



Hong Kong Government
Drainage Services Department

Strategic Sewage Disposal Scheme Stage 1 Principal Collection and Treatment System

Supplementary Environmental Impact Assessment

Executive Summary

May 1996

EIA-090/BC

EIA/011/96



MONTGOMERY WATSON

環協顧問工程師

in association with



Camp Dresser & McKee • Mott Connell • Scott Wilson Kirkpatrick • WGP Engineering • Operational Services Inc.

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Stage 1
Principal Collection and Treatment System**

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**A Paper Prepared by Mott Connell Limited
for Montgomery Watson**

SSDS Stage I Scheme
Environmental Assessment : Executive Summary

Background

1. The Strategic Sewage Disposal Scheme (SSDS) was founded on the principles developed in the Sewage Strategy Scheme (SSS) which was commissioned in 1988 in response to the growing concern that marine and coastal water quality and beach water quality throughout the territory were in decline. The stated aim of the SSS was to review and recommend water quality objectives for the coastal waters of Hong Kong based on their beneficial uses and, to develop strategic collection, treatment and disposal options for the disposal of effluent.
2. The Sewage Strategy Study concluded that in the long term an acceptable approach for treating industrial and domestic effluent could be achieved by combining land-based treatment and natural decay within the marine environment. A four phased approach was derived with the intention of providing early relief for water quality within Victoria Harbour, minimising disturbance to the environment during construction, without the need to reclaim additional land, and with a view to providing a low maintenance system with maximum flexibility. The Stage I Scheme, which is the subject of this Project, provides the integral collection and treatment system. The following three stages are adjuncts to this, and will sequentially provide the Ocean Outfall, the Hong Kong Island North Scheme, and the Hong Kong Island South West Scheme.
3. The Stage I Scheme comprises a conveyance system in deep tunnel which will connect Tseung Kwan O, Chai Wan and Tsuen Wan with Kwun Tong, whence it shall be conveyed to the new primary treatment works at Stonecutters Island, for treatment by chemically assisted sedimentation, prior to disposal via the Stage I Outfall, into marine waters to the southwest of Stonecutters Island. A schematic diagram of the collection system is illustrated on Figure E1.
4. The Stage I Scheme is divided into fifteen separate contract packages for the construction phase, six of which cover more than one site. Throughout the Study a series of Environmental Assessment Working Papers (EAWP) were prepared to provide input to the Contract Documentation for each individual Contract. Mitigation measures, monitoring proposals and specific environmental protection requirements referred to as "Particular Specification Clauses for Environmental Protection" were all included in these EAWP's. A standard set of Particular Specification Clauses for Environmental Protection were developed specifically for this Project and were used for all contracts. In addition to which supplementary conditions were also defined to reflect particular conditions or circumstances at individual sites.
5. Potential impacts pertaining to the operation of the Stage I Scheme relate to receiving water quality, odour generation, disposal of screenings from the treatment works and noise generated by the new facilities. Where potential problems may arise, mitigation measures were recommended so that these could also be specified in the contract documents.

Objectives of the Environmental Assessment

6. The stated objectives of the Environmental Assessment (Refer to Brief dated May 1993) are:
 - (a) to describe the proposed installations and related facilities and the requirements for their development;
 - (b) to identify and describe the elements of the community and environment likely to be affected by the Project;
 - (c) to minimise pollution and nuisance arising from the Project and its operation and environmental disturbance during construction and operation of the Project;
 - (d) to identify and evaluate the net environmental impacts and cumulative effects with other development projects expected to arise during the construction and operation phases of the Project;

- (e) to identify and specify methods, measures and standards to be included in the detailed design, which may be necessary to mitigate these impacts and reduce them to acceptance levels; and
- (f) to design and specify the environmental monitoring and audit requirements necessary to ensure the effectiveness of the environmental protection measures adopted.

Environmental Benefits of the Scheme

- 7. The main benefit of Environmental Improvement Scheme will be achieved through the implementation of the Stage II Scheme when the Ocean Outfall is commissioned, following which the Water Quality Objectives specified in the SSS will be fully achieved. Notwithstanding the foregoing a considerable improvement will also be achieved through the collection of numerous point sources of pollution which presently discharge, with little or no treatment, into receiving waters which no longer have the capacity to assimilate these pollution loads.
- 8. Other benefits of the Stage I Scheme include:
 - (i) the removal of pollution loads from water bodies in the Eastern New Territories and Port Shelter which are popular amenity and water sports/recreation areas;
 - (ii) the design of the collection, treatment and disposal scheme has reduced the scope for making expedient (illegal) connections to the sewers;
 - (iii) centralised treatment facilities for the extensive sewage catchment area in a remote location, with few potentially sensitive receivers in the vicinity is an added benefit; and
 - (iv) the logistics of operating to the high environmental standards required is easier at a central facility than at several smaller facilities throughout the urban area.

