

**LEGISLATIVE COUNCIL**  
**JOINT MEETING**  
**PANEL ON PLANNING, LANDS AND WORKS**  
**PANEL ON HOUSING**

**Unusual Settlement In Tseung Kwan O**

**BACKGROUND**

Unusual settlement being recorded in Tseung Kwan O (TKO) has raised extensive media interest and great public concern. We are proceeding with urgent investigations but, because of the large area over which we have recorded unusual settlement and the considerable depth of the strata to be explored, those investigations are complex and time consuming.

**AREAS AFFECTED BY UNUSUAL SETTLEMENT**

2. Unusual settlement has been recorded in three areas of TKO, shown in *Enclosure 1 (Drawing No. TKZ0059/1)* and described below.

**TKO Industrial Estate**

3. The Hong Kong Industrial Estates Corporation (HKIEC) reclaimed the land for the TKO Industrial Estate by employing their own consultants and contractors. The HKIEC appointed the Territory Development Department (TDD) to assist in managing the consultants and ensuring compliance with statutory and administrative procedures. The HKIEC is undertaking its own investigations with support and assistance from TDD to ascertain the causes and effects of the unusual settlement.

**TKO Area 86**

4. TKO Area 86 is just north of the TKO Industrial Estate. It will be developed by the Mass Transit Railway Corporation (MTRC) as a comprehensive development area to include the depot and a station for the MTRC Tseung Kwan O Extension (TKE). In 1998, the MTRC completed extensive investigations and installed instrumentation to monitor ground conditions. They have detailed records, going back to July 1998, of the settlement and groundwater levels in Area 86 and have designed their foundations to allow for it. The MTRC records have been provided to relevant government departments.

## **Tseung Kwan O Town Centre**

5. The affected area in TKO Town Centre is the area to the south of Sheung Tak Estate and is the focus of concern of TKO residents. Tong Ming Court and Beverly Garden are in this area, together with seven schools. Three lots for private housing, a Private Sector Participation Scheme (PSPS) housing site, an MTRC property development, an electricity sub-station and the MTRC TKE are also at various stages of construction in this area.

## **CAUSES OF THE UNUSUAL SETTLEMENT**

### **Reclamation and Settlement in General**

6. We are still investigating the causes of the unusual settlement in TKO. The measured settlement comprises two separate elements – normal settlement and unusual settlement. Normal settlement was expected and is allowed for in the design of buildings. We expected average normal settlement of about 300mm from one year after completion of reclamation. The settlement that we have recorded is significantly more than the amount of normal settlement that we expected.

### **Discovery of Unusual Settlement**

7. In TKO Industrial Estate, settlement has been monitored by HKIEC since completion of the reclamation in stages from 1993 to 1995. We first learnt about unusual settlement in a letter from HKIEC in August 1999. From April 1999 to end October 1999, the recorded total settlement is up to 340mm. However, there are signs of the rate of settlement slowing down since August 1999.

8. In Area 86 where reclamation was completed in stages from September 1994 to March 1997, the MTRC has recorded total settlement of 50mm to 900mm with an average of about 500mm since July 1998. TDD were first informed about the unusual settlement in Area 86 in April 1999.

9. In TKO Town Centre, our consultants initially recorded settlement only on surcharge mounds that we had formed on the reclamation area south of Tong Ming Court and Beverly Garden. The consultants first verbally told TDD in January 1999 that the rate of settlement had not slowed down as anticipated. We immediately instructed the consultants to pay close attention to the settlement and to submit settlement monitoring records. The first records submitted to TDD in April 1999 revealed unusual ground settlements. We have recorded total settlement of the surcharge mounds since May 1998 of from 200mm to 1400mm with an average of about 900mm. Of that amount, we suspect an average of about 550mm is unusual settlement. We must stress that this magnitude of settlement has been measured on top of 10m high surcharge mounds which will have accelerated and enhanced both the normal and unusual settlement. We only commenced recording settlement on

completed roads and seawalls in other parts of the town centre and nearby areas in April/May 1999. Since then we have recorded total settlement ranging from zero to the north, east and west of Sheung Tak Estate to 200mm on the southern seawall. Maximum settlement in Tong Tak Street near the entrance to Tong Ming Court is 80mm and near the entrance to Beverly Garden is 130mm since April 1999 to mid-October 1999.

### **Ground Water Draw Down**

10. In all three affected areas we have recorded a reduction in groundwater level and pressure in the completely decomposed tuff, the bedrock and, at most locations, in the alluvium (Location of different layers are illustrated in *Enclosure 2*). The drop in groundwater pressure from alluvium to bedrock appears to indicate that groundwater is being drained out from the bedrock. This is extremely unusual and we are carrying out investigations to determine the reasons for this phenomenon.

