For discussion

on 29 June 2004

LEGISLATIVE COUNCIL PANEL ON PLANNING, LANDS AND WORKS

Review of Project Implementation Issues of Harbour Area Treatment Scheme (HATS) Stage I

PURPOSE

This paper reports on the "Review of Project Implementation Issues of Harbour Area Treatment Scheme Stage I" conducted by the Environment, Transport and Works Bureau (ETWB), and informs Members of the proposed measures to improve the delivery of similar public works projects in future.

BACKGROUND

HATS Stage I

2. In 1989, Government completed the Sewage Strategy Study (SSS) on the overall sewage disposal strategy for Hong Kong. The SSS received policy support as set out in the White Paper: *Pollution in Hong Kong - A Time to Act (1989).* One of the key recommendations of SSS is to implement the Strategic Sewage Disposal Scheme (SSDS) for treatment and disposal of sewage around the Victoria Harbour. The SSDS was renamed the Harbour Area Treatment Scheme (HATS) in early 2002.

3. In 1992, Government proceeded to implement HATS Stage I by constructing a network of deep sewage conveyance tunnels in the urban areas and a primary sewage treatment facility at the Stonecutters Island. **Annex 1** shows the schematic layout of HATS Stage I.

4. Construction commenced in 1994 for completion in 1997. The major facilities of HATS Stage I other than the deep tunnel sewage conveyance system were completed essentially on time. This enabled the partial commissioning of the scheme in May 1997. The remaining works, comprising mainly deep sewage tunnels, however, were completed in 2001. The final cost of HATS Stage I is around $8.2 billion. **Annex 2** gives a summary of the key events of the project.

Post-implementation Review

5. The challenges encountered in the construction of HATS Stage I were unprecedented in Hong Kong. The experience of implementing the project, especially the construction of deep tunnels, is a valuable reference for improving delivery of similar projects in future. The ETWB has undertaken a post-implementation review on HATS Stage I (the Review). The objective of the Review is to examine and document the experience gained in the delivery of HATS Stage I with a view to utilising such experience in a beneficial way in future implementation of public works projects of a similar nature.

6. As requested by the Public Works Subcommittee in February 2001, the findings of the Review are now reported to the Planning, Lands and Works Panel.

SCOPE OF THE REVIEW

7. The Review examined issues related to the planning, design and construction of tunnelling works and the project implementation of HATS Stage I.

8. The Review did not cover the basic concept of HATS and the choice of deep tunnels for conveying sewage flows, which had already been examined and endorsed by the 2000 International Review Panel.

METHODOLOGY OF THE REVIEW

9. The Review has been conducted through 4 major stages –

(a) identification of issues: issues that warranted reviewing were identified by examining the performance of contract delivery and the justifications of major claims in the contracts, and by identifying concerns expressed by the public on the implementation of the project;

(b) search of relevant project records: a detailed search of all records of HATS Stage I relevant to the issues under review was carried out to establish key facts;

(c) detailed study of the issues: the key facts were examined and the existing policies, procedures and guidelines relevant to the issues were reviewed to assess whether there was room for improvement; and

(d) documentation of the review: a Review Report was compiled to document the findings and recommendations of the Review.

10. The Review was conducted by the Works Branch of ETWB with inputs provided by relevant departments, including the Drainage Services Department and the Geotechnical Engineering Office of the Civil Engineering Department (CED).

KEY FINDINGS AND RECOMMENDATIONS

11. The Review was completed in March 2004. It finds that with the valuable experience gained in HATS Stage I, the following aspects in future delivery of similar projects can be improved –

(a) planning and design of deep tunnels;
(b) risk management of underground works;
(c) selection and management of contractors; and
(d) the use of multiple contracts.

12. The Review recommends that the geological data obtained, the key experience gained and the lessons learnt from HATS Stage I should be documented for reference of future projects and, where appropriate, for release to the profession and the public. The Review also proposes other improvement measures for consideration in planning and design of deep tunnels, including the use of new ground investigation techniques to improve ground investigation, the enhancement of geotechnical assessment and the improvement in the control of ground settlement.

13. For better risk management in underground works, the Review proposes various measures to improve risk allocation, risk identification and mitigation, and disposal strategy formulation for forfeited plant.

14. With regard to the selection and management of contractors, recommendations include improvement measures in the selection process, dispute resolution mechanism, reduction of impact of forfeitures and imposition of regulatory actions on non-performing contractors.