The Design Objectives

- 9. Stage I of the Scheme was conceived to provide a tangible, but short-term benefit to water quality and must be viewed as an intermediate solution, pending implementation of Stage II of the SSDS. The primary objective is to improve the quality of water in and around the Harbour as soon as possible. The date for commissioning of the Stage I Scheme is scheduled for mid-1997.
- 10. The water quality objectives which are under most threat, and which Stage I will directly improve, are those relating to bacteriological pollution. The original design objective of the scheme was to collect and remove at least 95% of the E.coli load which will be achieved using a chemically assisted primary sedimentation process. The original Detailed Design Brief was based on the use of lime to enhance the sedimentation process. An instruction was given by the Client in January 1995 to change from lime to a dosing system based on ferric chloride. This instruction required changes to be made during the detailed design and supplementary assessments were commissioned to determine the environmental effects of this decision.
- 11. The primary engineering objectives for the Stage I (Interim) and Stage II (Ocean) Outfalls, as defined in the Design Memorandum, December 1993, are to provide a cost-effective scheme with a high degree of reliability, which is easy to maintain and has the flexibility for expansion in the future. It is a basic premise of the SSDS that impacts on people and the environment are reduced as far as is practical during both construction and operation of the Scheme.

Revisions to the Preliminary Design Concept

12. Following a review of the Preliminary Design some fundamental modifications were made in the Detailed Design for the Stage I Outfall upon which this EIA is based. In terms of impacts on the marine environment, the most significant change is that the outfall will not be constructed as an immersed tube, as recommended in the Preliminary Design, but rather as a tunnel. A benefit of the tunnelled option is that there will be a significant reduction in construction phase impacts on surrounding property and associated facilities compared with the immersed tube alternative.
13. Another fundamental change in the Detailed Design, was the revision of projected future discharge rates which are significantly greater than those previously forecast. Furthermore, the commissioning date of Stage II of the Scheme, in which the ocean outfall will be constructed, has been postponed from the original anticipated date of 2001, to a date some years later, thereby necessitating the Stage I Outfall to be operational for a longer period of time than originally anticipated. The Marine Department has also indicated that the Northern Fairway may be widened at some stage in the future, which poses a constraint in terms of the location of the outfall diffusers. In addition to the foregoing the primary sedimentation process will now be based on a ferric chloride dosing strategy rather than one based on lime.

Environmental Assessments

Noise

14. Noise levels associated with the construction works were determined by identifying activities which could take place at each site along with necessary items of equipment and corresponding sound power levels. Forecast construction noise levels at the sensitive receivers nearest to each of the work sites were determined for individual and multiple activities. Sensitive receivers were identified through site visits, which were repeated on a frequent basis at sites including Stonecutters Island where the British Armed Forces are retrenching personnel, in the existing accommodation blocks, following the closure of other barracks around the Territory.
15. At most sites, sensitive receivers are located about two hundred metres from noise sources. At Shau Kei Wan however the nearest sensitive receiver is a primary school which is located some 20m from the Preliminary Treatment Works. Predicted noise levels were estimated using the method detailed in the Technical Memorandum "Noise from Construction Work other than Percussive Piling, EPD 1989" and Technical Memorandum, "Noise from Percussive Piling, EPD 1991". The standards to be achieved are those set out in the Noise Control Ordinance and the guidelines provided in the Hong Kong Planning Standards and Guidelines (HKPSG). The site where the greatest number of people could potentially be affected by construction noise is Kwun Tong. An estimated 5,500 people could be affected by works at this site, albeit to varying degrees, for more than two years.
16. Once the Stage I Scheme has been commissioned the main sources of noise will include pumps, motors, air blowers, ventilation fans and the mechanical equipment for moving plant, equipment and waste around the sites. The Stonecutters Island Sewage Treatment Works is considered to be a single fixed noise source. As such all individual components of the Scheme at Stonecutters Island which could generate significant noise were identified, the sound pressure levels determined and a "noise budget" applied to each of the main components in order to comply with the overall Acceptable Noise Level prescribed for this site. At the other sites, all items of equipment which could generate noise were identified and a cumulative assessment carried out to determine the extent of any mitigation measures which may be required.
17. Once the Stage I Scheme has been commissioned there will be minimal impact on account of the ambient noise levels in the built up areas combined with the small number of noisy operations. Through the inclusion of noise minimisation measures such as acoustic louvres or through placing restrictions on sound pressure levels for individual items of equipment, in relevant Contracts, it has been possible to achieve acceptable noise levels for all sites.

