steep and vegetated.

Disused Track Option

10.49 This option involves constructing a temporary access utilising the disused track running across the lower slopes of Mount Davis which intersects with Victoria Road opposite the Caritas School at an elevation of +46.9 mPD. This option would require widening the existing narrow track to accommodate two trucks passing, modifying the grade to a maximum 10% and constructing a new section of road to access the southwest corner of the reclamation. Extensive earthworks and structures would be required (Ref 10.10) The area of the slope affected by construction is zoned as Green Belt on the OZP and designated a Landscape Protection Area in Metroplan.

KTIP Barging Point Option

10.50 In order to minimise the land traffic impact, a Marine Barging Point at the existing KTIP site has also been considered. This would involve vehicles driving into the former KTIP site (the buildings and chimneys are scheduled to be demolished by beginning of 1996), unloading public dump material directly on to barges for dumping on the Public Dump, then turning around and driving out of the site. The operation will require only a paved area to accommodate vehicle movement and waiting. It is not anticipated that material will be stockpiled on site.

10.51 However, the visual impact of marine and both the road access options are assessed in the following sections:

Visual Impact of the IWTS Option

10.52 A visual assessment of IWTS access road was included as part of the IEIA study for this project (Ref 10.11) and will not be considered further in this study. Recommendations were made with respect to its detailed design "to ensure both sympathetic landscape treatment of all parts of the transfer station and reinstatement of all disturbed areas as seen from the nearby viewing points. Additionally, the recommendations are made to ensure that the implementation process adopted will assist in minimizing potential visual impact." It was also stated that "the construction programme design should give attention to phasing and to the reduction of the construction area to a minimum commensurate with technical requirements".

10.53 The IWTS Option would have a severe visual impact from the highly sensitive viewpoints within the Mount Davis Cottage Area, including the Mount Davis Childrens' Playground, as they would look down on the intersection of the access road with Victoria Road.

Off-site screening, in the area of the residential units is recommended. Such mitigation measures would, however, result in screening part of the wider view from this elevated location, which may in fact be undesirable from the residents standpoint.

10.54 The IWTS Option would have an extremely high visual impact on the low-rise Old Peoples Home at the end of Sai Ning Street; the road is shown almost touching the building. In order to fully assess the visual impacts it would be necessary to examine the relative levels of the building and the road at this point. It is unlikely that effective visual mitigation measures would be possible, other than blocking any windows on the western side of the building. When considered in combination with the IWTS access and the other environmental impacts, it would be advisable to consider relocating this facility as it is likely that environmental mitigation measures would be unfeasible.

10.55 The design of the access roads in this Consultancy will not be detailed enough to fully assess the visual impact of this option. The road levels and the extent of any earthworks would need to be examined further as the detailed road design develops in order to assess the visual impacts at the lower levels, where the IWTS Option passes through the USD Depot. It is possible that the landform may screen the access road from the sensitive viewpoints in the Mount Davis Cottage Area.

10.56 Screening at ground level may assist in mitigating visual impacts from the Kennedy Town Temporary Recreation Ground and the lower levels of Serene Court. The upper floors of Serene Court would have a clear view of the access road in this location which would have a significant visual impact. This building will, however, be affected by the IWTS access road therefore the cumulative visual impacts may be less significant in this case.

10.57 The IWTS Option would have the distinct visual benefit of resulting in minimal disturbance to the vegetation and landform of the lower slopes of Mount Davis, designated a landscape protection area in Metroplan. The slope area affected by the IWTS option is currently stabilised with spray concrete and is therefore of low visual quality. The visual impact on the natural slopes, which will be significant when viewed from the sea and the future development on the Green Island, will therefore be minimal.

Visual Impact of Disused Track Option

10.58 The Disused Track Option will have a significant visual impact from the sensitive viewpoints on the western edge of the Mount Davis Cottage Area as well as the Caritas School, which is located opposite the proposed intersection with Victoria Road. A cross section and plan of the slope in this area (Figure 10.7) illustrates the likely visual impact from these sensitive viewpoints. The significance of the visual impact from these viewpoints will be completely dependent on the nature of the road formation, extent of earthworks and the type and extent of slope stabilisation required. Further examination of the extent and scope of works will be necessary in the detailed design stage in order to fully assess the visual impacts, as well as the effectiveness of any off-site screening. Once again, the off-site mitigation measures may have an undesirable impact when considered in the context of the wide view from these elevated viewpoints.

10.59 To meet the reclamation level from this higher level on Victoria Road, a long access road is required. Plans developed for this option (Ref: 10.10) indicate that an additional carriageway would be constructed down-slope of the existing track. Approaching the junction with Victoria Road, the two carriageways are separate but merge again at the junction. Preliminary profiles indicate that most of the new carriageway will be constructed as an elevated road structure. Retaining walls may also be necesssary to support the existing track. Nearing the existing shoreline, at around +22 mPD, the disused track ends and a new access is required. Here, it is proposed that both carriageways would be an elevated structure which would include a hair-pin curve, just beyond the limit of the western seawall. Below +13mPD, the access road would be formed on fill material.

10.60 The earthworks and road construction operations would inevitably result in the clearing of significant areas of the existing vegetation on the lower slopes of Mount Davis. The visual impacts cannot be fully assessed without more detailed information on the extent of the area that would be affected by construction. It is likely that considerable areas of vegetation on these slopes would be lost, particulary at the lower levels where the access road doubles back and around the hairpin. There is little separation between the carriageways in this area and it is therefore unlikely that any of the existing vegetation could be retained. This would have a severe visual impact on the views from the ferries. In the long term it could have a severe visual impact on the future development on the Green Island reclamation and more distant viewpoints.

10.61 Without geotechnical information on the stability of the slope it is not possible to assess whether temporary or permanent reinstatement of the existing vegetation would be possible. It is likely that the steepness and/or stability of the resulting slopes could preclude the planting of trees and shrubs in the short term. In the worst case, from a visual standpoint, it may be necessary to stabilise the slopes with spray concrete which may have to remain following removal of the access road.

10.62 It is unlikely that reinstatement of vegetation directly below the elevated structure would be possible due to lack of natural water and low light levels as the slope is west facing. Reinstatement in the area adjacent to the structure would be dependent on any slope stabilisation required and the methods employed.

10.63 Initial plans and profiles indicate that minimal vegetation disturbance will be required above the disused track, below Victoria Road. This will assist in mitigating views from Victoria Road, although due to the angle of the track, it will not assist in mitigating views from the Caritas school (Figure 10.7).

10.64 In order to make this route functional in civil and geotechnical engineering, as well as budgetary, terms, it could be difficult to reinstate any vegetation in this area. This would have an appreciable visual impact on the short-term and possibly long-term appearance of the lower slopes of Mount Davis especially from existing and future viewpoints to the north. In accordance with the new Works Branch Technical Circular on the appearance of slopes, alternatives that involve minimising the impact to existing vegetation should be considered wherever possible.

Visual Impact of KTIP Barging Point

10.65 Although the KTIP area is surrounded by sensitive viewpoints, the activities involved in the construction are not extensive and therefore impacts will be limited. The major visual impact of on-site activities will be related to the demolition of the KTIP structures and levelling of the site. Demolition works will result in a visual improvement in the area from existing viewpoints as the large incineration unit and chimney stacks will be removed.

Impact of Operational Activities

10.66 Operational activities consist of the actual dumping operations to fill and reclaim the area defined by the seawalls. The visual impact of these operations will depend on the strategy adopted; end-dumping by vehicle, marine dumping by barge or a combination of both. Marine dumping would be less visually intrusive within the existing seascape. The retained vegetation between Victoria Road and the disused access track will assist in mitigating the visual impact of trucks hauling material down to the dump.

10.67 The progressive reclamation of this area, from sea to land, will have a significant visual impact from all viewpoints. Reclamation in this area represents the alteration of the last section of undisturbed shoreline on the northern side of Hong Kong Island. The reclamation will create a significant visual intrusion as it will introduce a contrast in texture, colour and form and mark the transition from natural to man-made; a high quality seaview, will become a low quality view of a construction area for years to come.

10.68 The visual impact of this initial phase of the reclamation in this area will be the most significant as it marks the transition from natural to disturbed.

10.69 The visual impact will be particularly significant from higher viewpoints which look down on the reclaimed area, such as along Victoria Road and Kennedy Town. Stage I and most of Stage II of dumping operations will not be visible. Only as dumping moves towards Green Island will there be any significant visual impact. While the impact of the operations will be significant, due to the low population in the area relatively few people will be affected by this dramatic visual change. In addition, the existing screen of vegetation along Victoria Road will assist in mitigating the visual impact. The photomontage (Figure 10.8) illustrates the view from the Hill above Belchers; a distant and higher elevated viewpoint, popular for morning exercise.

10.70 The latter stages of the Public Dump operations will be clearly visible from the Mount Davis Cottage Area (Kung Mun Tsuen). The residents of this area will experience a severe, negative visual impact during the operational stages of the Public Dump (as well as during the subsequent construction work on the reclaimed land). It appears, however, that there are preliminary plans to relocate this community; dependent on the underground abattoir proposal. This would effectively remove one of the highly sensitive viewpoints and reduce the visual impact of the public dumping operations. As there is no programme for such relocation, it must however be assumed that there will be visual impacts and mitigation measures (probably off-site screening) will be necessary.

10.71 From lower levels on land and more distant viewpoints, the visual impact of this part of the reclamation will be slightly less significant than from higher viewpoints due to its relatively low profile (maximum 6mPD). The photomontage illustrates the visual impact from sensitive viewpoints on Kennedy Town Praya. (Figure 10.9)

10.72 Stage I public dumping operations in Areas 1 and 2, as well as some of the Stage II operations, will have a significant negative visual impact on the commuters on the outlying island passenger ferries. This is illustrated in the photomontage (Figure 10.10). As the ferries will still be using the Sulphur Channel route, they will have a close-up view of operations in this area. Once the ferries have been re-routed, the passengers will no longer be affected. Advance planting along the western sea wall would, nevertheless, assist in mitigating the visual impacts from these sensitive viewpoints.

10.73 As summarised in the GIRFS Draft Final Report (Ref 10.6), "During construction of the reclamation, it is unavoidable that there will be a high degree of visual disturbance resulting from reclamation operations. This will be visible from afar, from the sea and also by residents and workers in Kennedy Town. Screening large scale reclamation such as this is not practicable except in isolated instances."

Impact Following Completion

10.74 The GIFS TP13 (Ref 10.7) made proposals on the appearance of elements that will be constructed as part of the GIPD project. These recommendations are considered in this section as they have a visual impact on the completion of this project. The guidelines in GIRFS TP13 were endorsed by Government and became an integral component of the overall plan for the Green Island Reclamation.

10.75 The western seawall, constructed as part of the Public Dump project, will become a permanent feature of the reclamation. The GIRFS TP13 established guidelines for its appearance and design. It stated, "The 'gateway' position of the reclamation at the north-west extremity of Hong Kong Island reinforces the need to give careful consideration to the treatment of the wateredge ....the appearance of the edge from the harbour should also be considered". The paper continued, the "water edge ....is one of the key potential landscape and recreational assets" of the Green Island Reclamation and recommended the establishment of a public promenade as a priority.

10.76 The paper identified the western seawall as a "soft" semi-rural/recreational edge and proposed the cross-section illustrated in Figure 10.11. The paper states, "A sloping rock-faced profile is necessary also in engineering terms. The connection between this edge and the natural rock edge of Green Island will need to be carefully detailed, The use of water-worn rocks is preferred especially adjacent to paths."

10.77 GIRFS TP13 highlighted the visual importance of Green Island as a key element in the urban design and open space framework. In addition, the study drew attention to the importance of retaining the appearance of Green Island's existing, rocky shoreline. It is stated, "the proposed general reclamation level of +5 mPD will be on a level with the upper part of the rocky shore, which extends typically up to between +5 and +8 metres PD". Several design options were proposed for the shore edge on the reclamation side of the sea wall, and included:

- reclamation level at +5 mPD at the island edge therefore reducing the depth of exposed rock'
- reclamation level at +5 mPD at the island edge and constructing a new raised edge using water worn rocks to simulate the existing character of the shoreline,
- lowering the reclamation levels e.g. to the high water mark, at the island edges to reveal a greater depth of rock,
- eliminate the rock edge,
- establishing a lake or moat around part of the island.

10.78 The draft Master Landscape Plan for the Green Island Reclamation shows a lake around part of the southern shoreline of Green Island; retaining a section of the existing shoreline as a feature of a future Urban Fringe Park (Figure 10.12). From the TN (Sequence of Works) (Ref. 10.10) it appears that reclamation will take place up to the shore of Green Island which may have an impact on the completion of the project. The Master Landscape Plan is, however, only indicative of the layout of the public open space areas shown on the RODP. The final layout will be subject to detailed design and review on behalf of the managing Department which is, as yet, unresolved. If the lake option was pursued, it would be necessary to re-excavate an area for its construction.

10.79 Components of the Public Dump construction which will become permanent features of the Green Island reclamation should consider recommendations on visual matters made as part of the GIRFS and other studies. Unless the recommendations are now inappropriate, provision should be made for their implementation. If these recommendations are not considered they could be considered to have visual impacts on the completion stage.

10.80 Although the KTIP area is surrounded by sensitive viewpoints, the activities involved in the haulage, off-loading operation and barging will not have a significant impact. The KTIP site forms a relatively small component of the field of view. The operations will be compatible with those in the area and will, therefore, not draw attention to the particular site. (The adjacent markets and abattoir receive regular deliveries by lorry.) Similar barging operations take place on the adjacent waterfront area as well as the China Merchants Wharf. As the operation will affect the adjacent workshop users only, screening (by planting or hoarding) could be considered although is not essential for mitigation of the moderately and highly sensitive receivers. It is also possible that the KTIP barging point option may only be available for the first two years of public dumping and therefore the impacts would not be relevant during completion.

Cumulative Impacts

10.81 Consideration has been given to the number and scale of Government projects, both planned and in progress, in the vicinity of Mount Davis, Green Island and the Kennedy Town Waterfront. When this is considered in combination with the private development that will take place on the Green Island Reclamation, it is apparent that this part of Hong Kong Island will effectively become a construction site for the next 15 to 20 years.

10.82 The existing visual character of the area will change beyond recognition as this relatively undeveloped part of Hong Kong, will be transformed. The natural coastline will be become the interface between the existing natural landscape (on the lower slopes of Mount Davis) and the new urban environment. These natural areas will, inevitably, be under considerable pressure, as a direct or indirect result, of the development in the area.

10.83 A visual study was undertaken as part of the comprehensive planning of the GIRFS (Ref 10.7). In order to follow through the comprehensive and strategic visual aims of this study, it is important that each of the proposed projects respect the need to preserve the lower slopes of Mount Davis and Green Island, identified as natural landmarks within the future urban environment.

10.84 Wherever possible, a coordinated approach should be adopted to issues such as access for the IWTS, MDSTW, Route 7 and the GIPD. Assuming the IWTS access will go ahead, and should the Disused Track Option be selected as access to the Public Dump, in combination, the lower slopes of Mount Davis will suffer a devastating visual impact which will seriously affect the future visual amenity of the development on the Green Island Reclamation as well as more distant views of Hong Kong Island.

10.85 More specifically, the residential towers in Shek Tong Tsui, on Kennedy Town Praya would have oblique views of approximately 60% of the project area. While this is a sensitive viewpoint, it was considered that its significance would be reduced by distance, and the alternative views to the north. From the ground level and the lower floors, this view is essentially obscured by activity along the Kennedy Town waterfront. This activity marks the beginning of work on the Belcher Bay Reclamation and the construction of Route 7 (Sai Ying Pun to Belcher Bay Link). This will take place in very close proximity to these sensitive receivers and will therefore have a more significant visual impact on the residents than GIPD works.

Conclusions and Recommendations

Public Dump

10.86 The construction of the Public Dump will be one of the earlier projects that will gradually transform this last remaining section of undisturbed Hong Kong shoreline into a dense, urban area. Many Hong Kong residents will be aware of operations in this area and the visual impact will be significant. To the sensitive receivers in the area the visual impact will be considerable and unavoidable. There are, however, relatively few sensitive receivers that will be affected by the developments in the long term; the Mount Davis Cottage Area is likely to be relocated and the dominant land use in the area is actually Green Belt. Within this context of change, the impact of the Public Dump will be minimal. It does, however, represent the beginning of that transformation and the overall visual impact will be greater, because of this.

10.87 Following the assessment of possible visual impacts of the construction, operation and completion of the GIPD, recommendations have been made that will assist in minimising visual impacts at the detailed design stage:

- Adopt high visual standards for all operational and cumulative work in this area as a precedent for the future reclamation work and other projects in the area.

- Develop proposals for the construction and dumping operations that will minimise and mitigate any visual impacts.

- Due to its landscape value as a natural backdrop and its role in screening views from the landward side of the public dump, it is important to retain and minimise impact on the vegetation on the lower slopes of Mount Davis, below Victoria Road, during the course of work.

- Locate semi-permanent plant, such as the rock-crusher, as close as possible to the existing shoreline in Area 1 where it will be screened from view from Hong Kong Island. Incorporate hoardings or advance planting along the seawall to screen views from the sea. Particular attention should be given to minimising damage to the Green Island shoreline.

- Careful attention should be given to the detailed design and appearance of the western seawall and its interfaces. If possible, include planting as part of advance works to mitigate views of operations from the west.

- Carry out off-site planting, along Victoria Road and the Kennedy Town waterfront, for permanent and temporary visual mitigation.

10.88 Should vehicular access to the Public Dump prove essential it would be preferable, on a visual impact basis, to adopt the IWTS option to reduce the impact on the visually important lower slopes of Mt. Davis.

Disused Track Access

10.89 The Disused Track option is likely to involve major slope work and extensive removal of the existing vegetation. In accordance with the new Works Branch Technical Circular, alternatives that involve less impact to the existing slope should be pursued wherever possible.

10.90 Care should be taken to minimise the area affected by the work and, in particular, tree felling. It is strongly recommended that construction work is concentrated on one side of the existing track only; thereby preserving any vegetation either above or below the track. Sturdy fences (of non-timber material) should be erected to minimise damage to vegetation to be retained. A tree survey should be undertaken prior to the commencement of construction, to document the trees that will be removed during construction.

10.91 Construction methods should aim to minimise disturbance to the slopes. Engineers should work closely with landscape architects to devise the optimal alignment feasible methods to minimise tree removal. It is recommended that, wherever possible the access road is constructed on a temporary structure to minimise earthworks in the area.

10.92 Once the final access road alignment and areas of disturbance have been identified, detailed landscape proposals for temporary and long-term reinstatement of vegetated areas should be prepared.

Temporary reinstatement

10.93 Temporary reinstatement should be carried out adjacent to the structure to mitigate operational impacts. These areas are likely to be disturbed once the access is removed following completion. Temporary planting should include fast growing tree species, such as *Eucalyptus sps.* and *Acacia sps.* that will create a short term screen.

Permanent reinstatement

10.94 Permanent reinstatement should take place following the construction stage on newly formed permanent slopes that will not be affected when the temporary access road is removed. Permanent reinstatement should also take place following completion. Planting shall comprise a mixture of native and fast-growing woodland tree species. The fast growing species will quickly "heal" the slopes with the native species forming a more balanced ecological mix. Plant selection shall be based on those species removed during construction, as documented in the tree survey.

Marine Barging Point

10.95 In order to delay the significant visual impacts of road construction, the marine access option from the Marine Barging Point is supported on visual grounds in the interim period until the site is re-developed in mid-1997. Construction and operational visual impacts will be limited, where the prior removal of the KTIP structure and chimney stacks will result in an overall visual improvement to the area.

References

10.1 "Pollution in Hong Kong - A Time to Act", White Paper, Hong Kong Government, June 1989.

10.2 "Environmental Guidelines for planning in Hong Kong". An Extract from the Hong Kong Planning Standards and Guidelines. Hong Kong Government, August 1990.

10.3 "Application of the Environmental Impact Assessment Process to Major Private Sector Projects, Advice Note 2/92, Hong Kong Environmental Protection Department, 1992.

10.4 "Control of Visual Impact of Slopes", Works Branch Technical Circular No. 25/93, Hong Kong Government, July 1993.

10.5 Metroplan: Landscape Strategy for the Urban Fringe and Coastal Areas, Strategic Planning Unit, Lands & Works Branch, March 1989.

10.6 Green Island Reclamation Feasibility Study, Draft Final Report, Territory Development Department, Urban Area Development Office.

