Special Meeting of LegCo EA Panel on 26 October 1998
SSDS EIA - Tunnelling Aspects

Introduction

At the meeting on 5 October 1998, during discussion of the results of the first phase of the SSDS EIA study, Members of the Panel queried the engineering feasibility of constructing and operating the deep tunnels. Members also asked for a detailed analysis of what would be included in the geological surveys for SSDS Stage II. This paper aims at providing Members with further information concerning the construction and operation of the tunnels.

International Experience in Building and Operating Tunnels

2. Tunnels have been used world wide for various purposes including sewage collection, water supply and for public transportation systems. The most famous one is the deep tunnel used for transportation between France and Britain, which is over 50 km long under the English Channel. Some examples of the sewage collection and water transportation tunnels are listed below for reference:

a) **Sweden -** There have been two major tunnelling projects in Stockholm completed successfully through hard granite under the sea and urban areas. The **Saltsjo Tunnel** (7 km long and 3.5 m in diameter) was constructed at about 70 m below sea level in the late 1980s to transfer sewage from an inland sewage treatment plant to the sea for discharge. The **Snake** project, also in Stockholm, is a 2.8 km long 3.5 m diameter storm water storage tunnel, constructed at a depth of 40 m below sea level between 1990 and 1993. This tunnel also passes through predominantly granite.

b) **Australia -** The Sydney Deepwater Outfall Project consists of three outfalls under the same project banner. The three components were outfall tunnels at Malabar, North Head and Bondi. All tunnels were similar in that they were hard rock tunnels commenced onshore and taken to a termination point which had been determined from oceanographic studies and which would provide the desired level of dilution to the sewage as it was discharged. Similar to SSDS, the tunnels were 120 m to 150 m below sea level with bed rock cover about 50m deep and a total tunnel length of 10 km. The excavation of the main submarine tunnels was completed in 1988.

c) **San Diego, California -** The South Bay Ocean outfall was constructed under the Pacific Ocean at San Diego. The geology of the location is soft rock and watercharged sand with large boulders and cobbles throughout. The total length of the tunnel is 6 km, and diameter 5 m. It is 30 m below the seabed.

d) **Los Angeles, California -** Located in the Lake Arrowhead region of California, east of Los Angeles, the Arrowhead East Tunnel is part of a three tunnel project which will convey water into Los Angeles. The geology, depth and need to control water inflows makes this tunnel very similar to SSDS. The tunnel, having a diameter of 5 m and total length of 3 km, is being constructed in granite at depths between 30 m and 200 m. The area overlying the tunnel route is a groundwater source and a court order dictates that the tunnel should not affect the groundwater level. Consequently, a tight restriction on groundwater inflow applies. The tunnel route is to cross the San Andreas fault which is a large and active fault zone. At this time, one third of the tunnel has been built and work is on schedule.

e) **Boston -** The Boston Harbour project is one of U.S.A.'s largest public works project on wastewater treatment and disposal. This project, serving a total population of 2.5 million, consists of a deep tunnel with a diameter of 7.3 m and a total length of 15 km.

Local Experience in Tunnels

3. Tunnels have also been drilled in Hong Kong for various purposes, such as for water supply, cable routes, vehicle transportation (eg. the Lion Rock Tunnel, Tate's Cairn Tunnel), railway and MTR. Many of these tunnels pass through fault zones either on land or under the sea, as shown in the attached figure (Annex A). Of these systems, the most sophisticated one is possibly the water supply system, which comprises over 170 km of tunnels connecting the water service reservoirs. The development of the new airport at Chek Lap Kok already includes a 6 km water supply tunnel.

4. Although most of the tunnels shown here are on-shore, they faced similar construction problems such as crossing faults and water seepage problems as they are often below the water table. The SSDS Stage I Works is the first deep tunnel sewerage system in Hong Kong. It is unfortunate that the first tunnel contractor unilaterally suspended work. Independent legal and engineering experts advised us that there was no basis for that stoppage, so we took over the works in December 1996. In fact, we do have successful example of constructing deep sea tunnels locally. The Stage I Interim Outfall Tunnel, which is 5 m in diameter; 1.7 km in length; and about 100 m below the Harbour, has already been completed by another contractor.

5. For the six tunnels on which work stopped in 1996, the first of the new contracts was let in July 1997. It covers the two western tunnels. About 75% and 20% respectively of the boring works for the two tunnels have now been completed. The other two contracts for the eastern tunnels were awarded in January this year after additional funding was approved by the Legislative Council. Both contractors have had to replace or refurbish equipment left by the first contractor, but tunnelling works have now restarted.

Additional Surveys Required for SSDS Stage II

6. The geological conditions within Hong Kong's territory are quite well understood. The fault lines, in particular, are shown in Annex A.