Air Quality

18. Air quality impacts associated with the construction phase relate to initial site clearing works, demolition of existing facilities, retrofitting new equipment and plant, construction of the production/drop shafts, blasting, excavating, stockpiling, vehicle movements on unpaved surfaces and haul roads, and concrete batching. Key quantities of material and spoil have been computed for this project on a monthly basis. As there was no requirement for air quality modelling to be carried out in the Brief, these estimates were compared to the assumptions and modelling results given in the Preliminary Design EIA. On this basis it was concluded that fugitive dust emissions could be controlled through the mitigation measures proposed and that there would be no adverse impact at the sensitive receivers.
19. Once the Stage I Scheme has been commissioned the key concern is the potential emission of odours (particularly hydrogen sulphide gas). Odour assessments were undertaken for each component of the scheme which were defined as potential odour sources. Cumulative assessments were undertaken at Stonecutters Island and Kwun Tong, where all hydrogen sulphide sources were assessed individually and in cumulative terms to determine the odour impacts at corresponding sensitive receivers.
20. Hydrogen sulphide emission rates were estimated mainly from the results of the monitoring carried out specifically for this Study. The model used for estimating hydrogen sulphide concentrations at sensitive receivers was the Industrial Source Complex - Short Term (ISCST).
21. Following the preliminary assessments, it was found that odour control mechanisms would be required for the majority of the works comprising the SSDS Stage I Scheme. The extent of these mitigation measures was identified and are summarised in Table 1.

Table 1 Mitigation Measures

Location	Mitigation Measures Required	Deodorisation Requirements
		H ₂ S Removal Required
Chai Wan PTW Fine Screens Building Coarse Screens Building Grit Skip Building	(i)	3 ppm to 0.005 ppm
Shau Kei Wan PTW Coarse Screens Building Grit Skip Building	(i)	3 ppm to 0.005 ppm
Tseung Wan O PTW Grit Skip Building Coarse Screens Building Headworks Buildings	(i)	3 ppm to 0.005 ppm 3 ppm to 0.005 ppm
Kwun Tong PTW Coarse Screens Building Fine Screens Building Grit Skip Building	(i)	3 ppm to 0.005 ppm
Kwun Tong Pumping Station Connecting Culvert Wet Well	(iii)	99% removal
To Kwa Wan PTW Coarse Screens Building Fine Screens Building Grit Skip Building	(i)	3 ppm to 0.005 ppm

Table 1 Mitigation Measures (Cont'd)

Location	Mitigation Measures Required	Deodorisation Requirements
		H ₂ S Removal Required
Tsing Yi PTW Coarse Screens Building Fine Screens Building Aerated Grit Channels	(i) + (ii)	3 ppm to 0.005 ppm 3 ppm to 0.005 ppm
Stonecutters Island		
Stonecutters Island Main Pumping Station	(iii)	99% removal
Sludge Treatment facilities	(iv)	99% removal
Influent channel of Sedimentation Tanks	(iii)	99% removal
Flocculation Tanks, Main Distribution Channels and Sedimentation Tanks (Ferric Chloride or Ferric Sulphate Treatment Scenarios)	(v)	60% removal

Notes: (i) Covers are required for the detritors. Deodorisation units, capable of reducing hydrogen sulphide concentration from 0.5-3 ppm down to 0.005 ppm, will be installed downstream of the extraction fans of all screens buildings and grit skip buildings.

Hydrogen sulphide concentration of extracted air from those buildings is not expected to exceed 5 ppb (0.005 ppm = 5 ppb) after deodorisation. This is equivalent to 10 odour units and will be reduced to less than 5 odour units at sensitive receivers outside the boundaries after dilution.

(ii) A deodorisation unit with same specifications required to treat the air extracted from the two aerated grit channels.

(iii) Deodorisation units with 99% H₂S removal efficiency.

(iv) Locally mounted activated carbon odour control units to treat foul air from sludge tanks and sludge cake silos and a central odour control unit to treat foul air from centrifuge centrate, solids discharge port, transfer conveyors and centrate sump.

(v) 20-40 mg/l ferric chloride (or equivalent dosage of ferric sulphate to achieve 60% removal of H₂S which will be determined by jar tests) if dosed upstream of the sedimentation tanks.

Water Quality

22. Water quality impacts of the construction phase are primarily confined to those connected with the marine works for the outfall tunnel and diffuser sections, and relate to increased turbidity from sediment losses during dredging, off-site transportation, and the potential impacts on sensitive receivers. An assessment was undertaken which identified that sensitive receivers such as bathing beaches or fish culture or spawning grounds would not be adversely affected by this activity. Nonetheless measures to minimise the potential impacts on marine water quality were defined in the Contract in keeping with the requirement to minimise the effects of construction on the receiving environment.

23. As the upgrading of the preliminary treatment works will be carried out while the facilities remain in operation, for short periods of time during the construction phase, effluent will be discharged without pretreatment. In these cases, restrictions have been placed through the Conditions of Contract in terms of the frequency of such events.