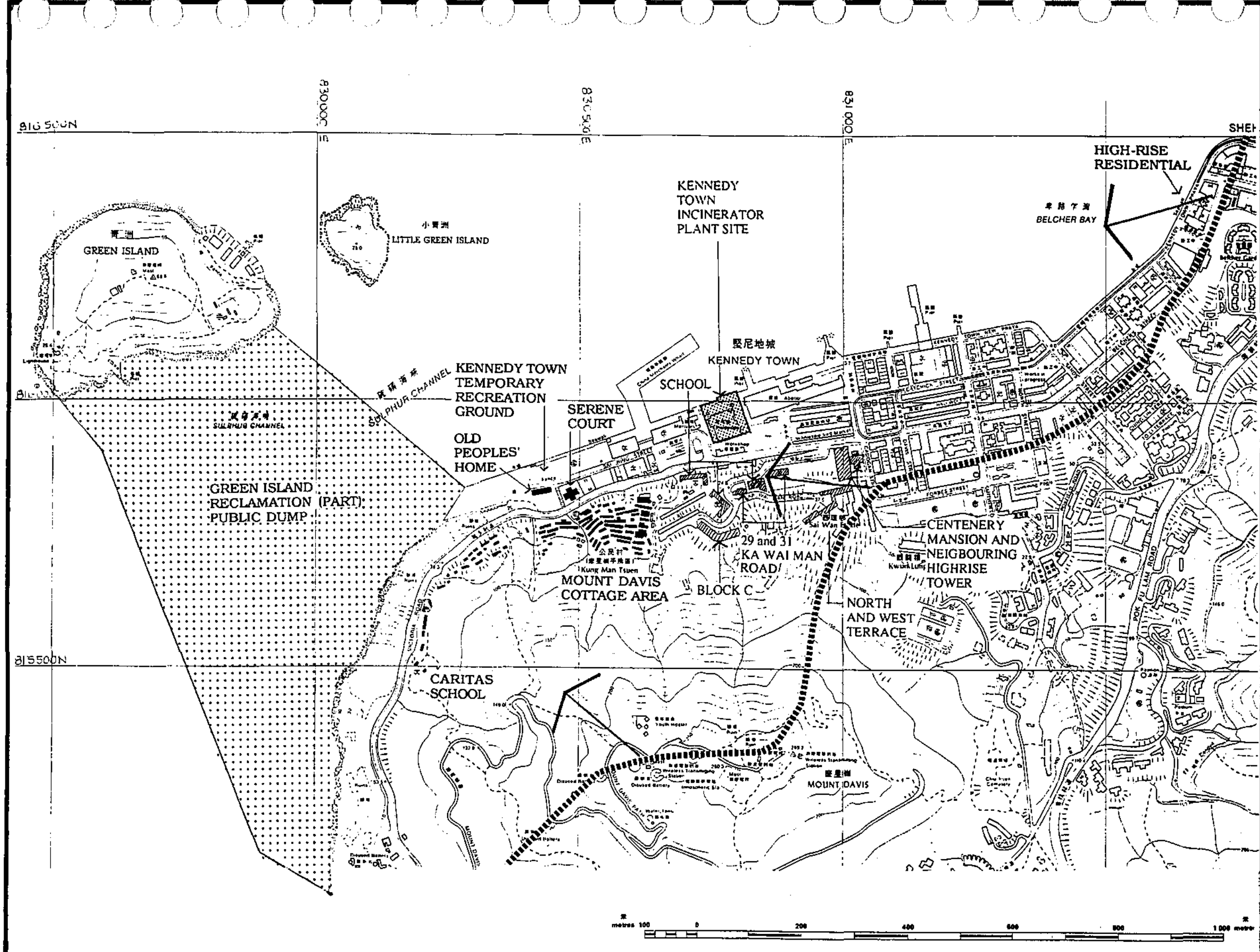
10.7 Green Island Reclamation Feasibility Study, Technical Paper No. 13 "Urban Design & Landscape Guidelines", Territory Development Department, Urban Area Development Office.

10.8 Scott Wilson Kirkpatrick, Green Island Public Dump (Part), Traffic Impact Assessment (Marine). Civil Engineering Department, 1993

10.9 Scott Wilson Kirkpatrick, Green Island Public Dump (Part), Technical Note on Sequence of Works. Civil Engineering Department, 1993

10.10 Scott Wilson Kirkpatrick, Green Island Public Dump (Part), Final Report (Traffic Impact Assessment) Volume 1 (Land). Civil Engineering Department, 1994

10.11 Island West Transfer Station, Initial Environmental Impact Assessment.



KEY

VISUAL ENVELOPE

SENSITIVE VIEWPOINTS TO PUBLIC DUMP

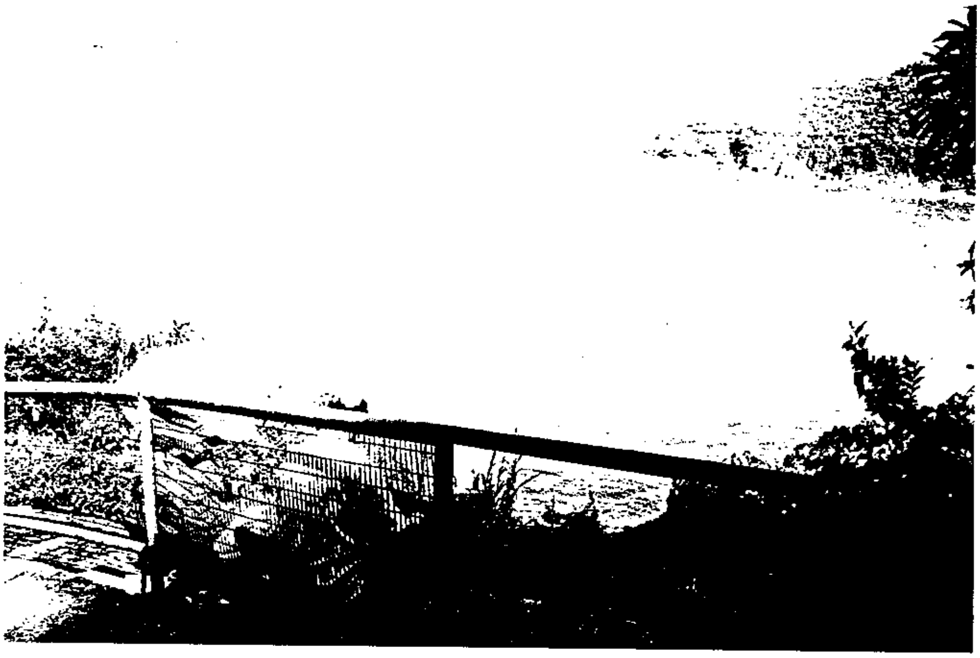
SENSITIVE VIEWPOINTS TO KENNEDY TOWN INCINERATOR PLANT (KTIP) SITE

GREEN ISLAND RECLAMATION (PART) – PUBLIC DUMP FINAL REPORT

Figure No. 10.1

Location of Sensitive Viewpoints

A. A gap in the existing vegetation allows a view of Green Island from Victoria Road.



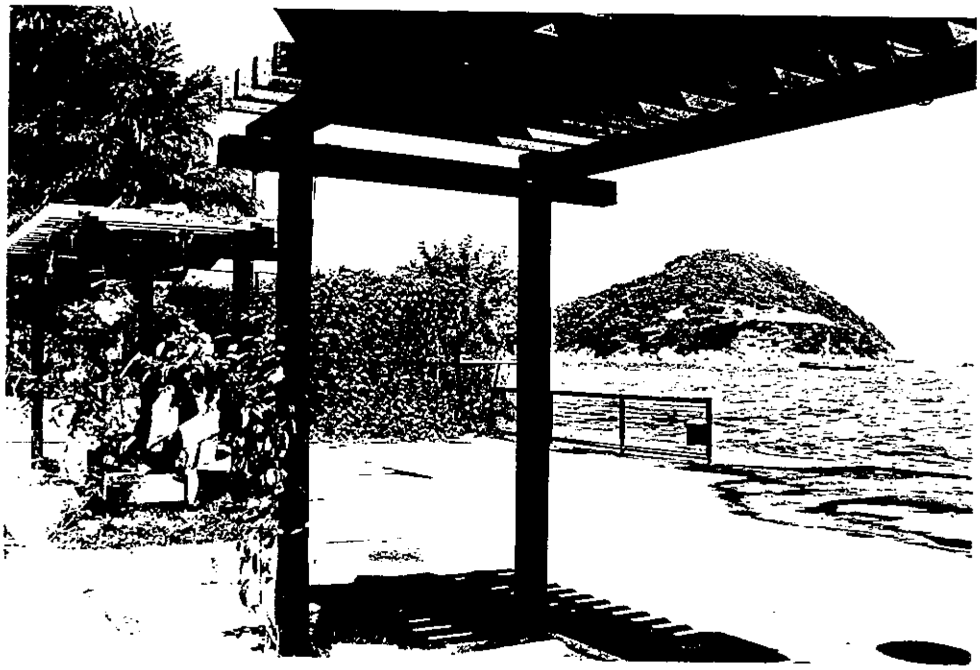
B. Uninterrupted views to Green Island from the track below Victoria Road; used for recreation.

GREEN ISLAND RECLAMATION (PART) – PUBLIC DUMP
FINAL REPORT (EIA)

Figure No.	10.2

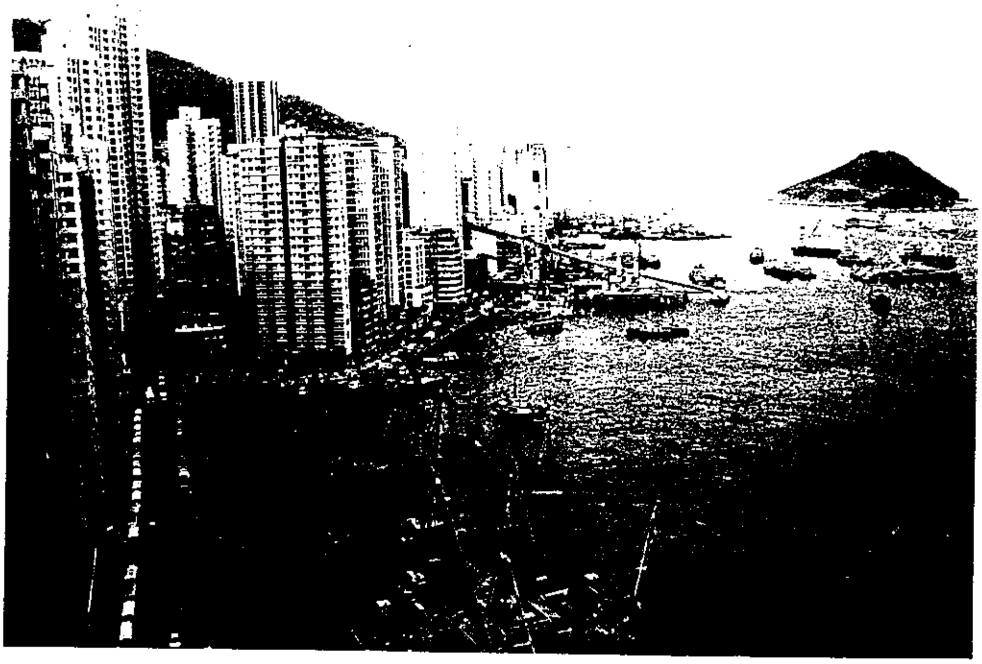
KEY VIEWPOINTS:
VICTORIA ROAD

A. View from western section of Mount Davis Cottage Area (Kung Man Tsuen) partially screened by existing vegetation along Victoria Road.



B. Climbers on fence at Refuse Collection Point screen views from the sitting area at the Kennedy Town Temporary Recreation Ground.

GREEN ISLAND RECLAMATION (PART) – PUBLIC DUMP FINAL REPORT (EIA)	
Figure No.	10.3
SCREENING FROM KEY VIEWPOINTS	



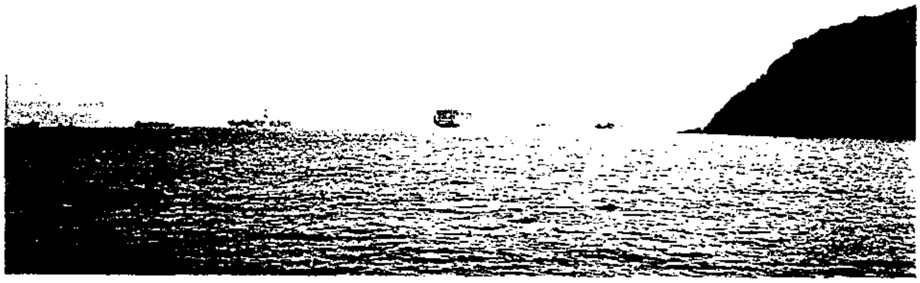
A. From residential towers on Kennedy Town Praya, the distant view is partially obstructed by waterfront activities.

B. At sea level, the more distant view is obstructed by activities on the Kennedy Town waterfront.

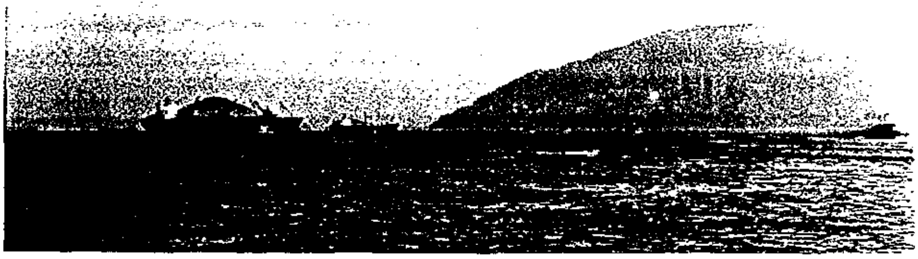
GREEN ISLAND RECLAMATION (PART) – PUBLIC DUMP
FINAL REPORT (EIA)

Figure No. 10.4

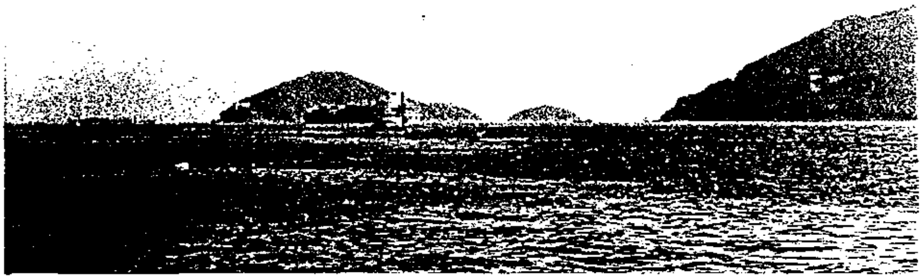
KEY VIEWPOINTS:
SHEK TONG TSUI



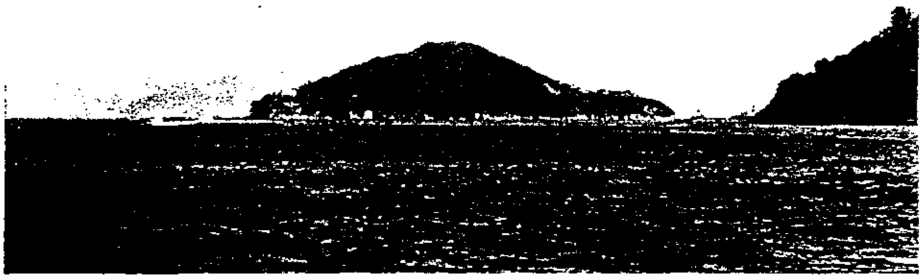
A. Ferry departing Lamma Island.



B. Marine traffic can obscure distant views.



C. Views of project area.



D. Green Island approaches, Mount Davis shoreline is screened.

E. Approaching Western District, the western project area is obscured.

GREEN ISLAND RECLAMATION (PART) - PUBLIC DUMP FINAL REPORT (EIA)	
Figure No.	10.5
VIEWS FROM THE LAMMA ISLAND FERRY	

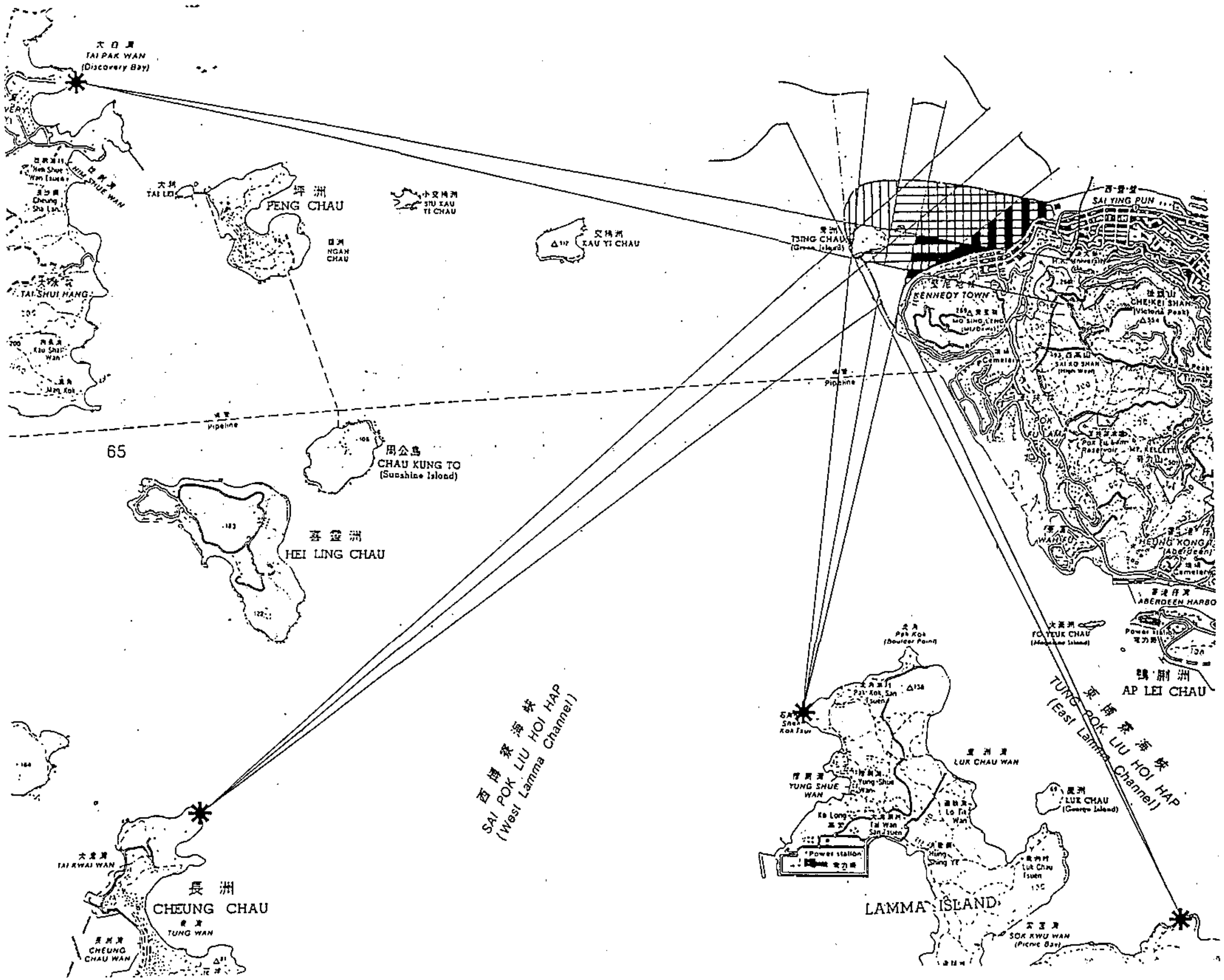


Figure reproduced from the Green Island Reclamation Feasibility Study, Technical Paper No. 13, "Urban Design & Landscape Guidelines"

KEY

- ZONE 1
- ZONE 2
- ZONE 3
- ZONE 4
- ZONE 5
- ZONE 6
- ZONE 7
- View Point
- Limit of Reclamation

In summary:

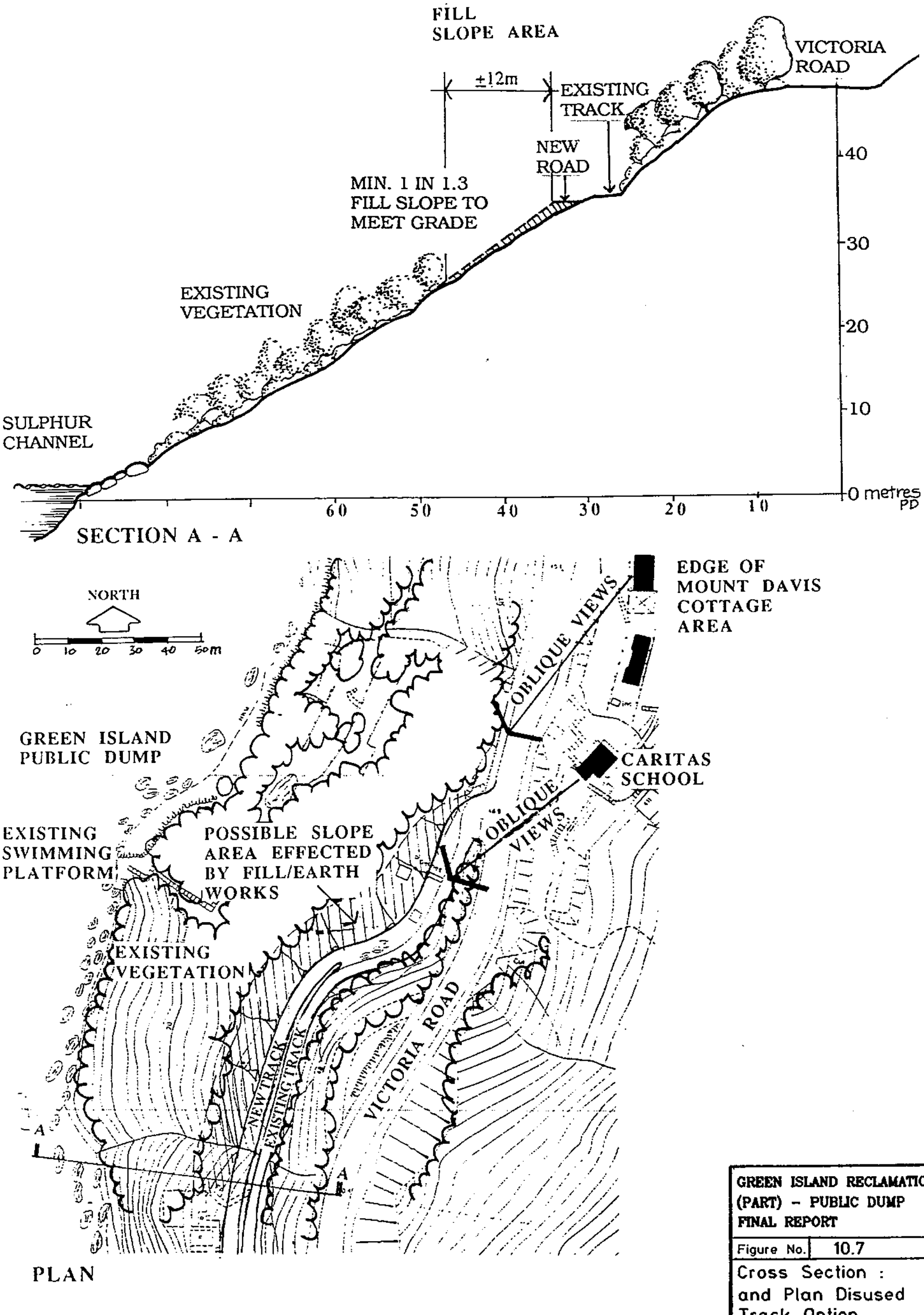
Zone 1= Area of Green Island reclamation screened to varying degrees from all viewpoints.