15. To improve delivery of multiple-contract projects, it is recommended that sectional completion of works should be better defined in relevant contract documents such that parties causing delays will be held responsible in accordance with the contractual liability. In addition, designers will be required to thoroughly evaluate all the merits and demerits of using multiple-contract arrangements in a project before their adoption.

16. The recommendations of the Review are outlined in detail in the Executive Summary of the Review Report at the **ENCLOSURE**.

IMPLEMENTATION OF RECOMMENDATIONS

17. In general, the recommended improvement measures are implemented in the following ways –

(a) Recommendations that involve new works policies or revision to existing works policies are implemented through active consideration, pilot study and promulgation of new or revised policies and procedures.

(b) For recommendations that will improve work practices in similar projects, such practices will be promulgated through issuing technical guidelines or updating existing works manuals.

(c) For recommendations to ensure that specific technical experience and observations on the implementation of HATS Stage I are taken on board by designers of future similar projects, implementation is being effected by conveying relevant experiences to the on-going engineering feasibility studies for HATS Stage 2.

(d) Recommendations involving release of information to the profession and the public will be implemented through the publicly accessible library of the CED.

18. Some of the improvement measures have already been promulgated through technical circulars. Most of the other measures will be in place by end-2004.

Environment, Transport and Works Bureau

21 June 2004

Enclosure

Review of Project Implementation Issues of Harbour Area Treatment Scheme Stage I

EXECUTIVE SUMMARY OF THE REVIEW REPORT

I. Project Delivery of Harbour Area Treatment Scheme (HATS) Stage I

1. The works of HATS Stage I comprise four key components: (i) construction of a chemically enhanced primary treatment works, (ii) construction of an interim submarine outfall, (iii) upgrading of seven existing preliminary treatment works, and (iv) construction of a deep tunnel sewage conveyance system. The first three facilities were completed essentially on time and within budget, enabling the partial commissioning of the HATS Stage I system in May 1997.

2. HATS Stage I is the first project in Hong Kong to construct deep sub-sea tunnels. However, the implementation of its original tunnel contracts was problematic, mostly in the forfeiture of the two contracts in December 1996. This together with the unforeseen adverse ground conditions and major breakdowns of machinery in the subsequent tunnel completion contracts caused major delays to completion of the tunnels and cost overruns. The full HATS Stage I System was finally commissioned in December 2001, at a total cost of $8.2 billion, against the original project estimate of $6.8 billion for completion in mid 1997.

II. Key Findings and Recommendations on Project Implementation Issues

A. Planning and design of deep tunnels

Ground Investigation

3. The level of ground investigation carried out in the planning and design stage of the original tunnel contracts was in general adequate and within the normal range reasonably expected at that time of large tunnelling project such as HATS Stage I.

4. In planning ground investigation programmes for future tunnelling projects, consideration will be given to taking advantage of new ground investigation techniques developed in the last decade to enhance the investigation of local geological features along the tunnels.

Geotechnical Assessment

5. It is considered that there has been adequate geotechnical assessment to establish the technical feasibility of the deep tunnels and the design of their alignments. Whilst limits on the amount of groundwater that could be allowed to come into the tunnels during construction had been set in the contracts to control ground settlement, there was, however, inadequate documentation of the reasons and justifications for those limits specified in the original tunnel contracts. In order to enhance the quality of geotechnical assessment in future tunnelling projects, Government will review and revise the requirements on the selection of design consultants and the documentation of geotechnical designs, and will consider the need for independent checking of geotechnical designs.

Control of Ground Settlement

6. Along the greater part of the tunnel alignment of HATS Stage I, the tunnelling works did not cause any noticeable ground settlement in the surrounding areas. The area that experienced significant ground settlements was Tseung Kwan O town centre, where significant groundwater level drawdown was observed during construction of the completion contracts in areas extending to great distances from the tunnel. That the zone of groundwater level drawdown might cause ground settlement as far as 1.8 km from the tunnel was not foreseen at the time of design. This experience is very important for the planning of ground settlement control in future deep tunnel projects.

7. To improve the control of ground settlement in future tunnelling projects, designers will be required to consult the Geotechnical Engineering Office of the Civil Engineering Department (GEO/CED) at the planning stage, to submit their detailed assessments of ground settlement due to tunnelling to the GEO/CED for checking and agreement before tendering of the works, and to specify comprehensive ground settlement monitoring programmes in tunnel contracts.