24. Once the Stage I Scheme has been commissioned, water quality is forecast to improve in terms of the E.coli counts and dissolved oxygen levels although not to such an extent that the Water Quality Objectives (WQO's) would be achieved. Full compliance with the criteria for suspended solids, and oxidised nitrogen is forecast, with 50% compliance with the WQO for ammonia on an annual basis even if no chemicals are added to enhance the sedimentation process. With the addition of 20-40 mg/l ferric chloride further improvements in water quality are forecast. However even with a 99% reduction in the bacterial count, full compliance with the WQO's will still not be achieved.

Waste Disposal

25. During construction of the Stage I Scheme an estimated 0.5Mm³ of spoil will be generated as a result of excavating the shafts and tunnels for the Stage I Scheme with up to 2.6Mm³ (unbulked) of marine mud dredged over a 6 month period. All of the dredged materials must be disposed of in accordance with requirements of EPD and the Fill Management Committee (FMC). The FMC advised that the 0.3Mm³ (bulked) of contaminated mud must be disposed of at the East Sha Chau Contaminated Mud Pits with the remaining marine mud being disposed of at the Ninepins Spoil Disposal Ground.
26. Excavation for the tunnels will take place through granite to the west and volcanic tuff to the east. While disposal of such material is at the Contractor's discretion, it has been generally recommended, wherever practical, that a waste minimisation policy should be adopted.
27. When all the facilities have been commissioned, the only significant solid wastes arising at the Preliminary Treatment Works will be grit and screenings. Disposal facilities for these materials are included in the upgrading of the treatment works and methods to minimise the impacts have been included in the contracts for each site. An estimated 520 tonne of sludge will be generated daily at Stonecutters on the basis of the addition of lime to enhance the sedimentation process. On the assumption that the dosing strategy will be based on ferric chloride the volume of sludge will increase to about 1700 tonne/day. It has been assumed that disposal of this sludge will be via barge, under a separate Contract from the rest of the facilities at the Stonecutters Island Sewage Treatment Works.

Vibration

28. Potential vibration problems were considered by identifying sensitive equipment, facilities, and properties in close proximity to each individual work site and determining the nature of the likely construction works. Communication was entered into with the Mines Division of the Civil Engineering Department and the Civil Aviation Department with regard to vibration levels which would be acceptable, in terms of peak particle velocities. These have been included in the Particular Specification for Environmental Protection in each contract.
29. Vibration effects following commissioning of the Stage I Scheme will result from operating pumps and motors. It has been previously accepted that this will not present a threat to the health of residents near such facilities. In view of the possible nuisance factor especially at night time, this issue was however taken into account in the Specification of Electrical and Mechanical Equipment for the various Contracts, and restrictions on vibration limits were defined.

Visual and Landscape Issues

30. Visual impacts during construction were considered in terms of the relatively short term change in land uses, the proximity of sensitive receivers and the predominant landscape features in the area through visiting the sites throughout the Study Period. Both visual and landscape impacts of the new facilities have been considered. The sewage treatment works at Stonecutters Island constitutes the most significant change to the landscape with visual impacts that will be perceived from land, sea and air. However, all of the sites were considered in terms of the relative value of the existing landscape, the degree of change as a result of the Stage I Scheme, the key features of the landscape at present and the proximity and nature of sensitive receptors.
31. Operational implications on existing users have been addressed by considering the final landform, operational requirements and the findings are summarised in Table 2.