Zone 7= Area of Green Island Reclamation visually obvious from all viewpoints.

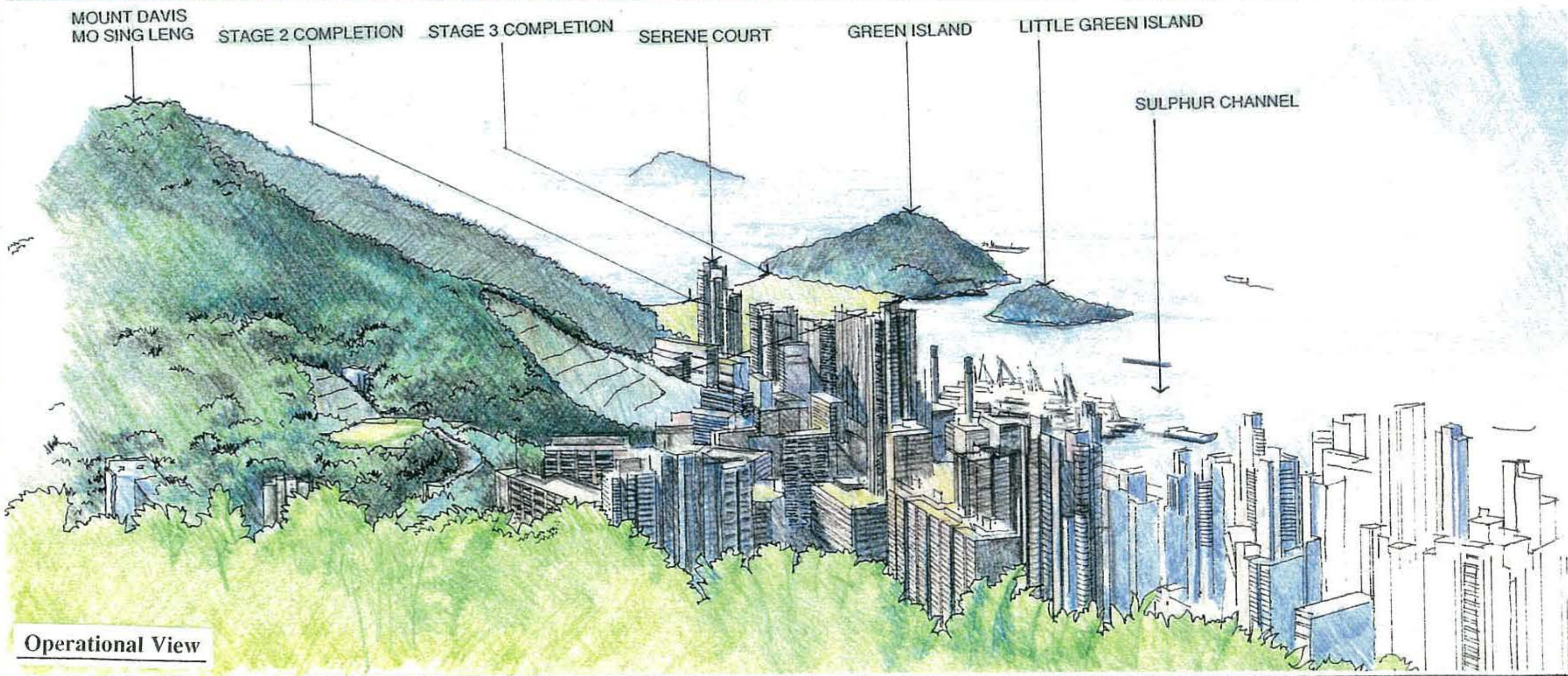
GREEN ISLAND RECLAMATION (PART) - PUBLIC DUMP FINAL REPORT

Figure No. 10.6

Diagram of Views : Outlying Islands



GREEN ISLAND RECLAMATION (PART) - PUBLIC DUMP FINAL REPORT	
Figure No.	10.7
Cross Section : and Plan Disused Track Option	



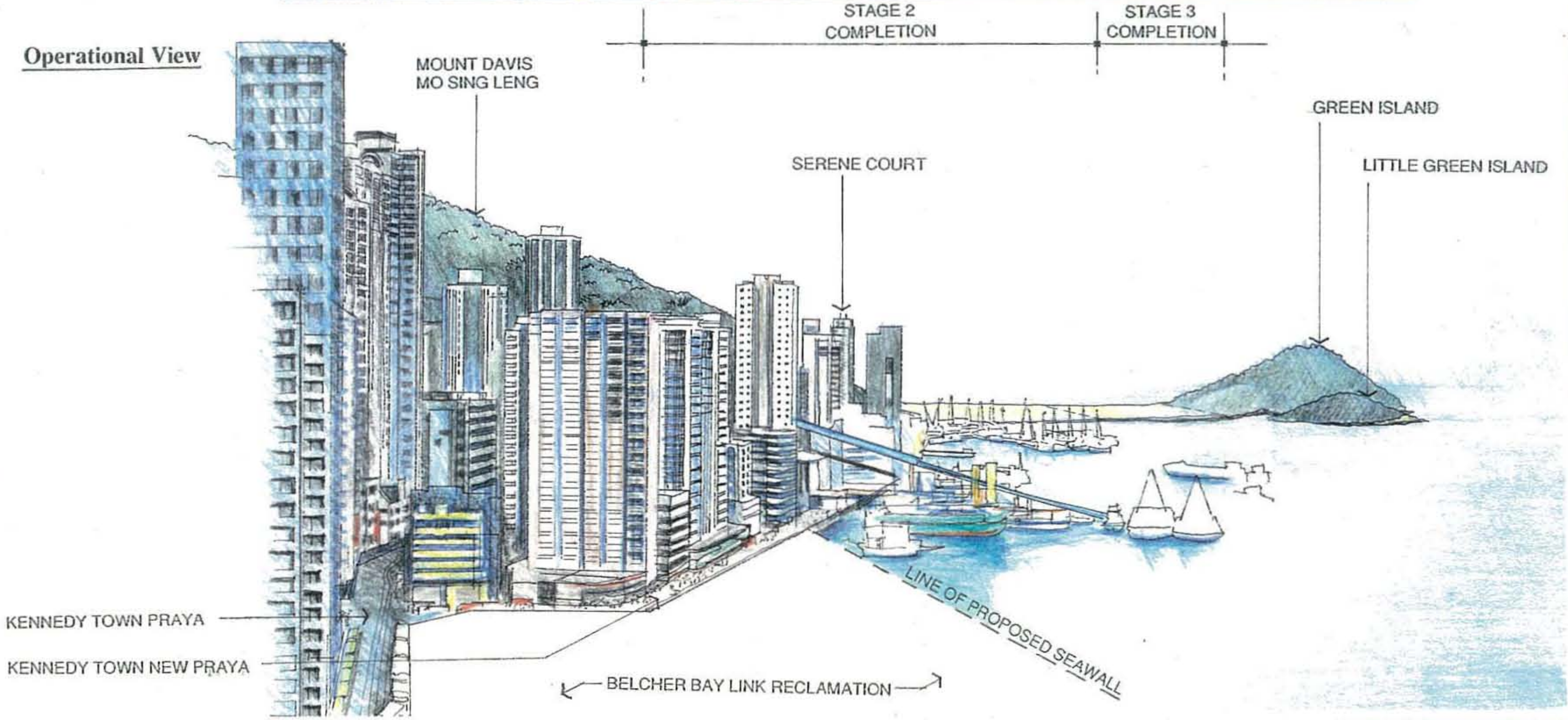
GREEN ISLAND RECLAMATION (PART) – PUBLIC DUMP FINAL REPORT (EIA)

Figure No. 10.8

PHOTOMONTAGE FROM THE HILL ABOVE BELCHERS

Existing View

Operational View



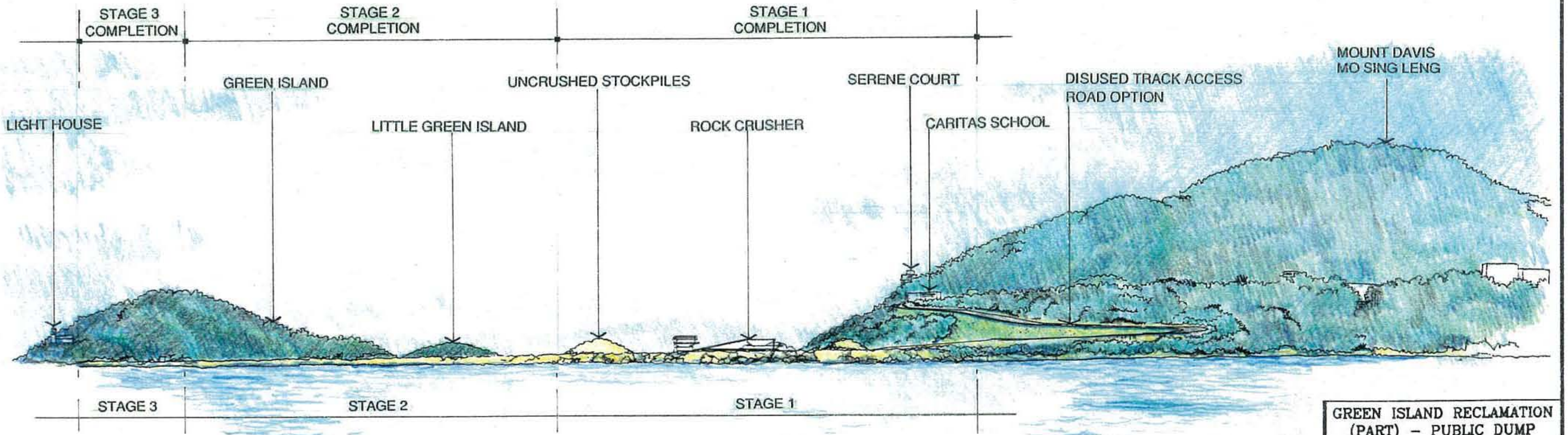
GREEN ISLAND RECLAMATION (PART) - PUBLIC DUMP FINAL REPORT (EIA)

Figure No. 10.9

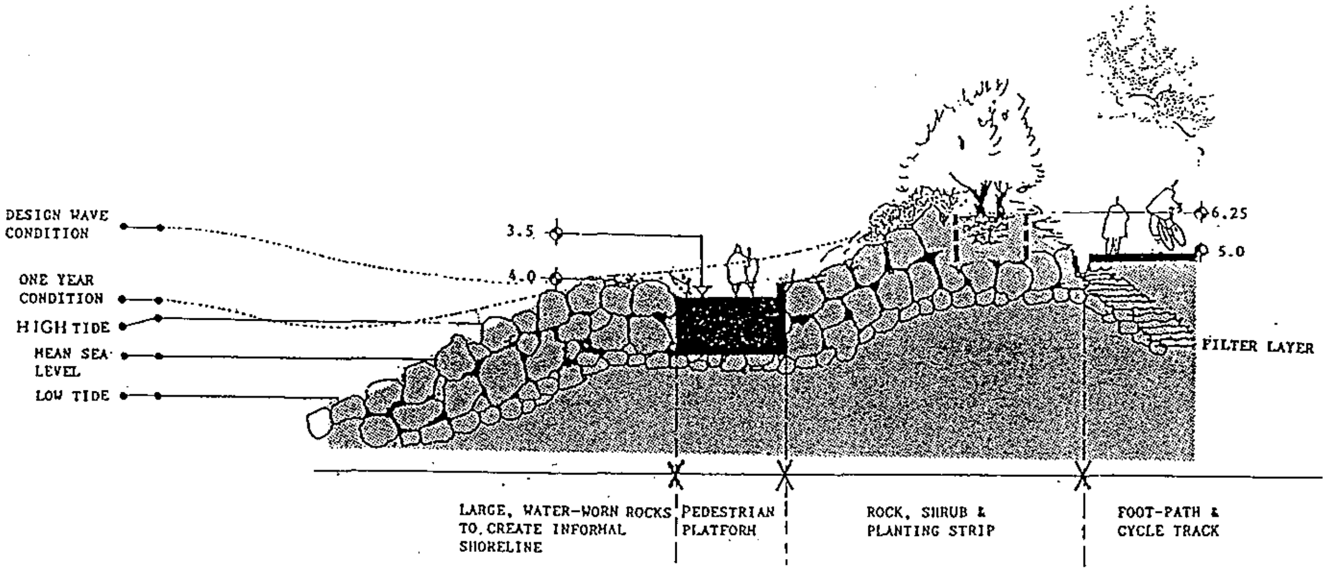
PHOTOMONTAGE FROM SENSITIVE VIEWPOINT ON KENNEDY TOWN PRAYA

Existing View

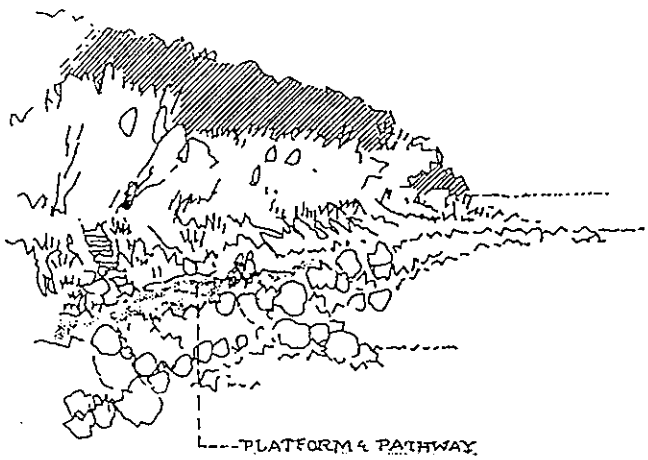
Operational View



GREEN ISLAND RECLAMATION (PART) – PUBLIC DUMP FINAL REPORT (EIA)	
Figure No.	10.10
PHOTOMONTAGE FROM OUTLYING ISLANDS FERRY	



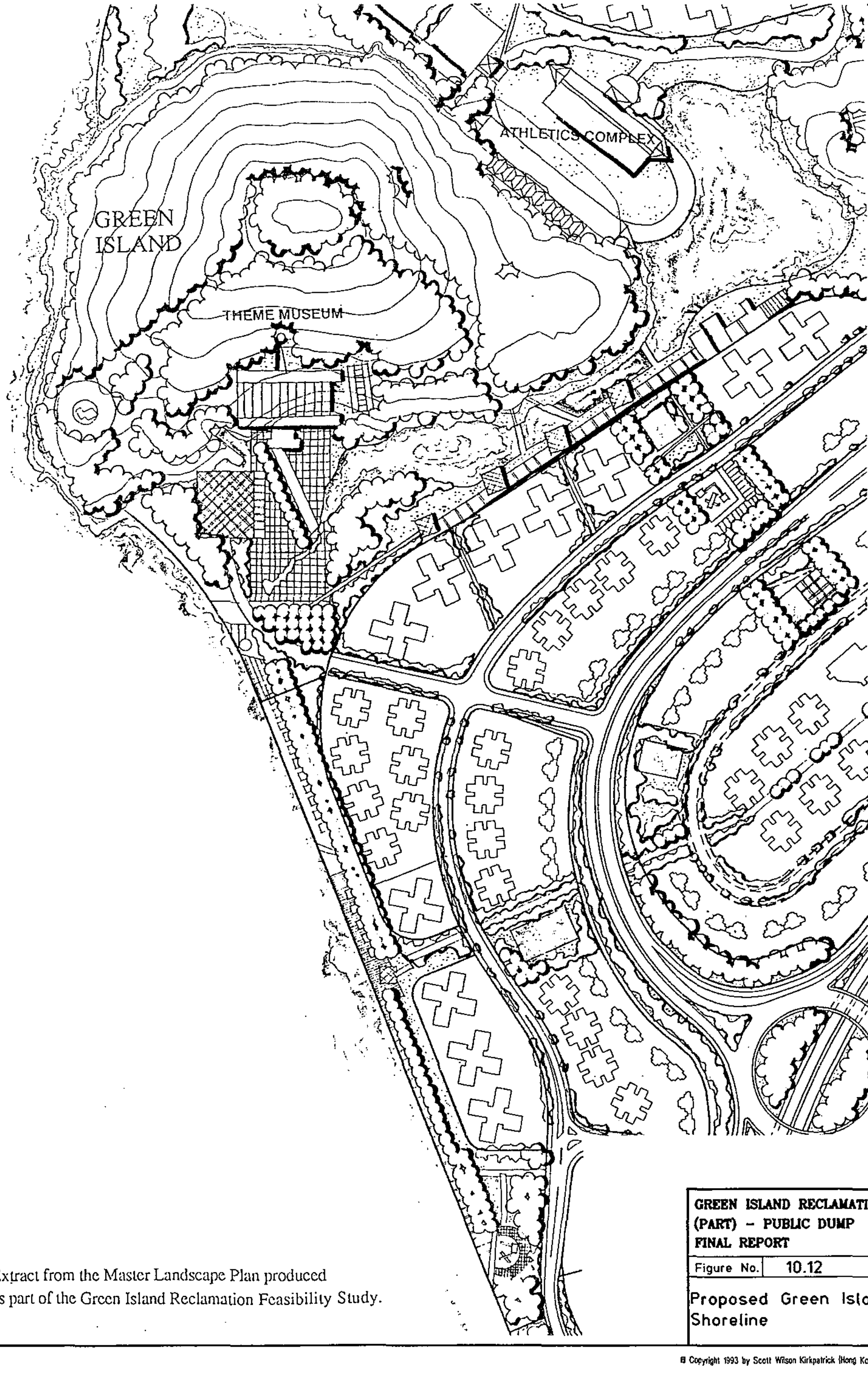
CROSS SECTION



SKETCH PERSPECTIVE

Figure reproduced from the Green Island Reclamation Feasibility Study, Technical Paper No. 13, "Urban Design & Landscape Guidelines"

GREEN ISLAND RECLAMATION (PART) - PUBLIC DUMP FINAL REPORT	
Figure No.	10.11
Detail of "Soft" Edge at Seawall	



Extract from the Master Landscape Plan produced as part of the Green Island Reclamation Feasibility Study.

GREEN ISLAND RECLAMATION (PART) – PUBLIC DUMP FINAL REPORT

Figure No. 10.12

Proposed Green Island Shoreline

11. MONITORING AND AUDIT REQUIREMENTS

Monitoring and Audit

11.1 The contractor shall be responsible for:

- implementing environmental controls and mitigation measures as specified in the Ennvironmental Monitoring and Audit Manual (EM&A) and ensuring that appropriate licences and permits in relation to construction and operational noise, air emissions, dredging of fill material, and dredging and disposal of marine muds are obtained from the relevant Authority; and

- adhering to any reasonable directions given by the Engineer's Representative (ER) with respect to maintenance of plant and equipment and the implementation of Action Plans in response to a breach of Trigger, Action and Target (TAT) limits specified in the EM&A Manual.