7. During the SSDS Site Investigation and Engineering Feasibility Study carried out in 1990 - 1993, we have drilled over 160 boreholes along the tunnel route of SSDS. This

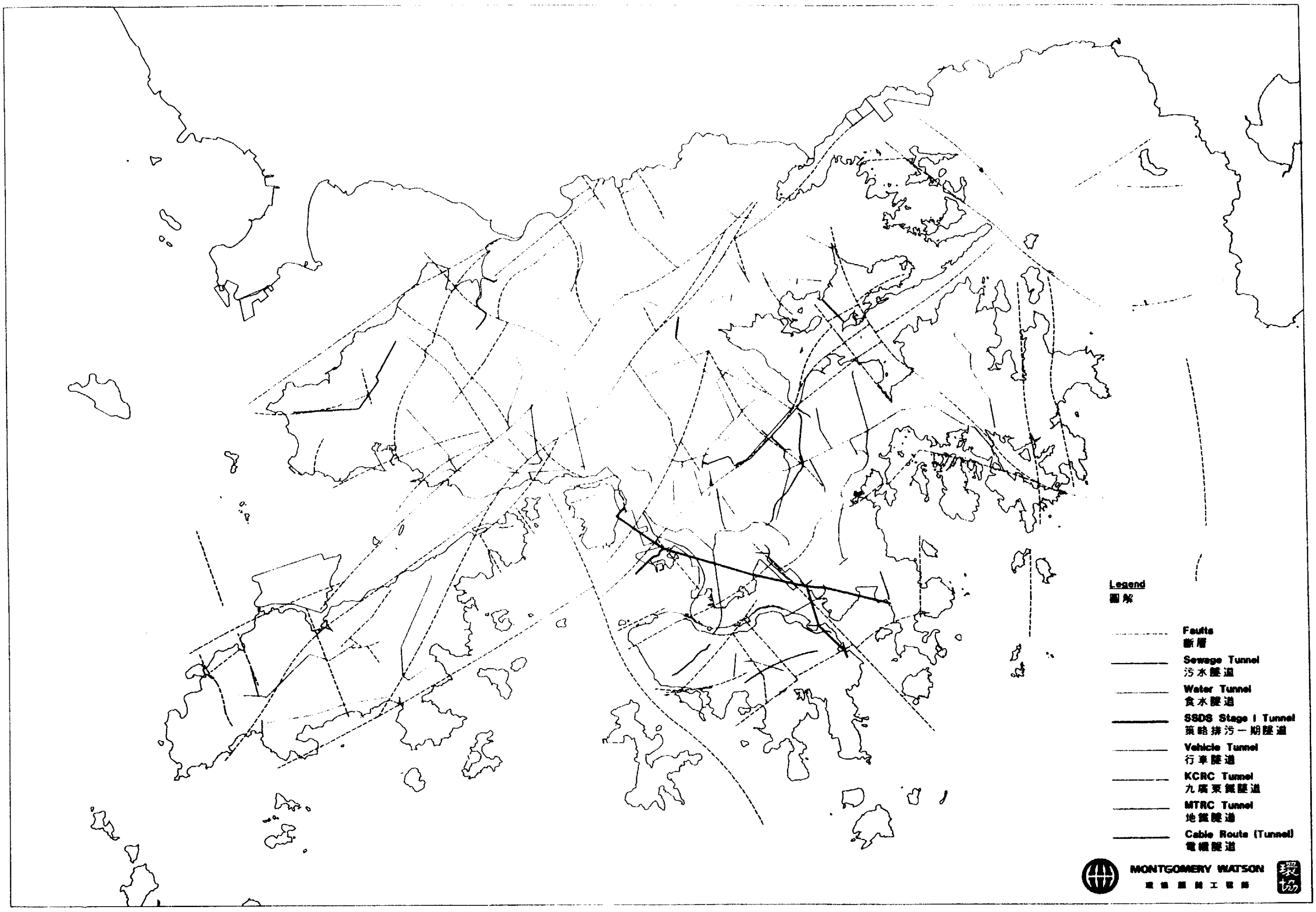
study had not identified any insurmountable problems for the construction and operation of deep tunnels.

8. On the other hand, we have little information concerning the geological conditions in the Lema Channel, which is outside Hong Kong's territory. The only relevant information we have so far is that there are two major parallel, strong to moderately active fault zones running along the southwest - northeast axis through the Dangan Basin, with the comparatively loose Ping Chan Formation sedimentation basin between them (Annex B). These two faults have not been intersected in boreholes and therefore their exact positions are not known accurately. Further site investigations to locate these faults will be needed to determine the optimal location of the outfall, should such an option be pursued.