Table 2 Site Characteristics and Visual Impacts

Site	Development Characteristics	Visual and Landscape Impact
Stonecutters Island	<p>Stonecutters Island Main Pumping Station approximately 50m diameter, 37.5m below ground level with a 20m high superstructure with a flat roof; North West Kowloon Pumping Station approximately 49m x 13m in plan and 5.8m deep. No superstructure at this facility;</p> <p>switchgear building 3 storeys, 44m x 30m in plan administration building 3 storeys, 46m x 26m; control building at NWKPS a 16.5m x 9.5m single storey building with 2 no. 5.5m x 5m transformer bays;</p> <p>transformer compounds, concrete slabs with walls but no roofs;</p> <p>roads, main access will be not less than 7.3m wide and 170mm thick reinforced concrete on 150mm thick sub-base. In entrance area roads will be constructed of concrete blocks;</p> <p>street lighting will provide an illumination level of at least 100 lux (either on columns or as floodlighting on buildings);</p> <p>berthing area;</p> <p>sedimentation tanks 10m high covering an area of 33,500m²;</p> <p>sludge collection and disposal, offices, workshops, fuel store, container storage area, seawall moorings; sludge treatment facilities, dewatering and drying plants housed in building 80m x 100m and 16m high. Boiler house may be housed separately. Sludge tanks with odour control units on roofs, fuel storage provided;</p> <p>master landscape plan prepared for this site</p>	<p>master landscape plan formulated to minimise visual and landscape impacts at an early stage of the operations. Residual impacts will be those observed from vantage points, passing marine vessels and from the air when arriving or departing from Chek Lap Kok Airport. Visual impacts are considered to be minor in connection with the development of this area for commercial uses.</p>
Stage I Outfall	<p>dropshaft entry culvert comprises a covered conduit 30m long ranging in size from 4.5m square at Chamber 15 to 8m wide by 7.5m high at the dropshaft, the shaft superstructure will be +10m PD and will be covered with removable concrete slabs for maintenance access;</p> <p>walls at Chamber 15 to be raised from existing 7mPD to 11mPD.</p>	<p>There will be no visual or landscape impact.</p>
Chai Wan	<p>upgraded PTW, drop shaft located within the existing works, operational access via existing road network, DSD security wall and screens already in place. Production shaft will be backfilled and returned to planned use</p>	<p>DSD security wall and hoardings presently exist round three sides of the site. Minimal impact</p>
Shau Kei Wan	<p>upgraded PTW, operational access past school 20m from entrance to site; highly visible from adjacent residential dwellings.</p>	<p>landscape value in this area not particularly high with shipyards to the east and a wholesale fishmarket due west.</p>
Kwun Tong	<p>upgraded PTW, nearest SR is 200m away.</p>	<p>minimal impact in view of surrounding uses.</p>
To Kwa Wan	<p>upgraded PTW, nearest SR is 200m away.</p>	<p>minimal impact in view of surrounding uses</p>
Tsing Yi	<p>upgraded PTW obscured from view by hanging bamboo and other dense foliage; operational and maintenance access will be via the existing road</p>	<p>site already obliterated from view by 5m high retaining wall to the north and a 10m high wall with tree planting to the west. Wider views from and to the Rambler Channel are limited by the container depot in close proximity to the site.</p>
Tseung Kwan O	<p>upgraded PTW about 2km from any existing or planned residential development</p>	<p>impacts are minor when considering the general construction works in this area and the long term industrial and commercial use of the adjacent land.</p>
Kwai Chung	<p>new PTW with landscaping features include: the design.</p>	<p>landscape quality at this site considered to be overstated in Preliminary Design Phase.</p>

Risk and Hazard Assessment

32. Risk and hazard assessments were undertaken individually for components of the Stage I Scheme by the Engineering Design teams for discrete contracts. Risk analyses were not included in the Brief to be undertaken as part of the EIA of the Detailed Design, although those were included in the EIA of the Preliminary Design, and the findings summarised in Table 3 below:

Table 3 Potential Risks Associated with Stage I Scheme

Risk	Analysis/Assessment
Accumulation of toxic and/or explosive gases (H ₂ S) in enclosed spaces	Design includes gas detectors and H ₂ S monitors in confined spaces. Conditions for access to confined spaces will be specified in Operations Manual.
Stonecutters Island Sewage Treatment Works	Failure or malfunctioning of the chemical dosing system. Basic treatment provided at the works although <u>E.coli</u> counts would be high.
Fugitive Dust from Chemical Dosing Facilities	Design will include enclosure and ventilation systems to minimise fugitive dust emissions.
Storage of Lime and Other Chemicals in Powder Form	Risk of explosions can be minimised through design of storage facilities.
Blockages or Siltation in the Tunnels	Designed to prevent siltation even under conditions of low flow and blockages prevented by upgrading of PTW's to include fine screening.
Outfall Failure	Emergency overflow included in the overall design
Failure at Pumping Stations	Spare motors and units have been specified in the M&E contract to minimise the risk of failure. Routine inspections and maintenance checks will be required to minimise the risks of failure.
Power Failure	Power to the pumping stations should be from different substations but the event of a power failure is very remote and thus no emergency substation has been included.

Environmental Monitoring and Audit Proposals

33. Monitoring of all activities associated with the Stage I Scheme is a prerequisite of the environmental control plan. Noise monitoring proposals have been made to ensure that the Contractors working methods do not generate noise levels which exceed the predefined limits or cause an unacceptable elevation in background noise levels or adverse impacts at the sensitive receivers. Noise generated by the ventilation fans, pumps and motors should be monitored at regular frequency, following the commissioning of the works and in response to any complaints received, to ensure the standards set have been achieved.
34. Air quality monitoring is also required at each of the works sites to ensure there is no adverse impact on the nearest sensitive receiver. Upon completion of the Stage I works, it is recommended that a comprehensive environmental audit is undertaken to confirm that the odour control systems are operating to the design standards and the filters at the chemical dosing facilities are conforming to the standards set. Monitoring of emissions and odour levels (by, inter alia, odour patrols and panels) will be required to confirm that the odour control units which are installed achieve the standards set at the site boundary.
35. Water quality monitoring of the marine works associated with the construction of the outfall and diffuser sections will be required to ensure the Contractor is operating within the requirements set for this Project with particular reference to suspended solids, dissolved oxygen and turbidity levels. Water quality monitoring of the receiving waters and the performance of the outfall has been recommended to determine whether the outfall is performing to the design specifications and to assist in the decision making process for the implementation of the Stage II Scheme.