11. TDD, MTRC and HKIEC have installed instruments to measure the settlement in different soil layers. These instruments are recording normal settlement in the marine deposits but significant settlement in the alluvium and completely decomposed tuff. The settlement in the latter two soil layers is unusual and probably it is principally arising from the reduction in groundwater pressure in those layers. We must complete further investigations and studies to confirm this.

### **Strategic Sewage Disposal Scheme (SSDS) Tunnel**

12. The concerned SSDS tunnel is about 5300 metres long, 4.23 metres diameter and up to 87 metres below ground level running from the Preliminary Treatment Works at TKO to a riser shaft located opposite Laguna City in Kwun Tong. Where this tunnel crosses the TKO Bay, it is about one kilometre from the TKO town centre where unusual settlement has been recorded.

13. The tunnel excavation was recently completed. The tunnel has been excavated without a lining and for the section underneath undeveloped area across the bay, groundwater inflow into the tunnel through geological faults and rock joints is controlled to allow a safe and practical tunnel construction to be carried out. In areas of high groundwater inflow, cement grout has been injected into the rock to reduce the flow. The average total water inflow to the tunnel for the full 5.3 km length is in the order of 6000 litres/minute.

14. Although this cannot be confirmed at present, pending completion of the further investigations, it is possible that the SSDS tunnel may be a contributing factor to the unusual settlement and, accordingly, it is considered prudent to take immediate steps to halt the inflow into the tunnel to stop the draw-down of groundwater. Following the recent completion of the tunnel excavation, the lining of the tunnel at locations with heavy inflow of groundwater is about to commence and will be completed by February/March 2000.

15. If the draw-down of groundwater is due to the SSDS tunnel, we expect the groundwater level and pressure will then start to recover. We cannot yet predict how long it will take for groundwater conditions to return fully to normal. However, the rate of settlement has already slowed down substantially as soil consolidation is well advanced. We expect any further unusual settlement to be very much less than that has occurred in recent months. We require more information to predict how much more settlement will occur.

## **SAFETY OF BUILDINGS**

16. The Buildings Department (BD) has carried out preliminary assessment of the impact on buildings due to the unusual settlement. The assessment concludes that no buildings are at risk.

17. Unusual settlement may add loading to the piled foundations. Preliminary assessment by BD using very conservative assumptions, has indicated that the total load on the piles of existing buildings is still well within the maximum capacity. Site inspections were carried out to the buildings and no signs of structural damage due to settlement were identified.

18. For buildings under construction, TDD and BD have written to developers and Authorised Persons respectively requiring them to investigate the impact of the unusual settlement on their developments. BD will ensure that the buildings are safe and are constructed in accordance with all the requirements of the Buildings Ordinance.