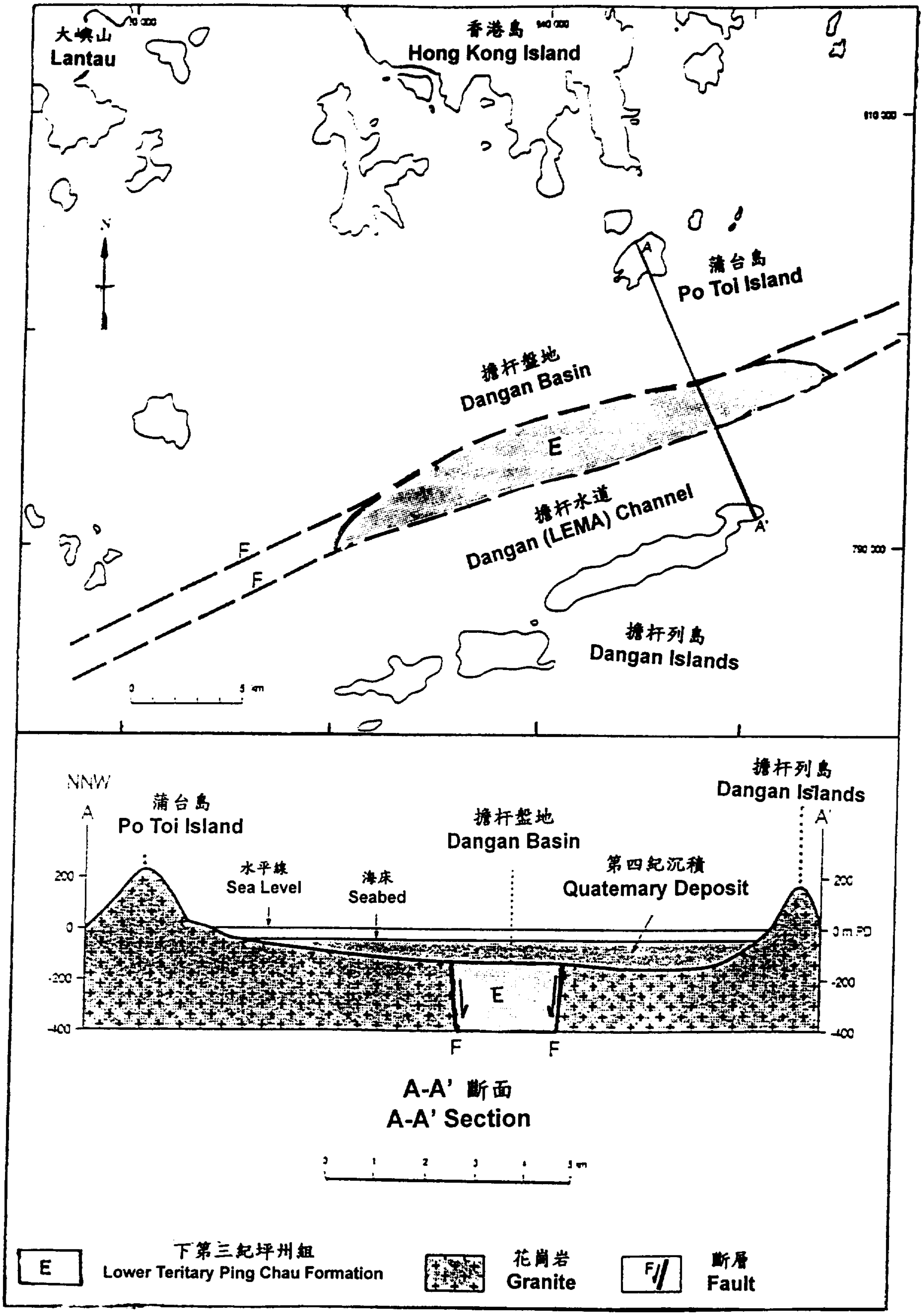
9. With the experience gained in the SSDS Stage I works, we have decided to carry out further marine investigations, including gravity and magnetic field surveys, in the Preliminary Project Feasibility Study (PPFS) for Stage II, to characterize the major geological features in the area. The cost of these geological surveys (to be completed within a year) is estimated to be $3 - 5 million, depending on the final decision of the option.

10. With this additional information, we will be in a better position to specify appropriate construction equipment in the tender as well as necessary mitigation measures to ensure smooth progress of the work. We will also be able to make minor adjustments to the routing, if necessary. With adequate site investigation, the construction risk can thus be minimized.

11. We have every confidence that the tunnels can be constructed in a timely and cost-effective manner and provide many years of trouble-free service.



CAD REF.\TUN MAP



地質地圖及擔杆盤地斷面

Geological Map and Section of the Dangan Basin