36. Methods of measuring, suspended solids, dissolved oxygen and water temperature and salinity throughout the water column provide a powerful monitoring tool which could be applied during the post-construction monitoring of the outfall plume dispersion. Suspended solids are measured using an acoustic doppler current profiler (ADCP). The method of converting acoustic backscatter intensity to solids concentrations in mg/l was developed in Hong Kong and has been used extensively throughout the Territory to monitor the primary effects of dredging and disposal of dredged material.
37. Vibration monitoring requirements were detailed by CAD in their letter of 17th February (Ref (42) in AS/WKS/650) to ensure the operational capability of the Non Directional Beacon at Stonecutters Island is unaffected by the construction works associated with Construction of the Stage 1 Outfall.

Environmental Complaints

38. Sensitive receivers in the vicinity of the work sites may occasionally receive significant impacts from construction activities and may result in a complaint informing the Client or the RSS of the situation. The following guidelines detail how the RSS should deal with any complaints as efficiently as possible.
- (a) all environmental complaints should be received by the CE/PD or SRE, and immediately passed to the RSS. Complaints to the SRE will be dealt with by bilingual staff;
 - (b) the complaint should be immediately logged by the RSS, and an interim reply made to the complainant. Details should also sent to DSD, EPD and other relevant parties;
 - (c) the RSS should immediately commence procedures for substantiating the validity of the complaint. An initial investigation should be made of the referred environmental parameter at the source of the complaint. If appropriate, monitoring should also be undertaken or increased to measure the impact from construction activities, with reference to the appropriate trigger, action and target levels;
 - (d) any action should be taken in accordance with the relevant action plan;
 - (e) if action is required by the Contractor he should inform the RSS of all steps taken, including any action and remedial work. Written reports and proposals should be also passed to the RSS by the Contractor;
 - (f) monitoring by the RSS should continue, to ensure that the Contractor's remediation measures are effective, and until the situation is resolved; and
 - (g) liaison should continue between the SRE and all relevant parties until the situation is resolved.
39. All complaints should be classified in each monthly Environmental Monitoring and Audit Reports detailing the complainant, validity of each complaints, action required, how it has been resolved, and correspondence between all parties.

Summary of the Findings

40. A summary of the results of this assessment for the construction and operation of the Stage I Scheme, are given in Table 4.

Table 4 Summary of the Impacts Associated with Construction and Operation at Individual Sites Comprising the Stage I Scheme

Site	Construction Works	Potential Impacts		Recommended Mitigation Measures for the Operation Phase
		Construction Phase	Operational Phase	
Stonecutters Island	sewage treatment works, pumping stations, sludge collection, treatment and disposal facilities, production shafts, modifications to existing pumping station	noise, dust	odour, noise, visual	Design of odour removal facilities, acoustic louvres and extensive landscaping
Stage I Outfall	on Stonecutters Island; drop chamber to connect to outfall tunnel and pair of diffusers	noise, water quality	water quality	Environmental controls during construction, design of diffuser and treatment level to achieve best degree of compliance with WQOs
Chai Wan	upgrading preliminary treatment works, construction of drop shaft and production shaft	noise, dust, traffic	odour, noise	Design of odour control facilities, silenced ventilation equipment
Shau Kei Wan	upgrading preliminary treatment works, construction of drop shaft	noise, dust, traffic, visual	odour, noise, visual	Screen planting of trees and inclusion of odour control facilities, silenced ventilation equipment and acoustic louvres
Kwun Tong	upgrading of preliminary treatment works, construction of drop shaft, pumping station and production shaft	noise, dust, traffic	noise, odour	Inclusion of odour control facilities, silenced ventilation equipment and acoustic louvres
To Kwa Wan	upgrading of preliminary treatment works, construction of drop shaft	noise, dust, traffic impacts	noise, odour	Inclusion of odour control facilities, silenced ventilation equipment and acoustic louvres
Tsing Yi	upgrading of preliminary treatment works, construction of a production/drop shaft	noise, dust	noise, odour	Inclusion of odour control facilities, silenced ventilation equipment and acoustic louvres
Tseung Kwan O	upgrading of preliminary treatment works and pumping station, construction of a production/drop shaft	dust and noise minimised by distance between site and sensitive receivers	odour	Inclusion of odour control facilities
Kwai Chung	modification to provide new treatment plant (under construction), construction of drop shaft	dust and noise	minimal	Not applicable (Minimal residual impacts expected)

Conclusions

41. On the basis of the foregoing the following conclusions have been drawn :

General

- Particular Specification Clauses and Special Particular Specification Clauses were developed for the protection of the environment during the construction and implementation of the Stage I Scheme. All specifications are feasible and practical and will offer a high degree of environmental protection during the construction and implementation of the Stage I Scheme.
- Without the implementation of this Environmental Improvement Scheme marine and bathing beach water quality will continue to decline.