Documentation of geological data and tunnelling experience

8. A good understanding of the ground conditions to be encountered in tunnels is one of the most important factors affecting the successful implementation of deep tunnel projects. As such, all the geological data of HATS Stage I will be made accessible to the general public, professional engineers and contractors through the Geotechnical Information Unit of the Civil Engineering Library of CED. Moreover, the tunnelling experience of HATS Stage I will be well documented for future reference.

B. Risk management of projects of underground works

Allocation of risks in ground condition

9. At the commencement of tunnel excavation, the original tunnel contractor encountered heavy groundwater inflows in two of the tunnels which called for additional ground treatment that he had not allowed for in the tendered prices. The contractor refused to proceed with the tunnelling works and asked the Government to absorb the additional construction costs and time for the necessary ground treatment works. Government rejected the request since the contract conditions stipulated that such works were the contractor's responsibility. All the Government's efforts to urge the contractor to restart the tunnelling works failed and the two original tunnel contracts were eventually forfeited.

10. In order to prevent recurrence of similar situations, Government is considering adopting a new policy on allocation of risks due to ground conditions. Government will share the risks with contractors, and suitable contract terms will be introduced to the effect that the contractors will be recompensed for additional expenses and time spent if ground conditions encountered are worse than expected. The new policy is being put on trial in a number of pilot projects. In addition, Government will adopt, where appropriate, the re-measurement form of contract such that works with high uncertainties will be paid based on the actual quantities of work done. These measures will alleviate the contractors' need to make large allowances in tender prices for ground-condition risks that might not eventually materialise, and hence reduce the chance of some contractors trimming down such risk allowances in tender prices to unreasonably low levels in order to win the contracts. The adoption of new policy on risk allocation and a re-measurement contract form will be more conducive to the successful completion of the works.

Identification and management of risks in ground condition

11. The impact of unforeseen ground conditions on the project costs and time for completion in HATS Stage I has demonstrated the importance of identification and management of ground condition risks in underground works. To improve the identification and management of risks in ground conditions in future projects, designers will in future be required to provide a comprehensive risk management plan at the design stage. In addition, Government will take into consideration the consultants' experience and knowledge in risk management in selecting consultants for project delivery.

Disposal of Critical Forfeited Plant

12. The failures of one of the tunnel boring machines and the material conveyance systems in the shafts of the tunnel completion contracts showed that serious defects in specialised tunnelling machinery could not be easily discovered, even by experts, by inspection and examination before plant failures occurred. The

existing guidelines on the formulation of disposal strategy for forfeited plant will be strengthened based on this experience so that it will be taken on board in future projects.

C. Selection and management of contractors of high risk projects

Selection of contractors in tunnel contracts

13. In accordance with the prevailing tender procedures at the time, contractors for the original tunnel contracts were pre-qualified based on the contractors' organisation, experience and resources. Tenders submitted by the pre-qualified contractors were checked against requirements including technical proposals, financial capability, performance records and safety records. Subject to the tenderers satisfying these requirements, tenders with the most competitive prices were selected.

14. The contractor selected for the two original tunnel contracts was later found to have chosen unsuitable construction plant that was incapable of dealing with the heavy groundwater inflows encountered in some of the tunnels. In the pre-qualification and tender evaluation for the tunnel completion contracts, much greater emphasis was therefore placed on the contractors' proposals on construction methods, machinery, works programme and plans for dealing with difficult ground conditions, particularly heavy groundwater inflows. This approach contributed significantly towards choosing suitable contractors to complete the tunnelling works.

15. For future underground works, Government will place more emphasis on contractors' appreciation of potentially problematic ground conditions in the pre-qualification exercises. If necessary, the pre-qualification exercise will solicit contractors' views on the "buildability" of the proposed design so that the contract documents may be further improved before embarking on the tender exercise. In the tender evaluation of these projects, more emphasis will be placed on tenderers' technical proposals particularly on their risk management approach, method statements and contingency plans.

Reduction of the impact of forfeitures

16. Tunnelling works involved high mobilisation cost and substantial additional costs will be incurred for remobilisation in case of forfeiture. From the experience of forfeiting the original tunnel contracts, due to legal complexities and the potentially very large sums involved, it would be difficult for the Government to fully recover its losses due to forfeiture from the defaulting contractor. It is therefore desirable to limit the contractors' abilities in front-loading the contract prices disproportionately.