11.2 The ER shall be responsible for:

- making provision for a programme of environmental monitoring and auditing in realtion to the construction, operation and post-completion stages of the Public Dump, in accordance to the requirements of EM&A Manual;

- ensuring that control and sample stations are suitably located to provide data of sufficient quality to detect any satistically significant effect of the works in relation to TAT limits specified in the EM&A Manual;

- ensuring that environmental reports and data gathered from the monitoring programme are interpreted with respect to TAT limits, and are completed and presented to the Employer and EPD in an efficient and clear manner; and

- ensuring that directions given for environmental protection by EPD and it's Representative are implemented by the contractor.

11.3 Auditing of monitoring results will be required to ensure that the construction and operation of the sites are compliant with environmental standards and guidelines, and performance criteria, as specified in this Chapter and the EM&A Manual, prepared separately under this Study. The Audit reports should be submitted on a regular monthly basis and be consistent with the requirements of Planning, Environment and Lands Branch General Circular 2/94 (Ref 11.1).

11.4 The EM&A Manual will provide the objectives and responsibilities of monitoring and audit, together with protocols for undertaking the roles. Environmental performance requirements and Action Plans will be formulated, within the constraints applicable prior to the commencement of a comprehensive baseline monitoring programme, and specific control and mitigation measures will be provided. The EM&A Manual therefore augments the content of this Chapter, and acts as the reference document in the monitoring and audit of the Contractor's environmental performance in each of the development phases for the Public Dump and Marine Barging Point.

11.5 It is recommended that the ER establishes a Monitoring Team (usually an analytical laboratory) and an Environmental Management and Audit Team to monitor and review the contractor's environmental performance. The Monitoring Team will be responsible for the collection and analysis of samples under the monitoring programme, as specified in the EM&A Manual. Persons undertaking the monitoring work shall be suitably qualified, and the sampling, analytical and reporting procedures shall be consistent with Hong Kong Laboratory Accreditation Standards (HOKLAS).

11.6 The environmental monitoring programme shall have the following objectives:

- to collect all environmental data necessary to determine any potential impacts identified in the EIA;

- to ensure continuity and consistency with monitoring surveys undertaken prior to the commencement of the works;

- to collect sufficient data to verify the effectiveness of monitoring stations in determining potentially significant impacts in the vicinity of the works;

- to allow data and information to be retrieved and interpreted throughout the operation of the works to verify compliance with appropriate environmental standards and pollution control requirements. Data must be of sufficient quality and quantity to allow the statistical variation to be determined between sample and control locations and between sample periods; and

- to establish a database of monitoring information throughout the control, operational and post-operational monitoring period of the works.

11.7 The Environmental Management & Audit Team will be responsible for ensuring that the works comply with relevant environmental standards and guidelines. The roles of monitoring and audit should be distinct to ensure an independent evaluation and reporting procedure of the contractor's environmental performance.

11.8 The Environmental Management & Audit Team should be independent of the contractor and Monitoring Team, and will report to the ER regarding the contractor's environmental performance and the requirement for the implementation of Action Plans. The key responsibilities of the team shall be as follows:

- to advise the ER during periodic inspections of the works to check working/management practices critical to the environmental integrity and acceptability of the site with respect to the identified environmental issues.

- to check that sampling and analytical procedures used in the monitoring programme are consistent and of an acceptable standard;

- to ascertain whether any extraneous activities to the works area unrelated to the works operation, may have influenced the monitoring data;

- to evaluate changes in measured parameters to detect any deterioration in environmental conditions associated with the undertaking of the works;

- to specify the implementation of staged Action Plans based on predetermined TAT limits to avoid a further detected deterioration in a measured environmental parameter. Implementation of Action Plans may include the specification of an increased frequency of monitoring, revision to operational practices and the application of remedial measures;

- to ensure that Action Plans are properly implemented by the contractor;

- to review actions taken in response to any complaints received from the general public and consider whether any alterations are required with respect to operation of the works. A clearly defined system shall be established to respond promptly to public complaints;

- to review periodically the overall monitoring programme with respect to monitoring locations, frequency, parameters measured, analytical techniques and environmental controls and revise if necessary;

- to conduct review meetings with contractor, Monitoring Team, ER and EPD's Representative to consider environmental performance of the proposed works and to identify any improvements in working practices to avoid any exceedance of TAT limits. Such meetings shall take place on a regular basis (i.e. fortnightly) with provision of more frequent meetings in the event of a breach of TAT limits; and

- to submit regular audit reports on the monitoring programme.

11.9 The tender document for the construction and operation of the sites should include a specification and programme for the environmental monitoring and audit role. Provision should also be made for a suitable baseline monitoring period (see below) to ensure development does not proceed in the absence of adequate baseline data. Details of monitoring regimes and monitoring and audit responsibilities will be set out in the EM&A Manual.

Baseline Monitoring

11.10 The purpose of baseline monitoring is to establish the ambient environmental level of a specified parameter (e.g. noise) prior to development in order to assess the magnitude of predicted impacts as a result of the Public Dump and post-completion phase of the development, and the Marine Barging Point. Baseline monitoring also permits the determination of environmental performance criteria for the construction, operation and post-completion phases of development (Public Dump). From the baseline monitoring programme, the TAT limits for environmental impacts with relevance to appropriate environmental standards and guidelines should be derived.

11.11 Baseline monitoring should be undertaken within a six week period to the commencement of construction by the Monitoring Team. This monitoring should allow for a suitable time period to account for temporal variability in environmental parameters and should be representative of prevailing ambient conditions, both on-site and at the identified sensitive receivers.

Noise

11.12 A baseline noise survey has been conducted as part of this study and the results have been reported in Chapter 4. Due to potential alterations in the ambient noise environment baseline monitoring should be undertaken prior to the construction of the Public Dump and Marine Barging Point. The monitoring locations and the measurement methodology should be identical to those selected and used for previous noise surveys for the purpose of comparing results. Additional monitoring sites should be selected as necessary.

Air Quality

11.13 Baseline monitoring for dust is recommended at Receiver 13 (Chapter 5) and any other receivers identified due to changes in the prevailing air quality environment, as for noise monitoring. Total and respirable particulates (TSP & RSP) should be monitored continuously for two weeks for 24 hour measurements and three times per day for 1 hour measurements. Measurements of baseline dust concentrations for sensitive receivers taken in the vicinity of the Marine Barging Point should be repeated prior to the construction of the Public Dump and Marine Barging Point.

Water Quality & Dredged Sediment

11.14 Baseline monitoring will be required to establish water quality of measured parameters immediately prior to the commencement of works. Measured parameters should include: water depth; dissolved oxygen (percentage saturation and concentration); temperature; salinity; turbidity and suspended solids at three depths including as follows:

- 1 m below the water surface;
- mid-water depth; and
- 1 m above the sea bed.

In water depths of less than 6 m this shall be reduced to 1 m from bottom and surface respectively.

11.15 Monitoring locations should include:

- M1 North-west of Green Island (N817 000 E829 000);
- M2 Off-shore of Kennedy Town salt water pumping station at Station GI-A Chapter) (N816050 E 830490); and
- M3 South-east of the point of the intersection of the sea wall and the land (N 814500 E829 500)

EPD has specified five additional monitoring stations which should be included in the baseline monitoring points. These stations are located at:

- M4 N815800 E829400;
- M5 N816050 E830050;
- M6 N815400 E829550;
- M7 N815600 E829700;
- M8 N816900 E829600.

The locations of the eight monitoring stations are shown in Figure 11.1.

11.16 Monitoring should be carried out four days per week (each day at mid flood and mid ebb tide) for four weeks prior to the commencement of works.

Sewerage

11.17 No further baseline monitoring of sewerage or stormwater outfalls is recommended.

Marine Ecology

11.18 A pre-construction phase study to determine the feasibility of translocating a representative community of marine fauna from the affected shores of Green Island to the north-western shores has been recommended. The scope of this study is described in Appendix 2, Table 3.

Terrestrial Ecology

11.19 A tree survey, as outlined in Chapter 9 should be undertaken within the area of Green Island which will be directly affected by the construction and operation of the public dump.

Visual

11.20 No further visual impact study is recommended at this stage.

Construction Monitoring

11.21 The purpose of construction monitoring is to detect any unacceptable environmental impacts according to legislative standards, appropriate guidelines and established environmental performance criteria.

11.22 All of the key issues addressed in this report will be of importance during the construction period. With the implementation of suitable mitigation measures, as outlined in this report, many impacts during restoration can be reduced to acceptable limits. However, residual (net) impacts will require regular monitoring to check compliance with statutory criteria and guideline recommendations.

11.23 Monitoring requirements should be as follows:

Noise

11.24 Daytime impact and compliance monitoring should be undertaken at least three times per week, involving measurement over a 30-minute period of typical activities, from the date of construction until the completion of the dump operation. Measurement should be carried out 1 m from the worst-affected external facades of the identified sensitive receivers. Noise measurements should be made in accordance with the Technical Memorandum on Noise from Construction Work other than percussive piling. A similar monitoring exercise should be undertaken at identified sensitive receivers adjacent to the Marine Barging Point.

Dust

11.25 Site boundary measurements for TSP and RSP at three times per day during normal construction period for 1-hour and once for 24 hours every six days should be conducted to ensure compliance with the guideline of 500 $\mu g/m^3$ hourly average and the respective 24-hour Air Quality Objectives (AQOs) for the Public Dump and Marine Barging Point. This procedure should also be carried out for Receiver 13 (Chapter 5) and others as appropriate for the Public Dump and the two closest sensitive receivers to the Marine Barging Point.

Water Quality/Sewerage Impact

11.26 Monitoring should be conducted as for baseline monitoring for the Public Dump at the seven locations, with a sampling frequency of at least four times per week (each day at mid-ebb and mid-flood tide) for the duration of the works. Suitable monitoring on a similar basis should be undertaken for any dredging activity associated with the Marine Barging Point.

Marine Ecology

11.27 Regular monitoring (i.e. weekly) during the construction phase will be required to ensure that the mitigation measures recommended in Chapter 8 are being effectively deployed. Construction impacts on marine ecology can be assessed by monitoring of the remnant biological community at the north-western shores of Green Island. Monitoring should also take account of any recommendations provided as part of the pre-construction phase study, as described in Appendix 2. Monitoring, at a minimum, should include:

i) checking for the disappearance of some indicator species which are particularly vulnerable to the stresses associated with the construction and operation of the Public Dump. Since the effect is probably most strongly felt by the filter-feeding and grazing animals (because of an increased suspended matter concentration interfering with filtration or growth of the food algae), species such as the grazing gastropods *Monodonta labio* and *Cellana grata* and the filter-feeding stalked barnacle *Capitulum mitella* may be employed as indicators.

ii) in the event of a breach of Target limits for suspended solids, direct monitoring of increases in suspended matter concentration may be performed in the vicinity of the north-western shores. Where there is a possibility of mobilization of contaminated sediments during the construction process, concentration of relevant contaminants should be monitored and the risks assessed accordingly.

iii) checking that the north-western shoreline is not used for storage of construction materials or waste generated from the construction activity.

Terrestrial Ecology

11.28 Regular monitoring (i.e. weekly) during the construction phase will be required to ensure that the mitigation measures recommended in Chapter 9 are being effectively deployed. Monitoring at a minimum, should include:

i) ensuring that no unnecessary species or habitats are destroyed, damaged or disturbed.

ii) ensuring that plant communities surrounding the works area are not adversely affected by storage or fires.

iii) ensuring that the disturbed areas are restored successfully with native plant species.

Operational Monitoring

11.29 Long-term monitoring requirements relate to monitoring during the operational phase of the reclamation through the deposition of public waste material and monitoring for the duration of barging activity at the Marine Barging Point. By conducting regular monitoring, it can be determined whether the sites are continuing to comply with environmental and safety objectives established and whether any deterioration in the environmental integrity of the sites is taking place in order that remedial action may be taken.

Noise

11.30 Monitoring requirements and non-compliance measures for the sites are as for construction monitoring

Air Quality

11.31 Monitoring requirements and non-compliance measures for the sites are as for construction monitoring

Water Quality and Dredged Sediments

11.32 Monitoring requirements and non-compliance measures for the sites are as for construction monitoring. Post-operation monitoring should be undertaken for three days per week each day for mid-ebb and mid-flood tide for a period of six weeks after cessations for marine works.

Marine and Terrestrial Ecology

11.33 Monitoring requirements and non-compliance measures for the Public Dump are as for construction monitoring.

Monitoring Following Completion (Public Dump)

11.34 Environmental impacts following the completion of the reclamation works are expected to be minimal during the standing period. Subsequent development of the reclamation area will require a separate construction monitoring programme based on the recommendations provided in this Chapter. Following the development of the reclamation area, significant environmental impacts are not envisaged, given the residential and open space nature of development proposed. Environmental monitoring may be restricted to the following:

Water Quality

11.35 Periodic monitoring (i.e. six monthly) based on the specifications in this Chapter are recommended at locations in the proximity of the reclamation to detect any long term adverse impacts. The number and proximity of these locations is dependent on the number of outfalls in the area and the nature of any discharges.

Marine and Terrestrial Ecology

11.36 Continued monitoring, based on the construction and operational monitoring recommendations, should be carried out to ensure adequate protection. In the longer term monitoring requirements may need to adjust to be compatible with future uses of the area.

Environmental Performance Limits and Action Plans

Environmental Performance Limits

11.37 Trigger, Action and Target limits for assessing environmental performance are defined as follows:

- Trigger limit: the Trigger limit is to provide an indication that environmental parameters are exceeding normal expected variability in baseline levels:
- Action limit: the Action limit is to provide an indication that appropriate remedial actions should be implemented to prevent a further unacceptable deterioration in the environmental quality of a parameter; and

- Target limit: the Target limit is based on legislative standards and/or recognised environmental performance guidelines and represents the maximum level of an environmental parameter at which the works must proceed.

11.38 The establishment of Trigger limits is dependent on the collection of a comprehensive and scientifically robust environmental date set on baseline conditions. Additional baseline monitoring data should be collected just prior to the commencement of construction, where the monitoring period is of sufficient duration to allow for the collection of representative data. Normal temporal and spatial variations in an environmental parameter need to be established, such that the Trigger limit can be set at the appropriate statistical boundary of the data range. Action limits should be set at mid-value (approximately) of the Trigger and Target limits (as defined be legislative standards and/or recognised environmental performance guidelines). Trigger and Action limits should be specified in a manner which is sensitive to genuine environmental deterioration, but such that they do not result in unnecessary interference or cessation of works.

11.39 An example of the specification of TAT limits is provided in Table 11.1 in relation to marine water quality. The actual determination of control values is dependent on the baseline monitoring programme and the relevant WQOs. Further information on the establishment of TAT levels in relation to the other environmental key issues is provided in the EM&A Manual.

Action Plans

11.40 It is important that remedial action is implemented in a constructive manner by the Employer's Representative to the progress of the works, and should involve pragmatic and cost-effective solutions to environmental impacts. Environmental protection measures related to the exceedance of Trigger and Action limits should be implemented in a timely and efficient manner so as to avoid breaches of the appropriate Target levels. Remedial action should be implemented through Action Plans, which are specific to the final sequence of works and working practices of the construction and operational phases of the Public Dump and Marine Barging Point. A framework for the Action Plans is shown in Table 11.2. Remedial actions should be based upon mitigation measures specified in the individual chapters of this report, as related to working practices and physical control measures.

11.41 Further information on the establishment and implementation of Action Plans in relation to the other environmental key issues is provided in the EM&A Manual of this Study.

Table 11.1: Examples of TAT Levels for Marine Water Quality

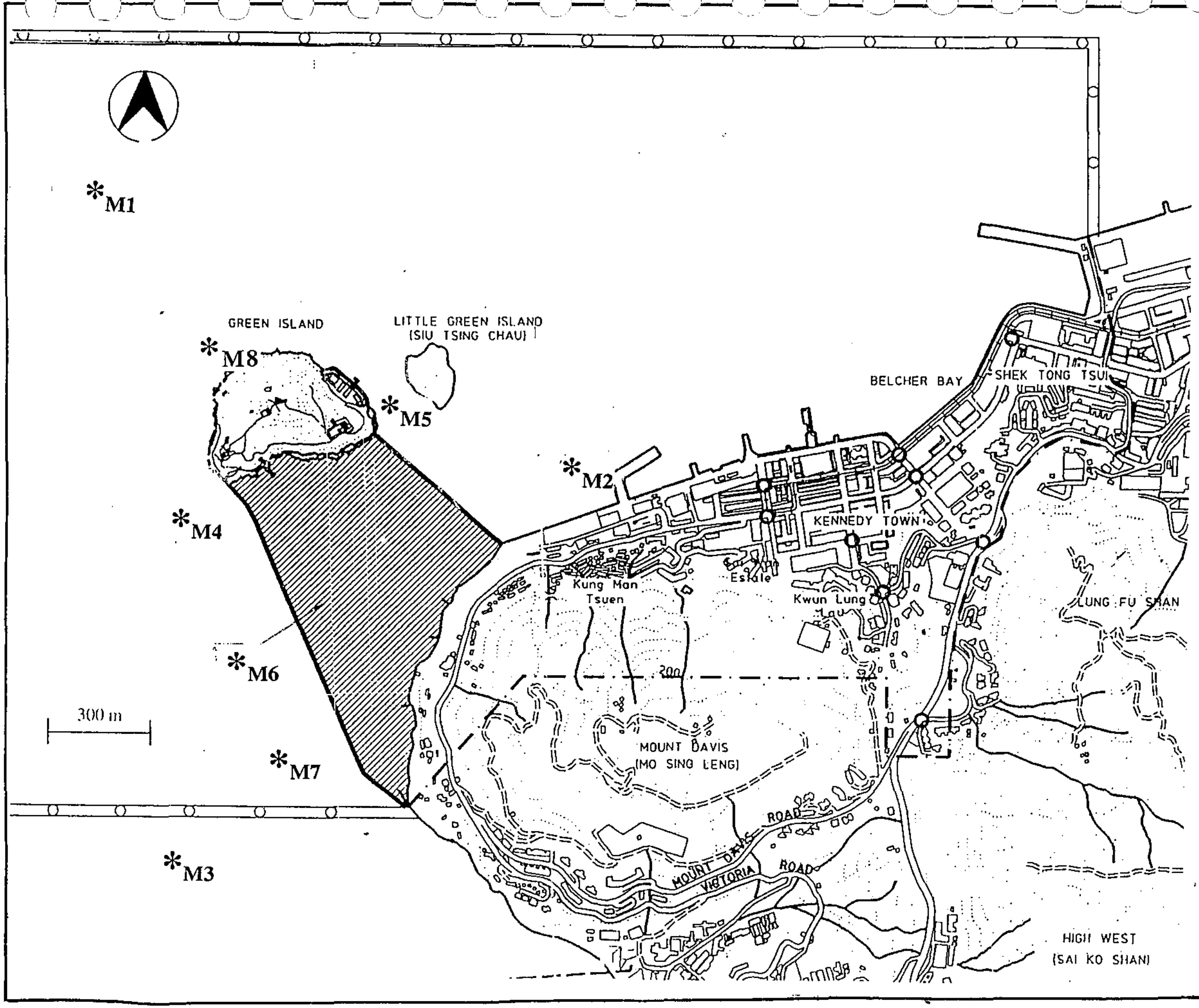
Parameter	Trigger	Action	Target
Depth Averaged DO	Control minus 15%	Control - 20%	Control minus 30% or 4mg/l whichever is greater
DO within 2m of the bottom	Control minus 15%	Control minus 20%	Control minus 30% or 2mg/l whichever is greater
Temperature	Control plus 15%	Control plus 20%	Control plus 30% or 2°C whichever is less
Turbidity	Control plus 15%	Control plus 20%	Control plus 30%
Suspended Solids	30 mg/l over background or total of 50 mg/l whichever is lower	30 mg/l over background or total of 50 mg/l whichever is lower	Total of 80 mg/l

Table 11.2: Action Plans - Generic Framework for Exceedance of Trigger, Target and Action Levels

Performance Limit	Action 1	Action 2	Action 3
Trigger	Notify contractor. Identify source of exceedance, review working practice, duration of works and proximity to sensitive receivers.	With cooperation of contractor, specify simple remedial measures to alleviate impact, as related to working practices and proximity to sensitive receivers.	Notify exceedance in regular monitoring reports, together with any remedial steps taken.
Action	Notify contractor. Commence additional monitoring in the proximity of the source and at nearest sensitive receiver(s).	Instruct contractor of remedial action required in relation to working practices or physical measures to prevent further deterioration in environmental quality.	Notify exceedance to Employer and in regular monitoring report, together with additional monitoring data and remedial steps taken.
Target	Notify contractor and Employer immediately. Continue additional monitoring at increased frequency and locations until it is proven that environmental impact has reverted back to below Target limits	Implement immediate remedial measures to curtail environmental impact and notify contractor and Employer of potential cessation of works failing any measured improvement.	Provide detailed report to contractor and Employer relating to exact date and reasons for exceednace. Include description of remedial action taken and present monitoring data to demonstrate abatement of impact to below Trigger Limit following implementation of remedial measures. Provide reference instructions to avoid repeat of similar adverse impact.

Reference

Ref 11.1 PELB General Circular 2/94. Public Access to Environmental Monitoring and Audit Reports.