Water Quality

- The overall objective of providing a short term improvement in water quality in Victoria Harbour, with minimal impact on the existing environment during construction, can be achieved if the mitigation measures described herein are adopted.

- During construction the most severe impacts on water quality will arise as a result of the marine works. These will be able to be mitigated to a level which is acceptable in terms of receiving water quality except in the immediate vicinity of the dredgers.
- Interpretation of the results of the modelling studies indicates that significant benefits can be accrued from the implementation of the Stage I Scheme especially in the Rambler Channel and under certain conditions in Victoria Harbour.
- The levels of lime or ferric chloride currently being considered are not able to elevate dissolved oxygen concentrations to the extent that the WQO's could be achieved.
- The most significant reductions in BOD are forecast in eastern Victoria Harbour, and in the Rambler Channel as a direct result of collecting up and treating numerous point sources of pollution.
- The levels of treatment provided have little effect on the removal of ammonia. By implication the addition of ferric chloride or the lowest level of lime, to pH 9.5, would permit at least 50% compliance with the WQO's on an annual basis although during the wet season on the neap tide the WQO's for ammonia will be exceeded especially in Victoria Harbour.
- The model results suggest that the WQO's for oxidised nitrogen could be achieved even in Victoria Harbour even without the addition of chemicals to enhance the sedimentation process.
- Elevations in chlorophyll-a may be expected possibly due to increased clarity in the water column as a result of reducing the unscreened pollution loads discharging into the waters especially in Victoria Harbour.
- Full compliance with the WQO's for suspended solids is forecast throughout the entire area regardless of the level of treatment applied.
- Despite the significant reductions in bacterial counts in Victoria Harbour full compliance with the WQO's would not be achieved even with a 99% removal of the bacterial pollution load.

Air Quality

- Mitigation measures proposed for each of the Contracts. (especially the tunnel contracts) will ensure the impacts of construction on ambient air quality will be minimal.
- Mitigation measures will be required to reduce the hydrogen sulphide emissions at the Stonecutters Island Sewage Treatment and all preliminary treatment works once the Stage I Scheme is operational. Odour control requirements were included in all pertinent Contracts to ensure that the E&M designs of all equipment comply with the guidelines provided by EPD. The cost of installing these mitigation measures is HK\$27M which is only a fraction of the HK\$5.4 billion estimated cost for completion for the construction of the Stage I Scheme.
- If a lime based treatment scenario is adopted, ammonia may create a localised odour nuisance in the sludge press room although the air in this room will be scrubbed before being released to the atmosphere. All other odour reduction requirements specified in the individual Contract documents will ensure compliance with the criterion set.
- If the treatment scenario is based on ferric chloride a reduction of 60% of the hydrogen sulphide emissions downstream of the Rapid Mix Chamber will be required to achieve the odour criteria (in cumulative terms). This reduction can be achieved through the application of ferric chloride at the concentration currently proposed in the Revised Design Memorandum.
- If the treatment scenario is to be based on ferric sulphate, trials (including laboratory tests) will be required to determine the dosage of ferric sulphate which would remove at least 60% of hydrogen sulphide downstream of the Rapid Mix Chambers.

Noise

- Noise generated during construction of the Stage I Scheme will impose severe restrictions on working practices at specific locations. An estimated 17,660 people could be affected at various stages of the construction phase if no mitigation measures is implemented. All of the imposed time constraints can be incorporated within the construction programme to achieve the overall aim of reducing the impact of these works on their environment. The estimated total cost of these temporary mitigation measures is HK\$1.5M (1995 prices).
- Vibration will not be an issue during either construction of the collection system or the construction of new facilities.
- Once operational, mitigation measures for noise reduction will be required at all sites except Tsueng Kwan O Preliminary Treatment Works and Pumping Station. Acoustic design specifications were included in all pertinent Contracts to ensure equipment and building design would comply with the HKPSG. The costs associated with these mitigation measures were estimated to be HK\$13M (1995 prices).