17. In future tunnelling projects, disproportional front-loading of contract payments will be avoided as far as possible to reduce the financial impact of forfeiture to Government. One approach being considered is to limit the tender prices for

general preliminary items and mobilisation works to a proportion of the total tender sum that will reflect the reasonable market prices of these works. This will balance the contractors' cashflow requirements and Government's need to reduce its risk of financial loss in case of forfeiture.

Regulatory actions on non-performing contractors

18. When the contractor's non-performance in the original tunnel contracts was under dispute in arbitration from 1997 to 2001, the Government did not impose serious regulatory actions on the contractor. Although the Government had taken a tough line with the contractor leading to forfeiture of the original tunnel contracts and the subsequent arbitration, Government decided that it would be more equitable not to impose serious regulatory actions pending the outcome of the arbitration. The apparent lack of regulatory actions might have sent a wrong message that the Government had tolerated poor performance of contractors.

19. In order to strengthen the Government's position on regulatory actions, new administrative guidelines[1] were introduced in April 2001 to enable Government to impose regulatory actions on contractors in appropriate circumstances whenever Government considers it appropriate to protect its interests, even when the issues leading to the taking of regulatory actions are being disputed by contractors in arbitration or litigation.

Resolution of dispute with contractors

20. In the dispute between Government and the original tunnel contractor over their respective contractual obligations in dealing with the groundwater inflows in tunnels, the contractor relied heavily on proposing to settle the dispute through ex-contractual negotiation rather than submitting formal claims on the key issues of costs and time for additional ground treatment work. The contractor stopped the tunnelling works and sought to amend the contract terms to relieve its contractual obligations in dealing with the groundwater inflow problems. The dispute involved accusations of the Consultants' design. Government therefore had to seek independent advice from external legal and technical experts to decide on the way forward.

21. In future projects with high risks of disputes, Government will consider using more proactive and collaborative dispute resolution techniques that would pre-appoint independent expert cum facilitator before the commencement of construction. In particular, pre-appointed experts cum facilitators (jointly appointed by Government and the contractor) would help pinpoint main concerns of each party at an early stage and might be more conducive to settling disputes amicably, shortening the time of dispute resolution and reducing the need for legal proceedings.

[1] The new administrative guidelines are set out in paragraph 5.1.4 of the Contractor Management Handbook.