* Monitoring locations

GREEN ISLAND RECLAMATION (PART) - PUBLIC DUMP FINAL REPORT

Figure No. 11.1

Marine Water Monitoring Locations

12. CONCLUSIONS AND RECOMMENDATIONS

12.1 The main conclusions and recommendations from the technical chapters of this report, which address each of the identified key environmental issues, are drawn together in this chapter.

Noise Impacts

Public Dump

12.2 Traffic on the access road is expected to generate facade noise levels in excess of 75 dB(A) (L_{eq}) at NSRs near its alignment. If the Disused Track Access Road option is chosen, excessive noise levels are experienced at the Sam Kindergarten and a number of village houses represented by NSRs 1 and 2. If the IWTS Access Road option is chosen, a greater number of village houses are affected. In addition, the highrise Serene Court (NSR4) is affected. The need for mitigation measures is therefore anticipated.

12.3 Given the expected 8-year lifespan of the filling operation, the installation of partial enclosure over the access road is recommended. An inwardly curved noise barrier along the access road will mitigate the noise impacts on the nearby NSR. The barrier material should have a mass per unit of surface area of at least 7 kg/m ^{2}, and should have acoustic lining. This mass per unit area conforms with British Standards and is deemed sufficient to block the transmission of most construction related noise through the barrier.

12.4 The barrier is subject to a detailed design that will consider the effectiveness of topography in providing barrier attenuation. However, the following preliminary information gives some indication of its anticipated height and length.

12.5 In order to provide effective protection to high-level receivers (either highrise facades or NSRs on elevated ground), the barrier should be curved inward over the access road. Its height will be constrained by the need to provide adequate clearance for dump-related vehicles. The width of the overhang should generally be limited to a single lane on the landward side. However, if the IWTS Access Road option is chosen, a short section of the haul road (approximately 20 m) adjacent to Serene Court may be totally enclosed.

12.6 The length of barrier required depends on the access road option chosen. If the IWTS Access Road option is chosen, the length of barrier would extend a length of about 200 m from the junction with Victoria road; this would take it approximately to the IWTS inbound road access tunnel turnoff. This length of barrier would protect Serene Court and Regent Heights. A preliminary assessment of the site indicates that the lowrise village receivers in Kung Man Tsuen would be adequately protected by topography.

12.7 If the Disused Track Access Road option is chosen, approximately 80 m of barrier would be required, starting at the junction with Victoria Road. It should be noted that vehicles exiting onto the public road should have adequate sight-lines along that road. For this reason, a full-height barrier cannot extend right up to the edge of Victoria Road. This safety requirement has implications for the effectiveness of the barrier, especially the school and two residences immediately across from the junction may require further mitigation at the receiver.

12.8 The Technical Memorandum on Noise from Construction Work other than Percussive Piling (Ref 4.1) indicates that an effective barrier (ie, one that is of sufficient size and weight, and without gaps) reduces noise at the receivers by about 10 dB(A). This would be sufficient to bring noise levels at NSRs near the access roads to levels within the traffic noise standards given in the Hong Kong Planning Standards and Guidelines.

12.9 If the land use permits, an alternative to the purpose-built barrier is an earth embankment. Like the purpose-built barrier, an embankment would have to be of adequate height to screen noise sensitive facades from a view of the access road.

12.10 In addition to the partial access road enclosure, good site practices to minimise noise are recommended. Good site practice during construction and operation can be encouraged through the inclusion of noise control clauses as shown in Appendix 1 of this report.

Marine Barging Point

12.11 Target noise criteria for Kenndy Town Jockey Club Clinic and for Lui Ming Choi Memorial School are exceeded for both NSRs during the construction period of the Marine Barging Point. However, existing buildings and additional mitigation measures can be expected to reduce noise impacts to levels below the daytime target noise criteria. For example, the presence of bus maintenance workshops to the forefront of Kennedy Town Jockey Club Clinic, which remove the line of sight to the construction site, will reduce noise levels by between 5 to 10 dB (A) thereby resulting in noise compliance. Other measures including a reduction in the number of PME items in use at any single time, and the erection of suitable temporary screening structures will serve to protect Lui Ming Choi Memorial School. It is recommended that construction works be scheduled to avoid examination times at the school to avoid exceedance of the relevant daytime target noise criteria.

12.12 The predictions for construction noise impacts on NSRs are dependent on the exact requirements of PME for construction of the barging point which have yet to be specified.

12.13 It is expected that the dominant noise source associated with the redevelopment of the site will be associated with the demolition of the former Kennedy Town Incineration Plant, which is outside the scope of this assessment. It is recommended that any noise barriers used to achieve satisfactory noise level at NSRs during demolition work should therefore be maintained for the duration of the construction works.

12.14 Noise impacts in exceedance of the relevant noise criteria during the operation of the barging point are not envisaged, provided that operations are restricted to day time working hours. Noise impacts associated with traffic serving the barging point are minor given existing and future traffic flows on Victoria Road and would only increase noise levels under a worst case scenario by approximately 1.5 dB (A).

Air Quality Impacts

Public Dump

12.15 The results of air dispersion modelling studies demonstrate that the sensitive receivers are unlikely to be adversely affected by particulate levels. TSP concentration will be below the recommended 1-hour guideline of 500ug/m^3 at all the sensitive receivers, and the 24-hour statutory TSP levels will also be complied with. The potential air quality impacts are greatly reduced by the decision not to place a concrete batching plant or rock crushing plant on the site.

12.16 TSP and RSP monitoring should be undertaken at Receiver 13 and another suitable site (ie Receiver 1, 7 or 9) to ensure that AQOs and guidelines are complied with. The contractor should provide detailed dust mitigation methods and rigidly adhere to them.

12.17 The assessment of odours from sewage laden stagnant water has indicated that sensitive recievers to the north of Vicotria Road may be affected. However, the predicted zones are likely to be an over estimate and the water is likely to become stagnant for only part of the tidal cycle and would not persist for more than two hours. The proposed development of the SSDS works and its associated interception of drainage waters should further mitigate the potential for odour impacts from the stagnant water area.

12.18 Based on a worst-case dilution factor (D) for assessment, it is concluded that a short term odour problem may be detectable due to the embayment of stangnat water. It will be neccessary to undertake odour assessment using an odour panel upon receipt of public complaints associated with the Works to detect any unacceptable impacts during the operational phase of the Public Dump.

12.19 Emissions from Public Dump vehicles were found to be insignificant.

Marine Barging Point

12.20 Air quality assessment of the proposed Marine Barging Point has shown that worst case dust (TSP) 1-hour concentrations of up to about 400 $\mu g/m^3$ can be expected during construction. This is less than the guideline value of 500 $\mu g/m^3$, and respective standards for 24-hour (260 $\mu g/m^3$) and annual (80 $\mu g/m^3$) are also not exceeded at the nearest sensitive receiver. Actual dust concentrations can be reduced substantially by limiting the working area of the site and implementing dust suppression measures (eg watering site surface twice daily).

12.21 Operational impacts associated with the handling and tipping of public dump material at the barging point will result in lesser dust impacts at sensitive receivers than construction activities. Operational impacts can be effectively minimised by the enclosure of the tipping operation to eliminate wind drift. Increases in ambient vehicle pollutant (eg CO, NO_x) concentrations from traffic associated with the barging point alone will be negligible.

Sewerage Impacts

Public Dump

12.22 There are five stormwater discharges that would be directly affected by the Green Island Public Dump. The feasibility of intercepting and diverting these southwards towards the western seawall of the Green Island Public Dump has been assessed as an appropriate permanent or semi-permanent measure. The discharge to fast flowing waters there will aid dispersion and dilution and thereby avoid deterioration of water quality. The northernmost of these existing outfalls may, in the long-term, be more appropriately diverted to future collector drains along the alignment of the existing Kennedy Town seawall which would transfer the effluent eastwards.

12.23 The locations and flow rates of all existing foul and stormwater discharges within the study area have been established and pollution loads estimated. There are several major infrastructure projects in the planning stage in the vicinity of Green Island which will each have some impact on the adjacent sewerage systems. Proposed changes to the sewerage systems have been identified and their impacts assessed, particularly in the case of the Belcher Bay Reclamation which impacts on the existing outfalls with the greatest pollution loadings. Findings have been incorporated into the water quality assessment.

12.24 There are no significant cumulative sewerage impacts in relation to the Island West Transfer Station barging point.

12.25 Recommendations for the diversion and interception of stormwater drains during the construction and operational phase are provided.

12.26 There are as yet no proposals to divert the existing small diameter foul sewer outfall discharging opposite Davis Street. The effect of this outfall has been addressed as part of the water quality assessment (Chapter 7).

12.27 Under the Water Pollution Control Ordinance, all effluents discharging within a WCZ are subject to obtaining a licence from EPD and complying with the stated conditions.

Marine Barging Point

12.28 The development of the Marine Barging Point will not result in the diversion of sewers or stormwater outlets, or result in the embayment of containmated marine waters. As such no impact on sewerage is envisaged.

Water Quality and Dredged Sediments

Public Dump

12.29 WQOs have been identified for the gazetted Western Buffer and Southern WCZs. Parts of the Victoria Harbour WCZ, have now also been gazetted in 1995, but the area around Green Island is not expected to be gazetted until 1996, when appropriate WQOs will be applied.

12.30 With the exception of the photoplankton, nutrients and total inorganic nitrogen there is compliance with the WQOs of the Southern and Western Buffer WCZs.

12.31 In Victoria Harbour TIN and dissolved oxygen in the bottom water would not comply with the WQOs if the same objectives as for the Southern and Western Buffer WCZs were applied to the Victoria Harbour WCZ.

12.32 There are no sensitive receivers in the immediate works area. The nearest sensitive receiver which could be impacted by the works is the Kennedy Town salt water pumping station.

12.33 The maximum suspended solids concentrations in Victoria Harbour exceed the target guidelines for water to be taken for flushing purposes (10 mg/l) but are below the guideline value for pump wear (140 mg/l). Concentration maxima currently reach 57mg/l.

12.34 Sediment plume modelling has shown that the mariculture zones at Ma Wan, Sok Kwu Wan and Lo Tik Wan, and the power station intakes at Tsing Yi and Lamma Island lie outside the +1mg/l suspended solids increase plume contour. The proposed sea water pumping station at Telegraph Bay, the existing stations in West Kowloon and along the north shore of Hong Kong Island are similarly outside that contour. Based on these results, the suspended solids elevation will not be detactable and will have no impact on them.

12.35 The environmental impacts on adjacent water bodies are considered to be minimal and acceptable based on the results of the modelling work. Nevertheless, after the modelling work had been completed, and in order to mitigate as far as possible any environmental impacts which might result from the occasional encroachment of the plume on the eastern shore of Green Island or in the East Lamma Channel, it was agreed between CED and EPD that the western seawall would be built as early as possible in the programme, and that dumping operations would take place only on a rising or slack tide.

12.36 The latest sediment surveys of the area, which investigated the depth of contamination using triplicate samples, confirmed that the samples were within the "Class A" category. As a result no special measures will be required during transport and disposal.

12.37 It is predicted that the suspended solids concentration at the Kennedy Town salt water pumping station will not increase above background levels. However, increases of a few mg/l may be expected a short distance offshore from the intake. It is recommended that precautionary provision be made that, should the measured flood difference concentration of suspended solids at the monitoring station offshore of the Kennedy Town salt water pumping station increase by more than 10mg/l above the baseline flood difference as a result of the works, then a silt screen should be installed around the station intake.

12.38 Predicted sediment deposition rates of 0.3-0.7mm/d will not significantly affect the sediment benthic in fauna beneath the plume.

12.39 The additional oxygen demand imposed on the water column by dispersed sediment resulting from dredging will range between 0.05 and 0.25 mg/l. Existing oxygen demand levels are in the range 1-2 mg/l and this increase is unlikely to have any significant effect on water quality.

12.40 The construction, operation and completion of the public dump reclamation give rise to no significant or unacceptable deteriorations in bacteriological quality of the marine waters in the immediate vicinity of the works and hence further afield. No mitigation measures are therefore necessary.

12.41 Floating booms with skirts should be used to retain floating timber, insulation material and plastics adjacent to the dumping area. Accumulated material should be removed daily.

12.42 The construction of the submerged seawalls and the subsequent filling will not give rise to measurable deterioration in water quality due to the storm and foul sewer discharges into the harbour.

12.43 The present surface water discharges into the works area from Victoria Road should be diverted to the south of the western seawall where currents exceed 0.2m/s.

12.44 Sewage derived from residential blocks built on the final reclamation should be treated at the Strategic Sewage Treatment works at Mount Davis.

Marine Barging Point

12.45 Soundings for the water depth in the basin adjacent to the loading area taken in 1984 and updated in 1994 show that there is insufficient depth for barge access immediately adjacent to the seawall. However, it is considered that the need for dredging can be avoided by the use of an extended loading ramp or use of a lighter barge and it has been stipulated by CED that the construction contract for the site will not allow dredging. Marine water quality construction impacts are therefore expected to be negligible.

Marine Ecology

Public Dump

12.46 The public dump will result in the destruction of a significant part of Victoria Harbour's last stretch of natural rocky shores. These shores house the remnants of the biological community, in particular the intertidal fauna, which pre-date development in the harbour. The species on these shores are generally much larger in size than their counterparts in other shores in Hong Kong. For example, individuals of the limpet *Cellana grata* found in the mid to high intertidal are about double the average size of their conspecifics elsewhere in Hong Kong. Similarly, the chiton *Liolophura japonica* is about 30-40% larger than their counterparts elsewhere in Hong Kong. The reasons for these large species size are not fully understood, therefore this habitat is of interest to scientists keen to understand the factors which have promoted such growth in species size.

12.47 Protection of the remnants of the shore life on Green Island and the Hong Kong Island site may be enhanced by minimizing disturbance to the north-west shoreline of Green Island. This shoreline may be afforded some natural protection as a result of its inaccessibility, however additional measures are considered necessary to safeguard this area in the future. During the construction phase restrictions should be applied to prevent these shores being used as storage areas for construction materials or temporary stockpiling areas for construction or other wastes. In addition, the recommendation of the Final Report of the Green Island Reclamation Feasibility Study (Ref 8.11) to create an Urban Fringe Park on Green Island is endorsed by this study with respect to marine ecology. It is further proposed that within the proposed Urban Fringe Park that access to the foreshore is restricted.

12.48 The amount of suspended matter in the water resulting from the construction activities should be effectively reduced by the use of suitable mitigation measures as described in Chapter 7. These include ensuring that barges are loaded in such a way as to prevent spillage during transport; the use of automatic self monitoring systems to discourage 'short dumping'; and ensuring that direct discharges from surface and storm water outfalls and unsewered discharges are intercepted prior to discharge. These will reduce the direct impact of the construction phase on the biological community and permit time for rehabilitation and mitigation measures to be implemented.

12.49 The translocation of a representative community of fauna from the affected shores to the north-western quarter of the island is recommended, preferably during Stage I or Stage II of the work. Species such as *Liolophura japonica* and *Cellana grata*have long life-spans in undisturbed environments and may therefore benefit from the translocation. Translocation also increases the local density of these species and may assist survival of these populations following the destruction of their other habitats on Green Island. The translocation is unlikely to be effective, however, unless the area is accorded some protection to ensure the proposed development, together with the accompanied stresses (eg. human disturbance) do not offset the translocation effort. The steep gradient of the northern shores of Green Island should provide some natural protection to the translocated populations.

12.50 Further quantification of the occurrence and distribution of species within the affected area will be required before detailed proposals can be made for translocating and monitoring of the marine community. A pre-construction phase study to determine the potential success of translocating fauna is therefore recommended. The proposed scope of further investigations is presented in Table 3 of Appendix 2. The transfer of fauna to the north-western shores is regarded as the only feasible mitigation measure due to the entire loss of the shoreline habitat on other parts of Green Island.

12.51 The subtidal community of Sulphur Channel will be destroyed by construction of the Public Dump. However, the results of the study by Fill Management Committee of CED have shown that the importance of this community is small.

Marine Barging Point

12.52 Marine ecological impacts associated with the development of the Marine Barging Point have not been assessed, as the urban foreshore and immediate marine environment are not considered to retain any significant ecological value.

Terrestrial Ecology

Public Dump

12.53 The flora of Green Island was found to be very species-rich, with an advanced succession comprising many woodland species. This is thought to reflect a lack of disturbance by fire and other factors. One protected plant species, *Pavetta hongkongensis*, was found. A full four season survey of bird fauna was not undertaken, but is not expected that many rare species are present. No large native mammals are present on the island. The invertebrate fauna were not surveyed in detail but may be of interest due to the high plant diversity, lack of disturbance and the dispersal barrier presented by the sea.

12.54 The direct impacts resulting from construction activities and the operation of the Public Dump will be a loss of vegetation along the southern shores of Green Island. Indirect effects following completion of the Public Dump will result from disturbance due to increased human access to the 'Island', the risk of fire, and the risk of invasion by predatory and exotic species. Proposed mitigation measures include prohibiting open fires, smoking and the storage of flammable materials on-site during the construction and operational phases; to prohibit the storage of construction materials and other wastes on Green Island other than within the works area; and a tree survey should be carried out by the contractor prior to the commencement of any works. Replacement planting of damaged or destroyed vegetation should be carried out on both Green Island and along the Hong Kong Island shoreline and should be consistent with the recommendations for landscape works proposed in Chapter 10.

12.55 On Stonecutters Island proposed mitigation for the loss of coastal habitat to reclamation involved construction of an artificial boulder shore for the displaced Reef Egrets and Night Herons. However, in view of access problems and the threat to other habitats this proposal has been changed to provision of pontoon-bridge rafts, from which the birds are expected to fish. Breeding takes place on large-boulder shores, with nests located at the foot of large (greater than 2 m) boulders on flat surfaces above sea level. Thus unless disturbance increases, adverse impacts on the Green Island population could be compensated, in the long term, by provision of an equivalent area of large-boulder shore on the reclamation. This would also benefit rocky shore invertebrate species displaced from southern Green Island. The constructed rocky shore should be fenced off to prevent animal-collectors and other human disturbance. In addition it is suggested that perches, such as floating rafts or buoys, are provided near the shore as foraging posts.

Access Routes

12.56 From a botanical and ecological point of view, the IWTS Access road option would cause less detrimental impact to the environment than the Disused Track option. This option represents a well-grown secondary woodland habitat composed of native and exotic tree species and is likely to provide a suitable habitat for various animal groups.

12.57 If the Disused Track option is adopted, special care must be taken to minimize the damage to the natural woodland down-slope of the track (i.e. between the track and the shoreline) when engineering work is carried out. Consideration should also be given, where possible, to limit the potential alteration in plant species composition as a result of increased light penetration or changes in the water table, for example. This can only be achieved by careful selection of the road alignment to avoid ecologically sensitive species.

12.58 Any trees destroyed during development should be replaced with native species, with the provision of nursery/pioneer species as appropriate, to assist in the succession to woodland coverage. A compensatory landscape scheme will be required by Government at the detailed design stage to recompense for the loss of trees. Aesthetically and ecologically important shrubs and trees should be fenced off for protection if they are exposed by the clearance of adjacent vegetation.

12.59 It is recommended that the ecological effects of all construction and operational activities be monitored. Monitoring and audit requirements are given in Chapter 11 of this report.

Marine Barging Point

12.60 Terrestrial ecological impacts associated with the development of the Marine Barging Point have not been assessed, as the site does not have any natural habitats and is not considered to retain any significant ecological value.

Visual Impacts

Public Dump

12.61 The construction of the Public Dump will be one of the earlier projects that will gradually transform this last remaining section of undisturbed Hong Kong shoreline into a dense, urban area. Many Hong Kong residents will be aware of operations in this area and the visual impact will be significant. To the sensitive receivers in the area the visual impact will be considerable and unavoidable. There are, however, relatively few sensitive receivers that will be affected by the developments in the long term; the Mount Davis Cottage Area is likely to be relocated and the dominant land use in the area is actually Green Belt. Within this context of change, the impact of the Public Dump will be minimal. It does, however, represent the beginning of that transformation and the overall visual impact will be greater, because of this.

12.62 Following the assessment of possible visual impacts of the construction, operation and completion of the GIPD, recommendations have been made that will assist in minimising visual impacts at the detailed design stage:

- Adopt high visual standards for all operational and cumulative work in this area as a precedence for the future reclamation work and other projects in the area.

- Develop proposals for the construction and dumping operations that will minimise and mitigate any visual impacts.

- Due to its landscape value as a natural backdrop and its role in screening views from the landward side of the public dump, it is important to retain and minimise impact on the vegetation on the lower slopes of Mount Davis, below Victoria Road, during the course of work.

- Locate semi-permanent plant, such as the rock-crusher, as close as possible to the existing shoreline in Area 1 where it will be screened from view from Hong Kong Island. Incorporate hoardings or advance planting along the seawall to screen views from the sea. Particular attention should be given to minimising damage to the Green Island shoreline.

- Careful attention should be given to the detailed design and appearance of the western seawall and its interfaces. If possible, include planting as part of advance works to mitigate views of operations from the west.

- Carry out off-site planting, along Victoria Road and the Kennedy Town waterfront, for permanent and temporary visual mitigation.

12.63 Should vehicular access to the Public Dump prove essential it would be preferable, on a visual impact basis, to adopt the IWTS option to reduce the impact on the visually important lower slopes of Mt. Davis.