Waste Disposal

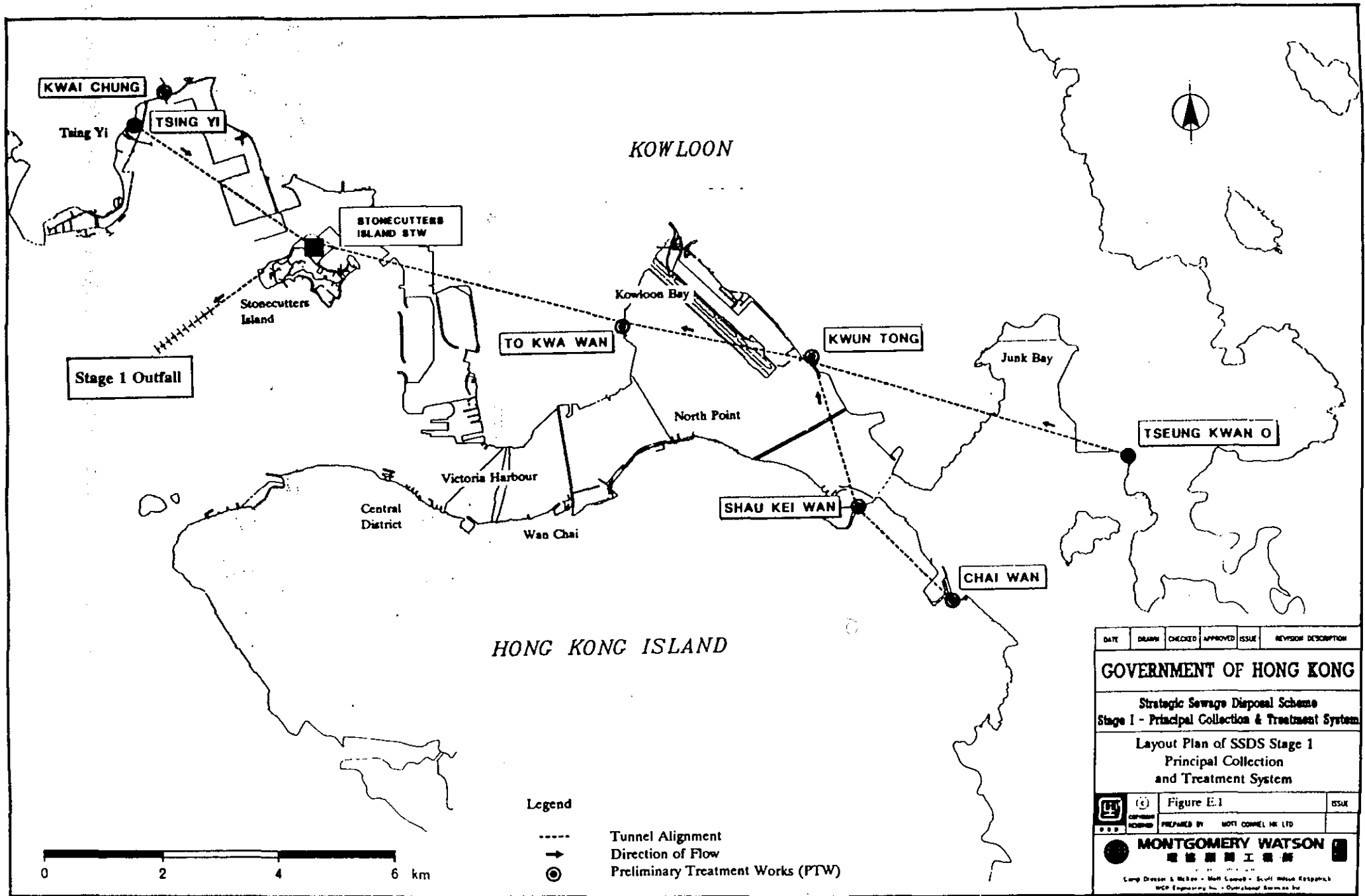
- During construction an estimated 214,000m³ of rock will be removed from the tunnels and 2.6Mm³ of marine mud will require disposal.
- Once operational the main sources of waste are screenings from the Preliminary Treatment Works and sludge from the Stonecutters Island Sewage Treatment Works. For the lime based scenario an average of 520 tonne per day of wet sludge will be disposed of to landfill. If the sedimentation strategy is based on ferric chloride, an estimated 1700 tonnes of sludge will be generated on a daily basis.

Visual

- Visual impacts will not be an issue during construction. A detailed master plan has been developed for the Stonecutters Island which will enhance the landscape value of this site.

Risks

- The risk of failure of the whole system is so remote as it would require all of the pumping stations and the SISTW to malfunction together. Periods when maintenance works need to be carried out should be scheduled for during night time hours when the flows are lowest.
- Incorporation of the safety measures will ensure that the potential downtime at any facility will be minimal.



DATE	DRAWN	CHECKED	APPROVED	ISSUE	REVISION DESCRIPTION
GOVERNMENT OF HONG KONG					
Strategic Sewage Disposal Scheme Stage 1 - Principal Collection & Treatment System					
Layout Plan of SSDS Stage 1 Principal Collection and Treatment System					
Figure E.1					ISSUE
PREPARED BY: MOTT MACDONALD HK LTD					
MONTGOMERY WATSON 建築師工程師					
<small>Consultants & Engineers - Main Contract - Staff House Extension MWP Engineering Inc. - Outstation Services Inc.</small>					