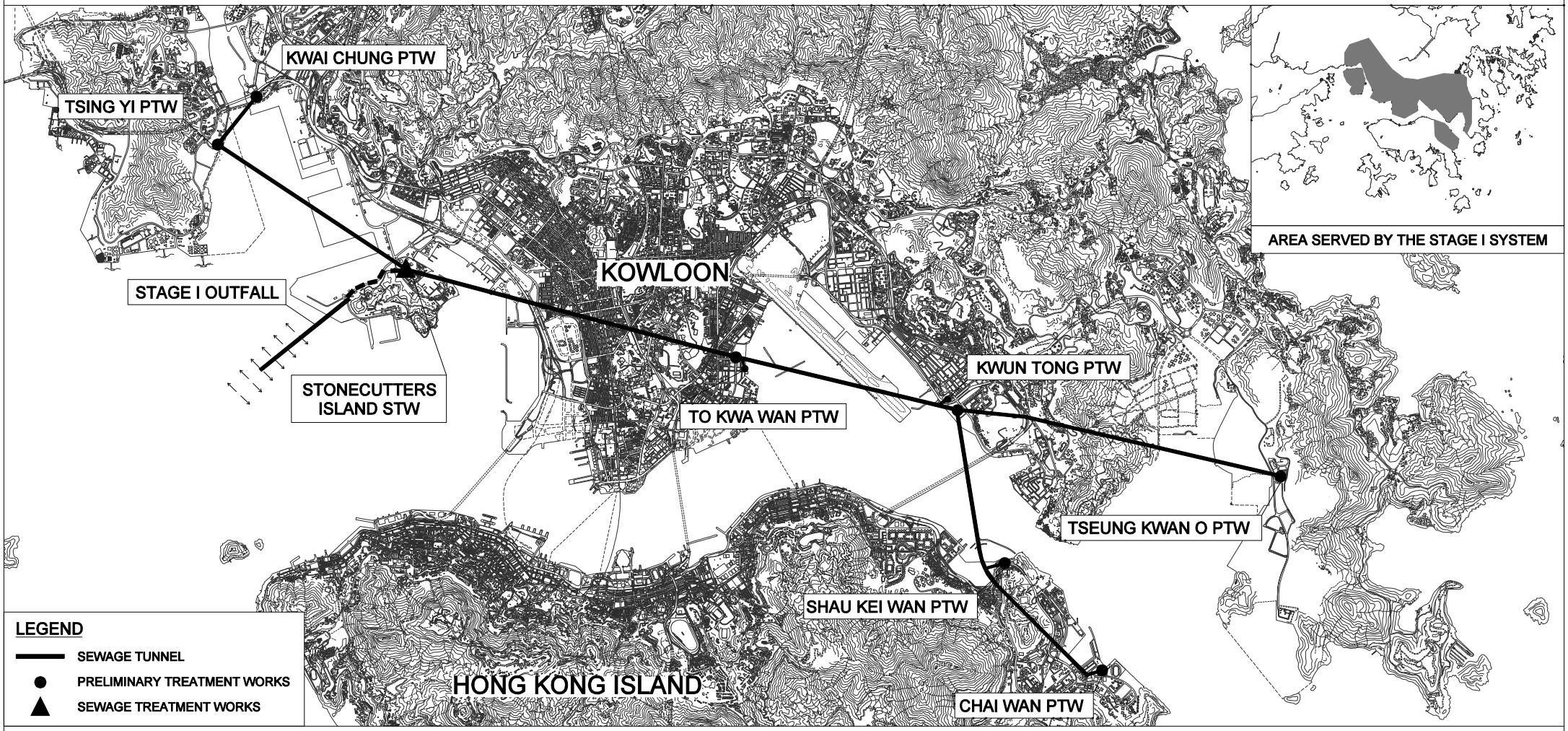
D. The use of multiple contracts

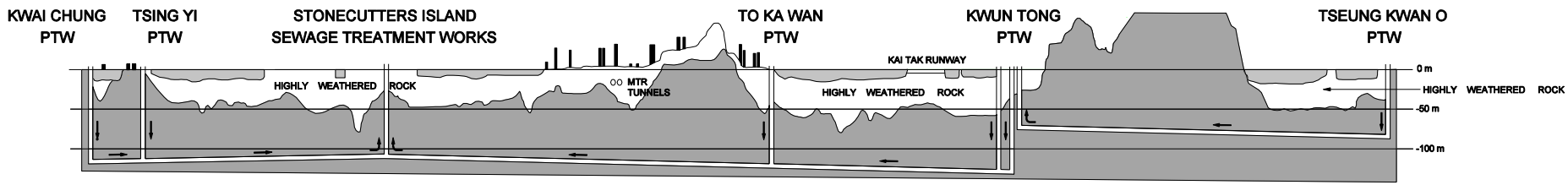
22. Construction of the Stonecutters Island Main Pumping Station was carried out under two concurrent contracts at the pumping station site, one for the civil works and the other for the electrical and mechanical (E&M) works. The civil contract was a conventional consultant-design-contractor-build contract and the E&M contract was a contractor-design-and-build contract in order that Government could select the most suitable contractor in each discipline to execute the highly specialised works. This arrangement, however, made it difficult for the Consultants to specify detailed sectional completion dates to control the schedule for mutual handing over of sites between the two contractors. During construction, the co-ordination of interface issues between the civil and the E&M contracts relied mainly on the liaison between the two contractors. Under the circumstances, it was found that such interface arrangement was difficult to control and delays did occur.

23. Construction of the vertical production shafts connecting the deep tunnels with the ground surface was carried out under two advance contracts ahead of main tunnel construction. This arrangement has definite programming benefits. However, there are also possible demerits including the lack of detailed information for designing the shaft sizes (as this would depend on methods of work adopted in the main contracts which were not then let), and consequential delays to the subsequent main contracts if delays occur in the advance contracts.

24. In order to improve the implementation of future concurrent contracts occupying the same site, Government will require sectional completion of the works to be defined in relevant contract documents as far as practicable such that the parties causing delays would be held responsible. In addition, designers will be required to evaluate thoroughly all the merits and demerits of using concurrent contracts and advance contracts before their adoption.