Disused Track Access

12.64 The Disused Track option is likely to involve major slope work and extensive removal of the existing vegetation. In accordance with the new Works Branch Technical Circular, alternatives that involve less impact to the existing slope should be pursued wherever possible.

12.65 Care should be taken to minimise the area affected by the work and, in particular, tree felling. It is strongly recommended that construction work is concentrated on one side of the existing track only; thereby preserving any vegetation either above or below the track. Sturdy fences (of non-timber material) should be erected to minimise damage to vegetation to be retained. A tree survey should be undertaken prior to the commencement of construction, to document the trees that will be removed during construction.

12.66 Construction methods should aim to minimise disturbance to the slopes. Engineers should work closely with landscape architects to devise the optimal alignment feasible methods to minimise tree removal. It is recommended that, wherever possible the access road is constructed on a temporary structure to minimise earthworks in the area.

12.67 Once the final access road alignment and areas of disturbance have been identified, detailed landscape proposals for temporary and long-term reinstatement of vegetated areas should be prepared.

Temporary reinstatement

12.68 Temporary reinstatement should be carried out adjacent to the structure to mitigate operational impacts. These areas are likely to be disturbed once the access is removed following completion. Temporary planting should include fast growing tree species, such as *Eucalyptus sps.* and *Acacia sps.* that will create a short term screen.

Permanent reinstatement

12.69 Permanent reinstatement should take place following the construction stage on newly formed permanent slopes that will not be affected when the temporary access road is removed. Permanent reinstatement should also take place following completion. Planting shall comprise a mixture of native and fast-growing woodland tree species. The fast growing species will quickly "heal" the slopes with the native species forming a more balanced ecological mix. Plant selection shall be based on those species removed during construction, as documented in the tree survey.

Marine Barging Point

12.70 In order to delay the significant visual impacts of road construction, the marine access option from the Marine Barging Point is supported on visual grounds in the interim period until the site is re-developed in mid-1997. Construction and operational visual impacts will be limited, where the prior removal of the KTIP structure and chimney stacks will result in an overall visual improvement to the area.

Monitoring and Audit Requirements

12.71 The monitoring and audit objectives and responsibilities during the baseline, construction, operational and post-completion phases of development, as relevant to the Public Dump and Marine Barging Point are defined. Monitoring requirements are specified with respect to location and frequency, together with a framework for determining environmental performance criteria and remedial Action Plans.

12.72 An Environmental Monitoring and Audit Manual, prepared separately to this report, augments the monitoring and audit requirements provided in this report and acts as the reference document in each of the development phases for the Public Dump and Marine Barging Point.

APPENDIX 1

Recommended Noise Pollution Control Clauses

APPENDIX 1

Recommended Noise Pollution Control Clauses

a) The Contractor's attention is drawn to the Summary Offences Ordinance and to the Noise Control Ordinance.

b) Before the commencement of any work, the Contractor shall submit for the Engineer's agreement the proposed sound-reducing measures for all plant and equipment to be used on the Site.

c) The Contractor shall provide an approved integrating sound level meter to IEC 651:1979 (Type 1) and 804:1985 (Type 1) and the manufacturer's recommended sound level calibrator for the exclusive use of the Engineer at all times. The Contractor shall maintain the equipment in proper working order and provide a substitute when the equipment are out of order or otherwise not available.

d) The sound level meter including the sound level calibrator shall be verified by the manufacturers every two years to ensure they perform the same levels of accuracies as stated in the manufacturer's specifications. That is to say at the at the time of measurements. The equipment shall have been verified within the last two years.

e) The Contractor shall ensure that all plant and equipment to be used on the site shall be effectively sound-reduced by means of silencers, mufflers, acoustic linings or shields, acoustic sheds or screens or other means, to avoid disturbance to any nearby noise sensitive receivers. Measured sound levels, other than that from percussive piling, from 0700 to 1900 hours on any day not being a general holiday shall not exceed an equivalent continuous A-weighted sound level (L_{eq}) of 75 dB(A) measured over any 30-minute period at 1 metre from the external facade of the nearest noise sensitive receiver. Any works causing excessive noise, e.g., operation of jack hammers, may be prohibited notwithstanding the above mentioned noise level restriction.

f) If a school is within close proximity to the Site, the Contractor shall liaise with School and the Examination Authority to ascertain the exact dates and times of all examination periods during the course of the contract. During school examination periods, the noise levels measured over any 30-minute periods due to the Contractor's equipment and construction operations shall not exceed 65 dB(A) as measured at 1 m from the closest external facade of the school.

g) The Contractor shall liaise with the schools and the Examination Authority to ascertain the exact dates and times of all examination periods during the course of the contract. Point can be deleted if the schools are either:

   i) more than 800 m away from the Construction Site with no obstructions in between.

   ii) more than 300 m away from the Construction Site with obstructions in between that can effectively screen off the construction noise.

h) Should the limits stated in the above sub-clauses (e) and (f) be exceeded, the construction operation(s) causing the excesses shall stop and shall not recommence until the Contractor has taken whatever measures, at their expense, acceptable to the Engineer that are necessary for compliance. Any stoppage or reduction in output resulting from compliance with this clause shall not entitle the Contractor to any extension of time for completion or any additional cost whatsoever.

i) Measures that are to be taken to protect adjacent schools and other adjacent noise sensitive receivers, if necessary, shall include, but not be limited to, adequate noise barriers. The barriers shall be of substantial construction and designed to reduce transmission of noise (simple plywood hoarding will not be sufficient). The barriers shall be surmounted with baffle boxes designed to reduce transmission of noise. The designs of the barriers shall be submitted to the Engineer for approval before works commence adjacent to schools and other occupied buildings.

j) The Contractor shall take reasonable precautions as instructed by the Engineer, to maintain all plant and silencing equipment in good condition in order to minimize noise emission during construction works.

k) The Contractor shall provide acoustic sheds or screens whenever applicable to shelter noisy construction works including the cutting of slope/knoll and road/rock breaking unless acoustically equivalent noise reduction measures are proposed and implemented to the satisfaction of the Engineer.

l) Notwithstanding the requirements and limitations set out in (f) above, the Engineer may, upon application in writing by the Contractor, allow the use of any equipment and the carrying out of any construction activities for any duration provided that he is satisfied with application which, in his opinion, to be of absolute necessity or of emergency nature, or adequate noise insulation has been provided to the noise sensitive receivers to be affected, and not in contravention with the Noise Control Ordinance in any respect.

m) For the purposes of the above clauses, any domestic premises, hotel, hostel, temporary housing accommodation, hospital, medical clinic, educational institution, place of public worship, library, court of law, or performing arts centre shall be considered a noise sensitive receiver.

n) *Location of Unused or Excavated Material:* The Contractor is required to submit the proposed method of working to the Engineer before commencing any excavation works. The method of working shall be designed, as far as is practicable, to ensure that a bund of material is located between the works and any schools and other occupied buildings in order to block transmission of noise.

o) *Proper Maintenance of Silenced Equipment:* The Contractor shall take reasonable precautions as instructed by the Engineer, to maintain all plant and silencing equipment in good condition in order to minimize noise emission during construction works.

APPENDIX 2

Species List from Marine Ecology Surveys

Table 1: List of Intertidal Animals Recorded from Green Island and the North-Western shores of Hong Kong Island.

Green Island

Phylum Ceolenterata
- Class Anthozoa
  - Haliplanella luciae
  - Unidentified sea anemone

Phylum Mollusca
- Class Gastropoda
  - Cellana grata
  - Cellana toreuma
  - Chlorostoma nigerrima
  - Chlorostoma sp.*
  - Diodora sp.
  - Liolophura japonica
  - Littorina articulata
  - Littorina brevicula
  - Lunella coronata
  - Monodonta labio
  - Nerita albicilla*
  - Nerita undata*
  - Nertia chameleon*
  - Nodilittorina radiata
  - Nodilittorina trochoides
  - Nodilittorina vidua
  - Notoacmea
  - Patelloida pgymaea
  - Patelloida saccharina
  - Puperita japonica*
  - Siphonaria japonica
  - Thais clavigera
- Class Bivalvia
  - Barbatia virescens
  - Septifer virgatus
  - Saccostrea cucullata

Phylum Arthropoda
- Class Crustacea
  - Balanus amphitrite
  - Capitulum mitella
  - Clibanarius sp.
  - Epixanthus frontalis
  - Eriphia laevimana smithi*
  - Gaetice depressus
  - Leptodius exaratus
  - Ligia exotica
  - Nanosesarma minutum
  - Pagarus sp.

Table 1 (Contn)

Parasesarma pictum
Parasesarma plicata
Unidentified porcelain crab
Tetraclita squamosa
Unidentified talitrid amphipod

Phylum Echinodermata
Class Echinoidea
Anthocidaris crassispina*

Phylum Vertebrata
Class Aves+
Motacilla flava (Yellow wagtail)*
Columba livia (Feral pigeon)*
Milvus migrans (Black kite)

Class Pisces
Bathygobius sp.

Western

Phylum Ceolenterata
Class Anthozoa
Haliplanella luciae
Unidentified sea anemone

Phylum Mollusca
Class Gastropoda
Cellana grata
Cellana toreuma
Chlorostoma nigerrima
Diodora sp.
Liolophura japonica
Littorina articulata
Littorina brevicula
Lunella coronata
Monodonta labio
Nodilittorina radiata
Nodilittorina trochoides
Nodilittorina vidua
Notoacmea
Patelloida pgymaea
Patelloida saccharina
Siphonaria japonica
Thais clavigera
Thais luteostoma#

Class Bivalvia
Barbatia virescens
Septifer virgatus
Saccostrea cucullata

Table 1 (Contn)

Phylum Arthropoda
    Class Crustacea
        Balanus amphitrite
        Capitulum mitella
        Clibanarius sp.
        Epixanthus frontalis
        Gaetice depressus
        Leptodius exaratus
        Ligia exotica
        Nanosesarma minutum
        Pagarus sp.
        Parasesarma pictum
        Unidentified porcelain crab
        Tetraclita squamosa
        Unidentified talitrid amphipod

Phylum Annelida
    Class Polychaeta
        Pomatoleios kraussi#

Phylum Vertebrata
    Class Aves+
        Milvus migrans (Black kite)

    Class Pisces
        Bathygobius sp.

Notes:
+ - species of birds only include those sighted on the shore
* - species not recorded from Western
# - species not recorded from Green Island

Table 2: List of Plant Species Recorded from Green Island and Western

Cerbera manghas
Clerodendron inerme
Ficus hispida
Ficus microcarpa
Ficus superba
Macaranga tanarium
Pandanus tectorius
Phoenix hanceana
Scaevola sericea

Table 3: **Proposed Scope of Work for the Pre-Construction Phase Ecological Study of the Intertidal Fauna of Green Island**

Further study of the intertidal fauna of Green Island has been recommended in Chapter 8 of this report. The proposed scope of work and estimates of costs and timescale are given below.

Objectives

The objectives of the proposed study are:

- to provide bio-monitoring data on the impact of the public dump project.
- to understand the possible factors underlying the observed large body size of common intertidal animals on the shores of the island; specifically looking at the factors of disturbance and food availability; and

Brief Description of Work

i) Population dynamics of grazing gastropods
Regular (monthly or biweekly, depending on the activity of the animals) sampling of the intertidal community of Green Island will be made for a duration of 14 months to understand the population dynamics of the important species, with particular emphasis on the limpet *Cellana grata*, the top shell *Monodonta labi* and the chiton *lophora japonica*. The density and size distribution of these animals will be estimated using random quadrats laid at different, fixed heights of the shore.

This sampling will be carried out at two sites on the island: the stretch of boulder shore northeast of the quarantine camp of the Correctional Services Department (Site A) and depending on the accessibility, the more exposed northwestern shores of the island (Site B).

ii) Growth and feeding ecology of the grazing gastropods and the impact of increased sedimentation
One possible reason for the large body size of the intertidal grazing gastropods on Green Island may be the high abundance of algal (particularly the cayanobacteria community) food on the shore. In order to understand the role of food availability on growth of the common grazing gastropods, the following investigations will be carried out:

a) estimation of the abundance of microalgae at Site A
Rock chip samples will be corrected and the abundance of microalgae (food for *Cellana, Liolophora* and *Monodonta*) estimated using the chemical extration-spectrophotometric method. The abundance of the various algal groups will also be estimated using the scanning electronic microscope.

b) growth rate of *Cellana grata* and *Monodonta labio*
In order to understand the factors underlying the large average body size of these gastropods compared to their counterparts on the Hong Kong Island shore, shells of individuals of these gastropods will be examined for their internal micro-banding structure. This technique allows daily growth rates to be estimated from the micro-growth bands deposited inside the shell layers. Shells of *C. grata* on the Green Island shore and the opposing shore on Hong Kong Island (near Sandy Bay) will be sectioned and their growth rates compared.

Since the technique is less effective on species with coiled shells, growth rates of the two populations of *M. labio* will be tagged and their growth rate over the study period of 14 months be followed and compared.

c) feeding impact of the gastropods
It is suspected that the main food source of the grazing gastropods is the cyanobacteria and encrusting algae on the intertidal rocks. These producers are, however, particularly responsive to sedimentation as their production may be severely suppressed by increased siltation. The potential impact of increased sedimentation on these gastropods will be studied with the use of manipulative experiments at Site A. Replicated cages will be set up on the boulder shore to either exclude *C. grate* or *M. labio* from or in the caged areas. The grazing impact of these gastropods can then be estimated by comparing the difference in microalgal abundance inside and outside the cages. Controls will be set up to eliminate the possible effects of caging.

A second part of the study will be to manipulate the sedimentation regime of caged areas (eg by regular removal of accumulated sediments) and monitor the impact of this on gastropod grazing activity, abundance and growth rate. The grazing gastropods may be used as a bio-monitor of the possible effects of sedimentation associated with the public dump project.

d) reciprocal translocation of populations
The role of disturbance and food availability can be further investigated by performing a reciprocal translocation of the populations of *C. grata* and *M. labio* at Green Island and Sandy Bay. Marked individuals of the two populations will be translocated to the other site and their subsequent growth rates compared. This experiment may be augmented by the use of molecular techniques to confirm that growth rate differences are due to environmental rather than genetic factors.

e) relocation of the fauna
Individuals of the community on the southern shores of Green Island which are to be affected by the Public Dumps project will be relocated to the northern shores of the island. This will increase local density of these large-bodied species to, hopefully, maintain recruitment to this part of the shore. These species may also be conserved through the relocation as most of the species are long-lived in undisturbed environments. Survival of marked individuals will be monitored every three months to assess the success of the relocation.

Cost

The following budget (based on 1994 costs) is proposed for the aforementioned work:

Item	**Unit Cost (HK$)**	**Subtotal (HK$)**
Research assistant x 14 months	14,000	196,000
Transportation Cost		15,000
Equipment (Spectrophotometer)		45,000
Experimental materials		20,000
Chemicals & SEM charges		20,000
Consumables		20,000
Shell sectioning		12,000
Total		**328,000**

APPENDIX 3

Species List from Terrestrial Ecology Surveys

Table 1 - Plants Recorded at Green Island During Field Surveys : 30 August 1993

TREES	
Species	**Family**
Acacia confusa	MIMOSACEAE
Acronychia pedunculata	RUTACEAE
Adenanthera pavonina	MIMOSACEAE
Aleurites moluccana	EUPHORBIACEAE
Aporusa dioica (A.chinensis)	EUPHORBIACEAE
Bridelia balansae	EUPHORBIACEAE
Bridelia tomentosa	EUPHORBIACEAE
Cassia sp.	CAESALPINIACEAE
Celtis philippensis	ULMACEAE
Celtis sinensis	ULMACEAE
Cerbera manghas	APOCYNACEAE
Cratoxylum ligustrinum	HYPERICACEAE
Cudrania tricuspidata	MORACEAE
Daphniphyllum calycinum	DAPHNIPHYLLACEAE
Delonix regia	CAESALPINIACEAE
Elaeocarpus chinensis	TILIACEAE
Euphoria longan	SANINDACEAE
Ficus microcarpa	MORACEAE
Ficus superba var. japonica	MORACEAE
Ficus variegata var. chlorocarpa	MORACEAE
Ficus variolosa	MORACEAE
Firmiana simplex	STERCULIACEAE
Hibiscus tiliaceus	MALVACEAE
Homalium cochinchinensis	FLACOURTIACEAE
Itea chinensis	ESCALLONIACEAE
Leucaena leucocephala	MIMOSACEAE
Litsea glutinosa	LAURACEAE
Livistona chinensis	ARECACEAE
Macaranga tanarius	EUPHORBIACEAE
Mallotus pa&iculatus	EUPHORBIACEAE
Microcos paniculata	TILIACEAE
Pandanus tectoris	PANDANACEAE
Pavetta hongkongensis	RUBIACEAE

Table 1 - Plants Recorded at Green Island During Field Surveys : 30 August 1993

TREES	
Species	**Family**
Pentaphylax euryoides	PENTAPHYLACACEAE
Phoenix hanceana	ARECACEAE
Phyllanthus emblica	EUPHORBIACEAE
Pithecellobium lucidum	MIMOSACEAE
Psidium guajava	MYRTACEAE
Pterospermum heterophyllum	STERCULIACEAE
Rhus hypoleuca	ANACARDIACEAE
Rhus succedanea	ANACARDIACEAE
Sapium sebiferum	EUPHORBIACEAE
Schefflera octophylla	ARALIACEAE
Scolopia saeva	FLACOURTIACEAE
Sterculia lanceolata	STERCULIACEAE
Syzygium hancei	MYRTACEAE
Syzygium jambos	MYRTACEAE
Zanthoxylum avicennae	RUTACEAE
Zanthoxylum cuspidatum	RUTACEAE

SHRUBS	
Species	**Family**
Agave angustifolia	AGAVACEAE
Ardisia crenata	MYRSINACEAE
Atalantia buxifolia	RUTACEAE
Breynia fruticosa	EUPHORBIACEAE
Catharanthus roseus	APOCYNACEAE
Clerodendrum inerme	VERBENACEAE
Croton sp.	EUPHORBIACEAE
Desmodium triquetrum (Pteroloma triquetrum)	PAPILIONACEAE
Desmos cochinchinensis	ANNONACEAE
Diospyros vaccinioides	EBENACEAE
Eurya sp.	THEACEAE
Ficus hirta	MORACEAE
Gardenia jasminoides	RUBIACEAE
Grewia biloba	TILIACEAE
Ilex asprella	AQUIFOLIACEAE

Table 1 - Plants Recorded at Green Island During Field Surveys : 30 August 1993

SHRUBS	
Species	**Family**
Ilex pubescens	AQUIFOLIACEAE
Ilex sp.	AQUIFOLIACEAE
Lantana camara	VERBENACEAE
Litsea rotundifolia vaar. oblongifolia	LAURACEAE
Malvastrum coromandelinum	MELASTOMATACEAE
Melastoma sanguineum	MELASTOMATACEAE
Phyllanthus cochinchinensis	PITTOSPORACEAE
Pittosporum glabratum	PITTOSPORACEAE
Psychotria rubra	RUBIACEAE
Rhaphiolepis indica	ROSACEAE
Rhapis excelsa	ARECACEAE
Scaevola sericea	GOODENIACEAE
Tithonia diversifolia	ASTERACEAE
Tricalysia dubia	RUBIACEAE
Urena lobata	MALVACEAE
Vitex negundo	VERBENACEAE
Wikstroemia indica	THYMELAEACEAE

CLIMBERS	
Species	**Family**
Acacia pennata	MIMOSACEAE
Asparagus cochinchinensis	LILIACEAE
Byttneria aspera	STERCULIACEAE
Calamus sp.	ARECACEAE
Cassytha filiformis	LAURACEAE
Cocculus trilobus	MENISPERMACEAE
Dalbergia benthami	PAPILIONACEAE
Dalbergia hancei	PAPILIONACEAE
Dalbergia millettii	PAPILIONACEAE
Dendrotrophe frutescens	SANTALACEAE
Embelia laeta	MYRSINACEAE
Embelia ribes	MYRSINACEAE
Embelia sp.	MYRSINACEAE
Gymnema alterniflorus	ASCLEPIADACEAE
Heterosmilax gaudichaudiana	SMILACACEAE

Table 1 - Plants Recorded at Green Island During Field Surveys : 30 August 1993

CLIMBERS	
Species	**Family**
Ipomoea cairica	CONVULVULACEAE
Melodinus suaveolens	APOCYNACEAE
Mikania micrantha	ASTERACEAE
Paederia scandens	RUBIACEAE
Pueraria phaseoloides	PAPILIONACEAE
Sageretia theezans	RHAMNACEAE
Smilax china	SMILACACEAE
Smilax lancaefolia	SMILACACEAE
Stephania sp.	MENISPERMACEAE
Strophanthus divaricatus	APOCYNACEAE
Strychnos angustiflora	STRYCHNACEAE
Tetracera asiatica	DILLENIACEAE
Trichosanthes sp.	CUCURBITACEAE
Uraria macrostachya	PAPILIONACEAE
Uvaria grandiflora	ANNONACEAE
Uvaria microcarpa	ANNONACEAE
Zan[illegible]oxylum nitidum	RUTACEAE