HARBOUR AREA TREATMENT SCHEME (HATS) STAGE I
SCHEMATIC LAYOUT





TUNNEL PROFILE

Annex 1

HARBOUR AREA TREATMENT SCHEME (HATS) STAGE I

SUMMARY OF KEY EVENTS

I. Feasibility Study and Detailed Design Consultancies of HATS Stage I

Feasibility Study

1. Government commissioned a consultancy study entitled "Strategic Sewage Disposal Scheme - Site Investigation and Engineering Studies" in June 1990 to carry out ground investigation, engineering feasibility studies and preliminary design for all stages of HATS. The part on the original HATS Stage I was completed in January 1992. Additional studies were carried out in late 1992 for the inclusion of Tseung Kwan O district in the catchment area of HATS Stage I.

Detailed Design and Construction Supervision

2. In July 1993, Government appointed consultants to prepare the detailed design and tender documents for the proposed works in HATS Stage I. Subsequently, the detailed design consultants (hereafter "the Consultants") also supervised the construction of the works contracts in HATS Stage I from 1994 to 2001.

Pre-construction Ground Investigation for HATS Stage I

3. A total of 144[1] inclined and vertical boreholes were drilled along the proposed tunnel alignments of HATS Stage I at both the feasibility study and the detailed design stage. Some of the boreholes were targeted at known or suspected fault zones.

4. To identify rock head and regions of weak zones along the proposed tunnel alignments running underneath the sea, geophysical surveys were also carried out in the feasibility study. For the part on HATS Stage I, the geophysical surveys covered most of the 10.3 km long undersea portion tunnel alignments. The feasibility study consultants issued two reports[2] in May 1993 and November 1993, presenting the consultant's interpretation of the ground investigation results and assessment of the ground conditions.

[1] Taking into account the six additional boreholes drilled in the original tunnel contracts before their forfeiture, a total of 150 boreholes were drilled along the proposed tunnel alignments before the completion tunnel contracts.

[2] The two reports were "SSDS Site Investigations and Engineering Studies Stage I – Kowloon System, Geological Summary Final Report (May 1993)" and "SSDS Site Investigations and Engineering Studies Stage I – Connection of Flows from Tseung Kwan O Development, Geological Summary Final Report (November 1993)".

II. Advance contracts for the production shafts

The purpose of advance contracts

5. In order to achieve early commissioning of the HATS Stage I, the Consultants proposed to start construction of production shafts[3] before commencement of the main tunnel construction. After prequalification to select appropriate tenderers, two advance contracts[4] were let in mid-1994 to construct, among other works, 7 numbers of production shafts for the deep tunnels.

Interface with the main tunnel contracts

6. In December 1994, Government awarded two contracts (see paragraph 8 below) for the construction of the deep tunnels in HATS Stage I. It was specified in these two tunnel contracts that the 7 production shafts being constructed under the advanced contracts would be handed over to the tunnel contractors in April and June 1995 respectively.

7. Because of adverse ground conditions, delays ranging from 2 to 7 months occurred in 6 out of the 7 production shafts, which affected the target handing over of the shafts to the main tunnel contractor. In order to remove the delays caused by the deferred handing over of the production shafts, Government entered into two acceleration agreements with the original tunnel contractor in late 1995.

III. The Original Tunnel Contracts

Selection of contractors

8. The sewage transfer system in HATS Stage I comprised six deep tunnels to be constructed under two contracts[5]. Pre-qualification of contractors was conducted between February 1994 and June 1994. Ten contractors were pre-qualified from

[3] Production shafts are temporary vertical shafts connecting the deep tunnels to ground surface for transportation of labour, machinery and materials and for removal of excavated materials during tunnel construction. In HATS Stage I, they were either backfilled after the completion of tunnelling works or converted to smaller-diameter permanent shafts for conveyance of sewage to and from the deep tunnels.

[4] The two advanced contracts were Contract DC/93/10 (constructing, among other works, 6 production shafts at Chai Wan, Tseung Kwan O, Kwun Tong, To Kwa Wan and Tsing Yi) and Contract DC/93/11 (constructing, among other works, a production shaft at Stonecutters Island).

[5] The two original tunnel contracts were Contract DC/93/13 (constructing 2 deep tunnels from Tseung Kwan O to Kwun Tong and from Chai Wan to Kwun Tong) and Contract DC/93/14 (constructing 4 deep tunnels from Kwun Tong to To Kwa Wan, from To Kwa Wan to Stonecutters Island, from Kwai Chung to Tsing Yi and from Tsing Yi to Stonecutters Island).

which tenders were invited in August 1994. Government awarded both contracts to the same contractor (the original tunnel contractor) in December 1994. Construction started in January 1995 for completion in May 1997.

Technical problems encountered during construction

9. After mobilisation, the original tunnel contractor started tunnel excavation works in late 1995. In January 1996, the original tunnel contractor began to encounter serious water inflows in two of the tunnels during tunnel excavation. There were, however, serious limitations on the capabilities of the drilling equipment mounted on the tunnel boring machines (TBM) for grouting to control groundwater inflow.

The original tunnel contractor's request for additional cost and time and stoppage of works

10. At a meeting with Government at the end of May 1996, the original tunnel contractor alleged that the problems of heavy groundwater inflows in the tunnels were not their responsibility and the costs and time needed to reduce the groundwater inflows to the specified limits should be borne by Government. However, both Government and the Consultants took the view that the responsibility for resolving the groundwater inflow problems and completing the contracts within the contract periods lay exclusively with the contractor.

11. In June 1996, excavation in the two tunnels which encountered heavy groundwater inflows was suspended by the contractor. In July 1996, the contractor stopped the works in the remaining four dry tunnels.

Government sought external legal and expert advice

12. In August 1996, Government appointed an external legal advisor to advise on the way forward. Through the external legal advisor, Government appointed two independent technical experts in end-August and mid-September 1996, one to advise on tunnel engineering issues and the other on geotechnical issues.

13. In mid-October 1996, technical meetings were held between Government's experts, the contractor's experts and the Consultants to discuss the way forward to facilitate the contractor’s resumption of tunnelling works. Matters discussed included changes of specifications on groundwater inflow limits and grouting procedures to relieve the original tunnel contractor's alleged impediments to proceeding with the tunnelling works, however, no agreement was reached at these meetings.

Contractor refused to re-commence the Works

14. Immediately after the meetings, the Consultants issued variation orders in both contracts to instruct modifications on TBMs for enhancement of drilling and grouting works, and to relax the specifications on water inflow limits and grouting procedures. The Government considered that the variation orders addressed all matters that had been raised by the contractor as impediments to the tunnelling works. The contractor, however, refused to accept the variation orders or to restart the tunnelling works.

15. In late October 1996, Government offered to conduct immediate mediation or early arbitration on the costs arising from the variation orders relaxing the specifications, provided that the contractor would re-commence the tunnelling works immediately. The contractor refused and insisted on negotiation to amend the fundamental terms of risk allocation in the contracts, which was considered non-negotiable by Government.

The two original tunnel contracts forfeited

16. In early November 1996, the contractor reaffirmed that their most important request was to have a supplementary agreement with Government on the risk allocation associated with ground conditions and ground treatment measures. Without such agreement, the contractor was not willing to re-commence works. Government advised the contractor of the possibility of immediate forfeiture if the contractor failed to re-commence the Works.

17. After the Consultants had served the required warnings and notifications under the contracts, the contractor still refused to recommence construction. Government forfeited the two tunnel contracts in late November 1996 and re-entered the sites in early December 1996.

Arbitration and Settlement

18. The contractor disputed the correctness of Government's action to forfeit the contracts and referred the dispute to arbitration in May 1997. The arbitration was completed in January 2001. The arbitral award was favourable to Government in all of the most significant issues concerning the parties' liabilities under dispute. Finally, Government reached a settlement agreement with the contractor in September 2001 to settle all the liabilities of the two parties arising from the two tunnel contracts, which was reported to the Legislative Council in October 2001.

IV. The Tunnel Completion Contracts

Selection of contractors

19. After forfeiture of the two original tunnel contracts, the outstanding tunnelling works were repackaged and tendered under three tunnel completion contracts. Pre-qualification for the completion contracts was conducted between December 1996 and February 1997. Seven contractors were pre-qualified from which tenders were invited for the first completion contract[6] in February 1997 and for the other two completion contracts[7] in June 1997. The contracts were subsequently awarded to three different contractors. The first tunnel completion contract started construction in July 1997 and the other two contracts in January 1998. The completion dates of the three completion contracts were set at August 1999, February 2000 and April 2000 respectively. As a result of the following events, the completions of the tunnelling works were delayed to December 2001.