HERBS	
Species	**Family**
Adenosma glutinosum	SCROPHULARIACEAE
Ageratum conyzoides	ASTERACEAE
Alocasia macrorrhiz	ARACEAE
Amorphophallus variabilis	ARACEAE
Aster baccharoides	ASTERACEAE
Bidens bipinnata	ASTERACEAE
Commelina communis	COMMELINACEAE
Elephantopus scaber	ASTERACEAE
Emilia sonchifolia	ASTERACEAE
Gynura divaricata	ASTERACEAE
Hedyotis sp.	RUBIACEAE
Liriope spicata	LILIACEAE
Mimosa pudica	MIMOSACEAE
Phyllanthus urinaria	EUPHORBIACEAE
Solanum nigrum	SOLANACEAE

Table 1 - Plants Recorded at Green Island During Field Surveys : 30 August 1993

Vernonia cinerea	ASTERACEAE
Zephranthes candida	AMARYLLIDACEAE

GRASSES AND SEDGES	
Species	**Family**
Apluda mutica	POACEAE
Arundinella sp.	POACEAE
Cyperus alternifolius	CYPERACEAE
Digitaria sp.	POACEAE
Fimbristylis thomsonii	CYPERACEAE
Imperata cylindrica	POACEAE
Ischaemum indicum	POACEAE
Lophatherum gracile	POACEAE
Miscanthus sinensis	POACEAE
Panicum maximum	POACEAE
Paspalum distichum	POACEAE
Paspalum sp.	POACEAE
Rhynchelytrum repens	POACEAE
Scleria levis	CYPERACEAE
Scleria sp.	POACEAE

FERNS	
Species	**Family**
Lygodium japonicum	SCHIZAEACEAE
Pteris multifida	PTERIS group
Sphenomeris chinensis	LINDSAEA group

Table 2 : Reptiles Recorded on Green Island During Field Survey: 30th August 1993

Habitat	Species	Number recorded
Woodland	*Gekko chinensis* Chinese Gecko	2 plus egg
Grassland/Shrubland	*Ptyas mucosus* Common Rat Snake	1
Buildings	*Hemidactylus bowringi* Bowring's Gecko	1

Table 3 : Avian Fauna Recorded on Green Island During Field Survey: 30th August 1993

COMMON NAME (Latin Name)	STATUS
BLACK-EARED KITE (Milvus migrans)	R
SPOTTED DOVE *(Streptopelia chinensis)*	R
WHITE-BREASTED KINGFISHER *(Halcyon smyrnensis)*	R
RUFOUS-BACKED SHRIKE *(Lanius schach)*	R
BROWN SHRIKE *(Lanius cristatus)*	V
BLACK DRONGO *(Dicrurus macrocercus)*	SV
MAGPIE *(Pica pica)*	R
JUNGLE CROW *(Corvus macrorhynchus)*	R
COLLARED CROW *(Corvus torquatus)*	R
BLACK-FACED LAUGHING THRUSH *(Garrulax perspicillatus)*	R
CRESTED MYNAH *(Acridotheres cristatellus)*	R
CRESTED BULBUL *(Pycnonotus jocosus)*	R
CHINESE BULBUL *(Pycnonotus sinensis)*	R
MAGPIE ROBIN *(Copsychus saularis)*	R
TREE SPARROW *(Passer montanus)*	R
LONG-TAILED TAILOR BIRD *(Orthotomus sutorius)*	R
YELLOW-BELLIED WREN-WARBLER *(Prinia flaviventris)*	R
WHITE-EYE *(Zosterops japonica)*	R
GREY WAGTAIL *(Motacilla cinerea)*	V
REEF EGRET *(Egretta sacra)*	R
COMMON SANDPIPER *(Actitis hypoleucos)*	V

Key to symbols: R resident, SV summer visitor, V non breeding visitor

Table 4 - Plants occurring in Site 1 (Island West Transfer Station Access Road Option)

Plant Species Abundance*	Origin	Remarks
TREES		
EUPHORBIACEAE		
Aleurites moluccana	E	
Bridelia tomentosa	N	Bl,Fr
Macaranga tanarius	N	Fr
Mallotus apelta	N	
CARICACEAE		
Carica papaya	E	Nr
CAESALPINIACEAE		
Cassia suratiensis	E	
ULMACEAE		
Celtis sinensis	N	Bl,Fr
MORACEAE		
Ficus elastica	E	
Ficus hispida	N	
Ficus microcarpa	N	Bl,Fr
Ficus superba var. japonica	N	Bl,Fr
Ficus variegata var. chlorocarpa	N	
Morus alba	N	Fr
MIMOSACEAE		
Leucaena leucocephala	N	Bl
LAURACEAE		
Litsea glutinosa	N	Bl
MAGNOLIACEAE		
Michelia alba	E	Bl
TILIACEAE		
Microcos paniculata	N	Bl,Nr
ARALIACEAE		
Schefflera octophylla	N	Bl,Nr
STERCULIACEAE		
Sterculia lanceolata	N	Bl
SHRUBS		
VERBENACEAE		
Lantana camara	E	Nr
NYCTAGINACEAE		
Mirabilis jalapa	E	
MALVACEA		
Urena lobata	N	
CLIMBERS		
CAESALPINIACEAE		
Bauhinia championi	N	
MENISPERMACEAE		
Diploclisia glaucescens	N	
ASCLEPIADACEAE		
Gymnema alterniflorus	N	

(Table 4 Contn.)

CONVULVULACEAE		
Ipomoea acuminata	N	
Ipomoea cairica	E	
Ipomoea haderacea	N	
ASTERACEAE		
Mikania micrantha	E	Nr
RUBIACEAE		
Paederia scandens	N	Nr
HERBS		
ASTERACEAE		
Ageratum conyzoides	N	Nr
ARACEAE		
Alocasia macrorrhiza	N	
AMARANTHACEAE		
Amaranthus viridis	N	Bl
OXALIDACEAE		
Oxalis sp.	N	Bl
GRASSES		
POACEAE		
Miscanthus sinensis	N	Bl
Neyraudia reynaudiana	N	
Panicum maximum	E	
FERNS		
SCHIZAEACEAE		
Lygodium japonicum	N	

Key: N = Native; E = Exotic; Nr = Nectar source for Butterflies and Wasps; Bl = Food plant for Butterfly larvae; Fr = Fruit source for birds etc.

* No figures for abundance for Option 1 are provided as plant specimens were in not abundant in any case, and often related to only a single specimen.

Table 5 Plants Occurring in Site 2 (Disused Track Option)

Plant Species Abundance	Origin	Remarks	
TREES			
RUTACEAE			
Acronychia pedunculata	O	N	Bl
EUPHORBIACEAE			
Aleurites moluccana	F	E	
Bridelia tomentosa	F	N	Bl,Fr
Macaranga tanarius	A	N	Fr
Mallotus apelta	F	N	
MORACEAE			
Artocarpus hypargyrea	R	N	
Broussonetia papyrifera	A	N	Bl,Fr
Ficus hispida	F	N	
Ficus microcarpa	C	N	Bl,Fr
Ficus superba var. japonica	F	N	Fr
Ficus variegata var. chlorocarpa	F	N	
Morus alba	O	N	Fr
CAESALPINIACEAE			
Bauhinia purpurea	O	N	Bl
POACEAE			
Bambusa spp.	F	N	
CARICACEAE			
Carica papaya	O	E	Nr
ULMACEAE			
Celtis sinensis	F	N	Bl,Fr
LAURACEAE			
Cinnamomum camphora	F	N	Bl
Litsea glutinosa	F	N	Bl
ARECACEAE			
Cocos nucifera	R	E	
ROSACEAE			
Eriobotrya japonica	O	E	
SAPINDACEAE			
Euphoria longan	O	E	
Litchi chinensis	O	E	Bl,Nr
MIMOSACEAE			
Leucaena leucocephala	C	N	Bl
TILIACEAE			
Microcos paniculata	F	N	Bl,Nr
MUSACEAE			
Musa sp.	O	E	Bl
APOCYNACEAE			
Plumeria rubra var. acutifolia	O	E	
ARALIACEAE			
Schefflera octophylla	F	N	Bl,Nr
STERCULIACEAE			
Sterculia lanceolata	F	N	Bl
MYRTACEAE			
Syzygium jambos	O	E	

Table 5 (Contn.)

VERBENACEAE			
Vitex quinata	O	N	
SHRUBS			
AMARANTHACEAE			
Achyranthes aspera	O	N	
ACANTHACEAE			
Barleria cristata	O	E	Bl
VERBENACEAE			
Callicarpa nidiflora	O	N	
Duranta repens	O	E	
EUPHORBIACEAE			
Croton lachnocarpus	O	N	
Pedilanthus tithymaloides	O	E	
Phyllanthus reticulatus	O	N	
ANNONACEAE			
Desmos cochinchinensis	F	N	Bl
MORACEAE			
Ficus hirta	F	N	
AQUIFOLIACEAE			
Ilex pubescens	O	N	
OLEACEAE			
Ligustrum sinense	F	N	
LAURACEAE			
Litsea rotundifolia oblongifolia	F	N	Bl,Nr
MYRSINACEAE			
Maesa perlarius	O	N	
MALVACEAE			
Sida rhombifolia	O	N	
CLIMBERS			
CAESALPINIACEAE			
Bauhinia championi	F	N	
Bauhinia glauca	F	N	
NYCTAGINACEAE			
Bougainvillea glabra	O	E	
Bougainvillea spectabilis	O	E	
ARECACEAE			
Calamus tetradactylus	F	N	Bl
CELASTRACEAE			
Celastrus hindsii	O	N	
PAPILIONACEAE			
Dalbergia hancei	O	N	
MENISPERMACEAE			
Diploclisia glaucescens	C	N	
GNETACEAE			
Gnetum montanum	F	N	
SMILACACEAE			
Heterosmilax gaudichaudiana	O	N	

Table 5 (Contn.)

CONVULVULACEAE			
Ipomoea acuminata	O	N	
Ipomoea cairica	A	E	
Ipomoea tuberosa	O	E	
ASTERACEAE			
Mikania micrantha	A	E	Nr
RUBIACEAE			
Paederia scandens	F	N	Nr
DILLENIACEAE			
Tetracera asiatica	C	N	
HERBS			
ASTERACEAE			
Ageratum conyzoides	F	N	Nr
Bidens pilosa	F	E	
Elephantopus tomentosa	F	N	
ARACEAE			
Alocasia macrorrhiza	A	N	
LILIACEAE			
Aloe vera	O	E	
Liriope spicata	C	N	
CRASSULACEAE			
Bryophyllum pinnatum	O	N	
EUPHORBIACEAE			
Euphorbia hirta	O	N	
SOLANACEAE			
Solanum nigrum	O	N	Fr
GRASSES			
POACEAE			
Capillipedium parviflorum	O	N	Bl
Lophatherum gracile	F	N	Bl
Miscanthus sinensis	F	N	Bl
Neyraudia reynaudiana	F	N	
Panicum maximum	F	E	
Paspalum conjugatum	O	N	Bl
Sporobolus fertilis	O	N	
SEDGES			
CYPERACEAE			
Cyperus alternifolius	C	E	
Cyperus kyllingia	F	N	
Fimbristylis thomsonii	O	N	
FERNS			
THELYPTERIDACEAE			
Christella parasitica	C	N	
SCHIZAEACEAE			
Lygodium flexuosum	F	N	
Lygodium japonicum	F	N	
PTERIS Group			
Pteris ensiformis	F	N	

Table 5 (Contn.)

Key:
Local Abundance: A = Abundant; C = Common; F = Frequent; O = Occasional; R = Rare;
Origin: E = Exotic; N = Native;
Remarks: Bl = Food plant for Butterfly larvae; Nr = Nectar source for Butterflies and Wasps;
Fr = Fruit for birds etc.

APPENDIX 4

Responses to Comments

Comments made on Fair Copies of the Final Report (Volume I) - Environmental Impact Assessment between October 1994 and January 1995

Department	Section Ref	Comments	Consultant's Response
EPD 15/10/94	I - General	(a) to (h)	All comments have been noted and will be included in the Final Report.
	II- Sequence of Works	(a) to (f)	All comments have been noted and amendments will be made as appropriate to the Final Report.
	III - Noise A (1) to (3)		These comments have been noted. The text of the Final Report will be edited accordingly.
	A (4) Para 26 on page (v)	The conclusion drawn on the last sentence is not accurate, the Consultants would need to revise their assessment and redraw the conclusion.	The conclusion in para 26 refers to Table 4.18 and para 4.47. Table 4.18 has been amended as a result of previous editing but the text in para 4.47 has not been amended accordingly. In the Final Report para 4.47 will be replaced with the following text and para 26 will be amended to reflect these changes. "The extent of the impact associated with the barging point traffic will be determined by two factors: firstly, whether 400 or 600 vehicle trips per day occur, and secondly the traffic flows prevailing on Victoria Road at the time that the barging point is in operation. The effect of the general increase in traffic in this area is to reduce the impact attributable to the Marine Barging Point. Using 1995 flows the increase in peak hour traffic noise will be 0.8 dB(A). Using 2001 flows the increase will be 0.7 dB(A). The exact vehicle movements are not known at this stage but it can be seen that as the flows increase beyond 400 per day then the increase in traffic noisemay exceed 1 dB(A), and hence could be considered as significant. Monitoring of flows during operation will allow this impact to be quantified and the extent of any mitigation required to be established."
	B (a) to (c)		Noted. These amendments will be made to the Final Report.

Comments made on Fair Copies of the Final Report (Volume I) - Environmental Impact Assessment between October 1994 and January 1995

Department	Section Ref	Comments	Consultant's Response
	B(d) Para 4.39 & Table 4.14 & 4.15	This is the first time both Tables and text in the Consultant's submission (only Tables 4.14 and 4.15 were given in September). Discrepancies are noted on the traffic data and conclusions drawn from these Tables. From the assessment the difference in dB(A) can go up to 3.4 dB(A), and hence it cannot be regarded as minimal. According to the methodology adopted in para 4.8 on page 16, mitigation measures should be proposed as the difference is more than 1 dB(A). Subsequent to an audit check on the traffic data adopted for the assessment, we note the following:	
		(i) Table 4.14 - % Heavy adopted for Victoria Road E & W/b leap from 30% to 52% and 45% respectively due to the Dump, it seems to be on the high side even assuming that all the increase in vehicles is dump trucks. (Similar scenario is noted on Table 4.15).	*Table 4.14, column 5, % Heavy* should read: Victoria Road E/b - 42% and Victoria Road W/b 38%
		(ii) the increase in traffic noise based on the data for Belchers St W/b reveals that the increase as claimed by the Consultant is on the high side. The Consultant is requested to scrutinise the figures shown in tables 4.14 and 4.15 and hence the conclusion drawn in para 4.39.	*Column 6 Facade noise level dB(A)* should read: Victoria Road - 1.6 dB(A) and Belchers St W/b 0.4 dB(A) It is the view of the Traffic Consultant's that the figures on numbers of movements are correct. Given this, the resultant increases in traffic noise specified for Catchick St, Kennedy Town Praya, Queen's Road, Pokfulam Road and Mt Davis Road are correct and the increases are not significant. The routes of significance are Victoria Road and Belcher St which have been discussed above. Similarly, with Table 4.15 the figures are considered to be correct and noise levels are not considered significant with the exception of Victoria Road and Rock Hill Street. We suggest that the first sentence of para 4.39 is replaced as follows: "The impact of increased traffic flows on public roads due to the presence of dump-related traffic is constrained by the prevailing high flows. The predicted increases in flows will further constrain the increase in noise levels. However, a significant increase in peak hour traffic noise may arise in Victoria Road. The most effective means of mitigating this impact is by resurfacing Victoria Road with porous asphalt which would more than compensate for the increase in noise due to dump traffic."

Comments made on Fair Copies of the Final Report (Volume I) - Environmental Impact Assessment between October 1994 and January 1995

Department	Section Ref	Comments	Consultant's Response
	(d) Table 4.18 and para 4.47	We note that there exist some discrepancies and contradictions on the volume of traffic flow data adopted for the assessment. Is the conversion of the veh/hr figures realistic from the daily figures which cover at least 10 hours of work? What is the justification for such a magnitude of change in veh/hr arising solely from a change in volume of accessing vehicles from 400 to 600 trips per day? Also how could it be that the traffic flow volumes in pcu/hr decrease while there should be an increase in traffic using the road. The revised Table 4.18 also yields an maximum increase in traffic noise impact @ 10m from kerb be 2.4 dB(A), not 1.5 dB(A) as quoted in line 2 of para 4.47, such an increase in noise level could no longer be regarded as "minor". The Consultant is requested to re-examine the assessment assumptions as well as the results and revise the conclusion given in the EIA report.	Agreed. Table 4.18 and para 4.47 are not compatible. Please refer to our response to comment A (4) for the revised text for para 4.47. In addition the following amendment will be made to Table 4.18 - The figures in brackets in the "With Site" columns will be deleted as the unbracket figures contain a 50% increase to represent 600 vehicle trips per day.
	(e) Para 4.55 and 4.57	Are the inwardly curved noise barrier and the short section of the haul road adjacent to Serene Court be totally enclosed agreeable to the relevant departments (eg TD and HyD)	Both departments have had the opportunity to comment on the RDFR and the DFR and have declined to comment.
	(f) Para 4.59 - last sentence	Please elaborate what is meant by 'require further mitigation at the receiver'. What is the proposal?	The following replacement text for the last sentence of para 4.59 is proposed: The safety requirement has implications for the effectiveness of the barrier, especially in relation to its ability to adequately mitigate noise levels at the school and the two residences immediately across the junction. At this stage the exact sight lines required, and hence the constraints on the barrier length are not known. Once this is established, and the exact effectiveness of the barrier determined, it may be that further mitigation will be required at these receptors. Such mitigation could take the form of the provision of secondary glazing together with mechanical ventilation for the properties so affected.

Comments made on Fair Copies of the Final Report (Volume I) - Environmental Impact Assessment between October 1994 and January 1995

Department	Section Ref	Comments	Consultant's Response
	(g)	There is no mention of the potential traffic noise impact on public roads as the result of the operation of the Public Dump in the Conclusion & Recommendation Section (Chapter 12) and at the end of Chapter 4.	Chapters 4 and 12 will be edited to incorporate the following comment: "The extent of the impact associated with increases in traffic on local roads will be determined by two factors: firstly, the number of vehicle trips per day, and secondly the traffic flows prevailing on Victoria Road at the time the site is in operation. The effect of the general increase in traffic in this area is to reduce the impact attributable to the site. Monitoring of flows during operation will be necessary in order for this impact to be quantified and the extent of any mitigation required to be established. Such mitigation would be likely to involve the surfacing of Victoria Road with porous asphalt."
	(h)	Please revise the Summary Chapter and Chapter 12 accordingly.	Noted. These chapters will be revised in the Final Report.
	IV - Air Pollution	(a) to (d)	Noted.
	(e) Para 5.112	This paragraph is confusing. Please summarise the paragraph in accordance with para 5.81, 5.82 and 5.83 and what are the proposed mitigation measures?	Para 5.112 will be replaced as follows: "It is difficult to quantify odours from the stagnant water area due to the uncertainty in its exact location and its variable size. However, the modelling results showed that the water is likely to become stagnant for part of the tidal cycle but will not persist for more than two hours. Sensitive receivers likely to be affected by stagnant water odour are those to the north of Victoria Road (ie Receivers 2, 6, 8 and 10). Natural flushing on the subsequent portion of the tide will prevent the impact from persisting for more that than a couple of hours and in due course the development of the SSDS works and its associated interception of drainage waters should further mitigate the potential for odour impacts from the stagnant water area."

Comments made on Fair Copies of the Final Report (Volume I) - Environmental Impact Assessment between October 1994 and January 1995

Department	Section Ref	Comments	Consultant's Response
	(f)	What will be the contractors' proposed detailed dust mitigation measures?	It will the responsibility of the contractor to propose mitigation measures which are acceptable. However, some mitigation measures are recommended in para 5.111. To make this clearer this section will be re-structured as follows: Para 5.111 Current para 5.114 becomes para 5.112 Revised para 5.112 becomes para 5.113 Current para 5.115 becomes para 5.114 Current para 5.113 becomes para 5.115
	(g)	Please revise summary Chapter and Chapter 12 accordingly.	Noted.
	(V) - Water Quality & Dredged Sediments A - Summary (a)		The text of theFinal Report will be edited accordingly.
	(b) para 45	We have reservations on the statement that "There are no sensitive receivers in the immediate works area". The consultants have to ascertain and state whether the littoral biota at the Green Island and the nearby residents on Hong Kong Island etc should be regarded as sensitive receivers.	Please note that this statement is exactly the same as the statement made in para 7.261 of the Revised Draft Final Report, which was included in the DFR, using the same wording, in December 1993 (then para 7.204). It is not considered appropriate that the identification of sensitive receivers should be commented upon for the first time at this late stage of the contract.
	(c) para 51	This para indicates that the dredging activities will impose an additional oxygen demand between 2.5% and 25% of the existing D O level. If the 25% case occurs, we do not think the effect on water quality is insignificant. The consultants may wish to readdress this para accordingly.	Please note that para 51 in the Summary chapter relates to para 7.267. Para 7.267 has been reworded in response to EPD's comment (h). Para 51 will be replaced in the Final Report with th same wording.
	(d) para 52	Apart from the bacteriological water quality the consultants are required to state whether the assessed results of other water quality parameters are also acceptable.	This is one of a series of conclusions presented in paras 48 - 52 inclusive which comment on other aspects of water quality impact and should not, therefore, be interpreted in isolation. This statement was included inthe RDFR as para7.268.