Reuse of forfeited plant

20. In the completion contracts, the contractors were allowed to choose whether to use or replace the plant left on site from the forfeited contracts. The completion contractors eventually chose to use most of the major forfeited plant on site, including three TBMs and four mucking systems[8] in production shafts.

Failure of mucking systems

21. In November 1997, one of the contractors experienced problems in operating the gantry crane of the mucking system at the Tsing Yi shaft. Overseas winch experts were then invited to inspect the mucking gantry and concluded that the mucking gantry could not be safely used and had to be replaced. Physical works for the replacement of the mucking gantry at the Tsing Yi shaft took place from March to June 1998. Subsequently, three similar mucking systems in the other two contracts were also replaced. The replacement of the three mucking gantries took place from May to November 1998. Progress of tunnel excavation in the associated tunnels was significantly affected by the replacement of the mucking gantries.

[6] The first completion contract was Contract DC/96/20 completing 2 deep tunnels from Kwai Chung to Tsing Yi and from Tsing Yi to Stonecutters Island.

[7] The other two completion contracts were Contract DC/96/17 (completing 2 deep tunnels from Tseung Kwan O to Kwun Tong and from Chai Wan to Kwun Tong) and Contract DC/96/18 (completing 2 deep tunnels from Kwun Tong to To Kwa Wan and from To Kwa Wan to Stonecutter Islands).

[8] Mucking system is a vertical lifting device installed at each production shaft for conveying the excavated materials from the deep tunnel to ground surface for disposal.

Major breakdown of one of the tunnel boring machines (TBM)

22. In early June 1999, a major breakdown occurred within the TBM in the Kwun Tong to To Kwa Wan Tunnel, and excavation of the tunnel came to a standstill. The replacement parts of the TBM had to be procured from overseas and reassembly of the TBM was eventually completed in end October 1999. Excavation in the Kwun Tong to To Kwa Wan Tunnel restarted in early November 1999 after a 5-month delay.

Excavation through difficult grounds

23. Progress of tunnelling works had also been significantly affected by the extensive amount of ground treatment required to deal with the difficult grounds encountered. The greatest challenges were encountered within the Tsing Yi to Stonecutters Island Tunnel in association with the 16 m wide Lead Mine Pass Fault and the 278 m wide Tolo Channel Fault. It took 4 months to excavate through the Lead Mine Pass Fault and another 10 months to excavate through the Tolo Channel Fault. Difficult ground was also encountered in a number of other locations slowing down the progress of tunnel excavation.

V. Contracts for the Stonecutters Island Main Pumping Station

Concurrent contracts for the construction of the Stonecutters Island Main Pumping Station (SCIMPS)

24. Construction of SCIMPS was mainly carried out under two contracts, one for the electrical and mechanical (E&M) works[9] and the other for the civil works[10].

25. The E&M works were tendered as a design-and-build contract in which the contractor was required to design, supply, install and commission the E&M plant in the pumping stations. Pre-qualification was conducted from March to July 1994 and tenders were invited in September 1994. The E&M contract was subsequently awarded on 16 January 1995 and commenced in January 1995 with original contractual due dates for sectional completion from December 1996 to June 1997. Works were progressively completed between April 1997 and April 2000. Reasons for delay in this contract included late handing over of sites from the civil contractor to the E&M contractor, repairs of equipment defects caused by the E&M contractor and changes to the contract requirements due to late completion of the deep tunnels. For those culpable delays of the E&M contractor, liquidated damages were imposed on the E&M contractor according to the contract terms.

[9] The E&M contract was Contract DE/93/18 for the supply and installation of the E&M equipment in the four pumping stations of HATS Stage I, including SCIMPS.

[10] The civil works contract was Contract DC/93/16 for the construction of the civil and building works for SCIMPS and the North West Kowloon Pumping Station.

26. Tenders for the civil works contract were invited in October 1994 and the contract was awarded on 31 March 1995. It was a conventional consultant-design-contractor-build type of contract and it commenced in April 1995 with original contractual due dates for sectional completions from November 1995 to May 1997. Works were progressively completed between October 1995 and March 2001. Reasons for delay in this contract included late handing over of sites from the E&M contractor to the civil contractor, additional works instructed by the Consultants due to forfeiture of the original tunnel contracts and changes of project requirements, and repairs of construction defects caused by the civil contractor. For those culpable delay of the civil contractor, liquidated damages were again imposed on the civil contractor according to the contract terms.