Comments made on Fair Copies of the Final Report (Volume I) - Environmental Impact Assessment between October 1994 and January 1995

Department	Section Ref	Comments	Consultant's Response
	(e) para 53	"Scavenging sampans" for collection of floating refuse/debris should also be incorporated as a mitigation measure for the open dumping activities.	The recommended use of "scavenging sampans" has been included in para 7.181 of the RDFR. We do not think it critical that this level of detail should be included in the Summary.
	B - Chap 6 Sewerage Impacts (a) para 6.15	Our previous comments on the continued discharge of the existing foul sewer opposite to Davis Street to the inshore waters has been responded to by the consultants. Since their response involves some proposed actions for improving the water quality at the seafront, the consultants should incorporate the above response in this para of the final report as well.	Noted. This will be added to para 6.15 in the Final Report as follows: "However, part of the sewer system along Davis Street has been diverted inland already by DSD, thereby reducing the catchment area and flows which will directly discharge to inshore waters. In order to divert the remaining foul sewer system a substantial length of sewer would have to be relaid to new gradients in order to connect to the new foul sewer system further inland. The design of DSD's new sewer system in the vicinity would need to be assessed to establish whether it would have the capacity for this extra flow. This approach would be a sensible course of action to improve water quality at the seafront."
	(b) Tables 6.2 and 6.3	The consultants have to clarify the rationale behind amending some figures of the 'Estimated Pollution Load' in the above tables.	The figures were amended as a result of arithmetic error.
	C - Chap 7 Water Quality (b) para 7.5	We could hardly agree with the content of this para due to the following reasons, the consultants need to amend or totally delete this paragraph. (reasons not listed here)	This statement is in essence the same as the one in para 7.5 of the DFR in Dec 1993. The conclusion with which it is now being compared was also in the same report under para 7.213. However: (i) There is no breach of WQO predicted by the water quality modelling. Para 55 of the Summary observes that, when the Sulphur Channel is fully closed, the DO concentration in the lower layer of Belcher Bay will fall and fail to meet the **possible** WQO. As yet the Victoria Harbour WCZ has not been declared; there is therefore no WQO to be breached. (ii) This paragraph states our conclusion, based on our study, of what is needed to maintain impacts within acceptable limits based on available criteria. We do not feel it appropriate that this should be changed to match an actual course of action agreed subsequently by CED.

Comments made on Fair Copies of the Final Report (Volume I) - Environmental Impact Assessment between October 1994 and January 1995

Department	Section Ref	Comments	Consultant's Response
	(c) and (d)		This will be corrected in the Final Report.
	(e) para 7.254	Since the requirement of dredging for the Marine Barging Point is no longer valid, the consultants should check whether this para is still relevant. If the answer is negative, they should delete the whole para.	This paragraph will be deleted in the Final Report.
	(f) para 7.259	What is meant by nitrate WQO and what is the proposed mitigation measure?	This conclusion was drawn in para 7.202 in the DFR submitted in Dec 1993 and has not been previously commented upon. Once again we do not consider that such a comment should be made for the first time at this late stage of the study.
	(g) para 7.274	Is the unit of SS in % rather that mg/l (ie increase by more than -% above the baseline)?	The unit of mg/l is correct.
	(h) para 7.267	Please replace 'which is currently in the range 1-2 mg/l' by 'which is within the current margin 1-2 mg/l above the guideline values for Dissolved Oxygen'. Is this what the Consultants mean?	No, this is not the intended meaning. The paragraph will be reworded as follows: "The additional oxygen demand imposed on the water column by dispersed sediment resulting from dredging will range between 0.05 ad 0.25 mg/l. Existing oxygen demand levels are in the range 1-2 mg/l and this increase is unlikely to have any significant effect on water quality."
	(i)	There should be some assessments in the text regarding the water quality impacts of the construction of the permanent barging berths at the southwest corner of the Dump Site, while the operation impacts will be addressed by the responsible party in due course.	At the meeting held at CED building on 5 August 1994 it was agreed that no assessment of the permanent barging points would be made and this aspect would not be covered in the water quality section of the report (Chapter 7).
	(j)	Please revise the Summary chapter and Chapter 12 accordingly.	Noted.
	E - Chap 11 (a)	Referring to the 3rd line in the first para., the consultant should obtain a licence for the dredging of marine mud at the project site.	This is a matter for CED.
	(b) para 11.15	We suggest to shift the locations of the monitoring stations *M1 closer to the northern shoreline of Green Island (as shown on the enclosed drawing) in order to have a better control on the water quality there so that the littoral/sub-littoral biota in the close vicinity will be less affected.	We do not agree to shifting the location of station *M1. It has as it has been positioned through consideration of the plumes.

Comments made on Fair Copies of the Final Report (Volume I) - Environmental Impact Assessment between October 1994 and January 1995

Department	Section Ref	Comments	Consultant's Response
	(c) para 11.40		This will be added in the Final Report.
	(d) - Table 11.1	The TAT levels proposed for the temperature parameter is suggested to be deleted from the Table. Usually the plus/minus 2°C commonly adopted for this parameter is considered adequate for the monitoring and audit works.	Temperature parameter will be deleted.
		VI - Marine Ecology & Terrestrial Ecology	
	(a) para 8.15	'is of academic value'. What is the follow up action / recommendation?	We suggest 'academic value' is replaced with 'scientific interest'. As recommendation is made in para 8.29 to conduct further investigations to determine the ecological value of this community and a more detailed scope of works is put forward in Appendix 2.
	(b) para 8.22	What are the proposed mitigation measures for the intoxication?	No mitigation measures are proposed. The Consultants are simply drawing attention to an impact which may occur, but which cannot be quantified or defined with confidence.
	(c) para 9.44	What is the final recommendation?	We have not made a final recommendation in para 9.44. However, we think it reasonable to draw attention to the ecological value of any Hong Kong woodland which has not as yet experienced significant human access and hence general degradation. Such areas have a value in conservation, but the loss of this area on Green Island is not in itself environmentally unacceptable. Recommendations are proposed in paragraphs 9.61 and 9.62.
	VII - Monitoring and Audit Requirements	All comments	Noted. These will be edited accordingly in the Final Report.
	VIII	There should be a schedule of mitigation measures in table form enclosed as an appendix.	A summary of mitigation measures (in tabular form) will be included in the EM&A Manual.

Comments made on Fair Copies of the Final Report (Volume I) - Environmental Impact Assessment between October 1994 and January 1995

Department	Section Ref	Comments	Consultant's Response
DAF	IX - Marine Ecology & Terrestrial Ecology		
	(a) para 8.26	Who is responsible and follow up the proposed mitigation measure as described. Have the relevant government departments agreed to?	The recommended mitigation measures could be undertaken by the contractor, as a requirement of the contract, or by the relevant government department. It is for government to decide which department should take responsibility for conservation of ecology in Hong Kong. Possibilities include AFD, EPD or the Works Department; in this case CED.
	(c) para 8.33	As the results of the benthic surveys of the Sulphur Channel in another EIA report for West of Sulphur Channel Marine Borrow Area have been known. This report, therefore, should be able to include such information as it is relevant to the present assessment.	Further information has recently become available as a result of the focused EIA study for West of Sulphur Channel. However, it is not considered reasonable at this stage in the Green Island EIA study to incorporate new information which has only just become available.
	(d) para 9.43	Presumably the bird study of the resident bird population as mentioned in para 9.42 should be able to clarify the uncertainty as expressed in the last sentence of this para. If this is the case, the consultant should make such cross reference as appropriate.	The survey referred to in para 9.42 and Appendix 3 refers to Green Island only and not to the coastline of Hong Kong Island therefore it is not appropriate to cross reference.
	(e) Appendix 2 and 3	Cost estimation for additional studies re presumable based on current prices. In this connection, please add "as at........1994" or similar statements for clarification where appropriate.	Correct. This will be clarified in the relevant paragraphs of these appendices.

Comments made on Fair Copies of the Final Report (Volume I) - Environmental Impact Assessment between October 1994 and January 1995

Department	Section Ref	Comments	Consultant's Response
DAF 4/11/94	(a) Paragraph 8.3	"Preliminary findings" might have to be re-worded	Noted.
	(b) Paragraph 8.6	It appeared that there was little evaluation/emphasis on the report regarding the effect to Green Island and the northwestern shores of Hong Kong Island by the proposed works in terms of special features like uniqueness of the community, their education and scientific values and their conservation potential.	Text will be re-worded to include more detailed evaluation of the northwestern shores.
	(c) Paragraph 8.7	It mentioned about "the occurrence of some taxa rarely recorded on similar habitats elsewhere in Hong Kong". However under paragraph 8.13 some species/animals mentioned are related to their occurrence elsewhere in Victoria Harbour. Perhaps the emphasis should be placed on a more global term like Hong Kong or Southeast China. Also the importance of the size of the species/animals appeared to be over-stressed.	The text will be revised to clarify the occurrence of these species within Hong Kong and the importance of their size.
	(d) Paragraph 8.15	It was considered that justification on potential educational site or any site with academic value should be made not purely on "size" basis.	Agreed.
	(e) Paragraph 8.28	There was doubt on the inclusion of this paragraph under the heading of "cumulative impacts".	Agreed. This paragraph will be deleted.
	(f) Paragraph 8.29 & 8.30	The content of these paragraphs and the recommendation/ conclusion made should be reviewed.	Noted.
	(g) Paragraph 8.31	The proposed mitigation measures, like construction of seawall prior to any filling, could be repeated here rather than referring to previous chapter. What species/community proposed to be transplanted could be added to this paragraph.	Mitigation measures mentioned in previous chapters will be re-stated in Chapter 8 and the species to be transplanted will be made clear.
	(h) Paragraph 8.33	CED agreed to clarify with Fill Management Committee regarding inclusion of statements of findings from the EIA Study for the adjoining marine barrow area.	Agreed. The results of the West of Sulphur Channel EIA will be included in this report.

Comments made on Fair Copies of the Final Report (Volume I) - Environmental Impact Assessment between October 1994 and January 1995

Department	Section Ref	Comments	Consultant's Response
	(i) Paragraph 9.5	The word "preliminary" might need to be reconsidered.	Noted.
	(j) Paragraph 9.23	The impact to Reef Egret "due to the diminishing natural shoreline available locally as a foraging ground" might need to be reviewed. This in particular related to Paragraph 9.40 which mentioned about a possible depletion of local populations of this species. Would there be any mitigation measures required?	Mitigation measures will be included in the revised text for Chapter 9.
	(k) Paragraph 9.27	The word "preliminary" might have to have revised.	Noted.
	(l) Paragraph 9.59 & 9.61	The cause and details for the recommended survey should be reviewed. Would there be any mitigation measures required, like replacement of planting? Besides, signage warning of fire risks was unacceptable as a mitigation measures.	Agreed. The need for further survey work will be reviewed together with the mitigation measures proposed.
DAF 7/12/94	Chapter 9	Further clarification required on the purpose and scope of the additional survey work required.	Agreed.
		The provision of a rubble-faced pitched slope seawalls with large size armour rock would be a useful mitigation measure in relation to the loss of shoreline due to the implementation of the public dump project.	Agreed. This recommendation has been included.
		Further clarification is required to highlight the extent of <u>direct</u> impacts on the terrestrial ecology of Green Island as a result of the implementation of the public dump project as opposed to indirect impact/damage.	Noted. The text will be revised to clarify which are direct as opposed to indirect impacts of the public dump project.

Comments made on Fair Copies of the Final Report (Volume I) - Environmental Impact Assessment between October 1994 and January 1995

Department	Section Ref	Comments	Consultant's Response
EPD 13/12/94	Chap 4 - Noise Para. 4.47	Amend the wordings "an hence could be considered as significant." to read as "and hence would need attention".	Agreed.
	Table 4.15	I appreciate that Table 4.14 has been revised in accordance with our previous comments. However, the consultants have not confirmed whether the % Heavy and increase in traffic noise laid down in the Table 4.15 would also be amended, in particularly for Victoria Road (E/b & W/b) and Rock Hill Street (W/b).	The data given in Table 4.15 are correct.
	Table 4.39	Amend the suggested sentences to read as "The impact ... by the prevailing traffic flows. However, an increase of 1.6 dB(A) in peak hour traffic noise may ...". The suggested porous asphalt surfacing for Victoria Road should be agreeable to HyD before it can be accepted as mitigation measures.	As the proposed mitigation measure of resurfacing Victoria Road with porous asphalt was unacceptable to Highways Department for maintenance reasons and in view of the slight increase in noise levels compared to the high background noise levels, the first sentence will be amended as: "The impact of increased traffic flows on public roads due to the presence of dump-related traffic constrained by the prevailing traffic flows. However, an increase of 1.6dB(A) in peak hour traffic noise may arise in Victoria Road. The use of porous asphalt for resurfacing is not warranted under the circumstances from maintenance point of view as advised by Highways Department. Alternative mitigation measures will be identified and discussed as agreed with EPD.
	Table 4.59	Since there is no standing policy to provide window consultation and air-conditioning to redress construction noise impact, the last sentence of the suggested text should be deleted and further suggestions needed.	The proposed mitigation measures will no longer be considered. The last sentence will be amended to read as "This safety requirement has implications for the effectiveness of the barrier especially in relation to its ability to adequately mitigate noise levels at the school and the two residences immediately across the junction. At this stage the exact sight lines required are not known and hence the constraints on the barrier dimensions cannot be assessed. It may be that further mitigation will be required at these receptors.

Comments made on Fair Copies of the Final Report (Volume I) - Environmental Impact Assessment between October 1994 and January 1995

Department	Section Ref	Comments	Consultant's Response
	Chap 7 - Water		
	(a)	It is necessary to include and confirm in the report that the assessment covers the water quality impacts arising from the permanent barging berths at the southwestern corner of the dump site.	The following sentence will be added to para. 3.6: "In addition a long term barging berth for public dump material is proposed next to the IWTS marine reception area. However, the end user of these berthing facilities will have to undertake a separate EIA."
	(b)	An additional monitoring station positioned near to the northern shoreline of Green Island should be included in the monitoring programme.	Agreed. An additional monitoring station (M8) has been positioned close to the northern shoreline of Green Island. The grid reference is N816900 E829600. It will be added to para. 11.15 and Figure 11.1.
	(c)	The consultants failed to include in the report the agreement made between CED and EPD that large scale public dumping activities should only be allowed in periods of rising or slack tides and that the western seawall should be constructed as early as possible to confine the dumping impacts from affecting the sensitive receivers in the East Lamma Channel. Both CED and the consultants agreed to incorporate these requirements as mitigation measures in the final report.	The following text will be added to para. 7.264. "To mitigate the environmental effects as far as possible, however, it was agreed between CED and EPD subsequent to modelling work that the construction programme would be adjusted so that the western seawall would be built as early as possible and that dumping operations would only take place on a rising tide.
	Para. 7.267		This paragraph will be re-worded as follows: "The additional oxygen demand imposed on the water column by dispersed sediment resulting from dredging will range between 0.05 and 0.25 mg/l. Existing oxygen demand levels are in the range 1-2 mg/l and this is unlikely to have a significant effect on water quality".
	Chapter 5 - Air	Outstanding issues following ESWG meeting 30/11/94.	A copy of the revised text for pages 54 and 55 is attached. Please note in particular, paras. 5.78, 5.79 and 5.80 and footnotes to Table 5.12.

Comments made on Fair Copies of the Final Report (Volume I) - Environmental Impact Assessment between October 1994 and January 1995

Department	Section Ref	Comments	Consultant's Response
EPD 18/1/95	Chapter 7	Paras. 7.257 - 7.259 : all these paras. related to the status of the declaration of the Victoria Harbour as WCZ and the existing water quality in Victoria Harbour. I do not see how they can be treated as part of the conclusions of the study. Rather than citing existing conditions, the consultants should focus on the impacts of the project on the water quality and sensitive receivers in Victoria Harbour WCZ and E Lamma Channel and state whether they will be adversely affected by the project. In any case, the first phase of the Victoria Harbour WCZ was already gazetted in 1994 and the second and third phase will be declared in 1995 and 1996 respectively. Furthermore, TIN not nitrate is used in the WQOs.	Para. 7.257 will be modified as follows: "WQOs have been identified for the gazetted Western Buffer and Southern WCZs. Parts of the Victoria Harbour WCZ have now also been gazetted, but the area around Green Island is not expected to be gazetted until 1996, when appropriate WQOs will be applied." Para. 7.258 will be modified to read as follows: "With the exception of photoplankton, nutrients, and total inorganic nitrogen, ..." Para. 7.259 : Replace "nitrate" by "TIN".
	Para. 7.260	The consultants fail to state which of the two criteria or whether an intermediate value should be used for protection of the water intake and as the criterion for determining the acceptability of the SS elevation caused by the project. The consultants must conclude, based on the plume modelling results and their professional judgement, whether the Kennedy Town intake would be adversely affected. Paras. 7.265 and 7.263 virtually refer to the same issue and should be combined with this para.	The consultants consider that the paragraph is valid as it is.
	Para. 7.261	Isn't Kennedy Town intake a sensitive receiver close to the works area? This para. should be placed before para. 7.260.	The Consultants propose the existing sentence should remain, but the following sentence will be added.: "The nearest sensitive receiver which could be impacted by the works is the Kennedy Town salt water pumping station". Moreover, this paragraph will be relocated before 7.260.
	Para. 7.262	The para. does not tell the significance of the impacts. What one wants to know is whether the plume will have adverse impacts on the water quality and sensitive receivers and not the plume contour. The consultants should point out that based on the plume modelling, the SS elevation in sensitive areas will not be detectable and has no impact on them.	The Consultants considered that there will be no adverse impact and propose to add an additional sentence at the end of the paragraph : "Based on these results, the SS elevation will not be detactable and will have no impact on them."

Comments made on Fair Copies of the Final Report (Volume I) - Environmental Impact Assessment between October 1994 and January 1995

Department	Section Ref	Comments	Consultant's Response
	Para. 7.263	Obviously, the analytical results from the first survey are unreliable and should be disregarded. So, what is the purpose of mentioning the first survey and the problems it created in the "Conclusion and Recommendation" Section? This will only lead to confusion.	Originally, the Consultants did not include the first survey results in the report, but in response to earlier comments from EPD, they were subsequently added. The Consultants propose that this paragraph should be replaced with the following : "The latest sediment surveys of the area, which investigated the depth of contamination using triplicate samples, confirmed that the samples were within the "Class A" category. As a result, no special measures will be required during transport and disposal."
	Para. 7.264	The message conveyed by this para. is very unclear. The para. should be amended to reflect the results of plume modelling which indicates that on some occasions the plume will encroach upon the eastern shore of Green Island and travel into the E. Lamma Channel. Although the impacts are considered by the consultants to be minimal and acceptable, to mitigate the effect as far as possible, CED and EPD agreed that (i) the western seawall should be built asap., and, (ii) dumping operations will take place only on a rising tide or slack tide. This para. should follow para. 7.262.	The Consultants proposed to modify the second sentence as follows: "The environmental impacts are considered to be minimal and acceptable. Nevertheless, after the modelling work had been completed, and in order to mitigate as far as possible any environmental impacts which might result from the occasional encroachment of the plume on the eastern shore of Green Island or in the East Lamma Channel, it was agreed between CED and EPD that the western seawall would be built as early as possible in the programme, and that dumping operations would take place only on a rising or slack tide." As suggested, the Consultants will place this paragraph after 7.262.
	Para. 7.273	On the basis of the consultants' assessment in para. 7.265 and their recommendation in this para., it seems that the consultants consider a SS level in the odour of 20 ppm should be used as the criterion for acceptance. This does not accord with para. 7.260 which uses 10 ppm and 140 ppm as the guidelines. As pointed out in our comments on para. 7.260, the consultants must indicate clearly the maximum acceptable SS level and whether the intake will be adversely affected. If 10 ppm or 20 ppm is used, it is evident that this level will be exceeded and mitigation measure such as the provision of silt screen should be implemented.	The consultants propose this paragraph should be combined with 7.265, and 7.265 should be revised as follows : "It is predicted that the suspended solids concentration at the Kennedy Town salt water pumping station will not increase above background levels. However, increase of a few mg/l may be expected a short distance offshore from the intake. It is recommended that precautionary provision be made that, should the measured flood difference concentration of suspended solids at the monitoring station offshore of the Kennedy Town salt water pumping station increase by more than 10mg/l above the baseline flood difference as a result of the works, then a silt screen should be installed around the station intake."

Scott Wilson Kirkpatrick • 38th Floor Metroplaza Tower 1 • 223 Hing Fong Road • Kwai Fong • Hong Kong
Telephone (852) 2428 8866 • Fax (852) 2428 9922