## **SAFETY OF UTILITIES**

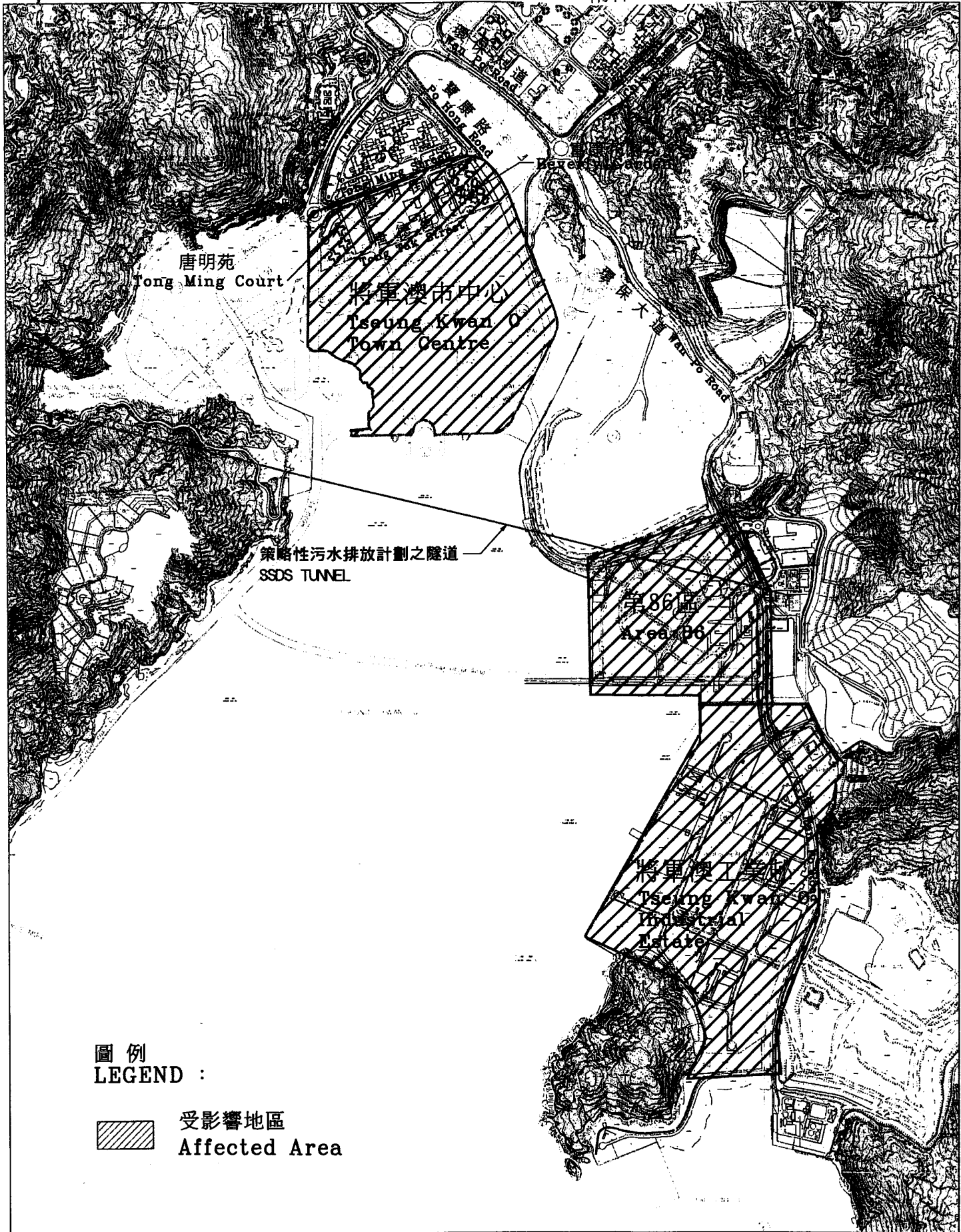
19. The amount of settlement varies from area to area and there are no sudden changes in amount of settlement. TDD has met all utility companies who have confirmed there should be little risk to their installations. However, they have agreed to increase the frequency of their regular inspections in affected areas. Within private lots, the utilities are the responsibility of the owners. Generally there should be no risk unless there is a rigid connection between the outside service and the buildings.

## **FURTHER INVESTIGATIONS**


20. We have commenced the drilling of 50 additional deep boreholes to collect soil samples for laboratory testing. Those boreholes in 17 clusters will be installed with instruments to measure groundwater levels and settlement in different soil layers. We shall monitor those instruments until groundwater pressure has returned to near normal. We shall also continue to monitor ground settlement.





21. With this updated information, BD and developers should be able to carry out further assessment to ensure safety of buildings. TDD's consultants will predict further settlement and attempt to identify the causes of the unusual settlement. With the information on groundwater level and bedrock condition at each borehole, the consultants should be able to identify the locations towards which the ground water is flowing and how it reaches that location. If the instruments record most of the settlement is occurring in the lower soil layers, the consultants should be able to demonstrate if most of that settlement is due to draw-down of groundwater. The consultants may identify more than one cause of the unusual settlement and further investigations could then be necessary to refine the findings.

Territory Development Department  
NT East Development Office  
December 1999

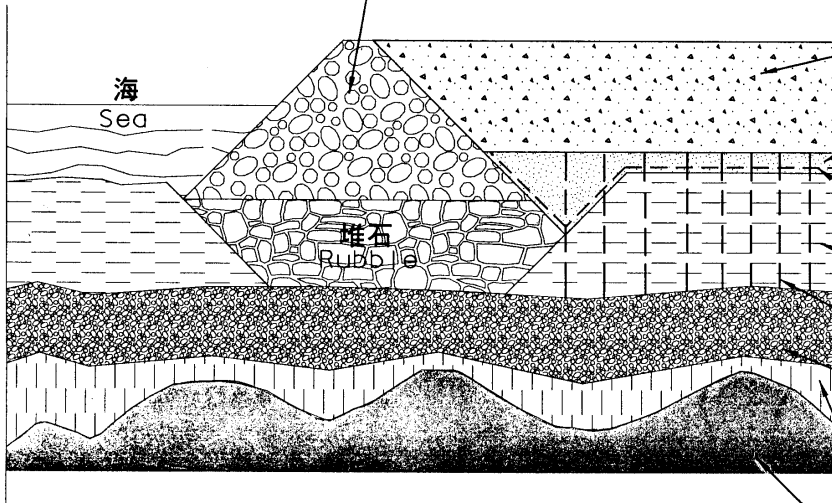


圖例  
LEGEND :

 受影響地區  
Affected Area

drawing title 受不尋常沉降影響的將軍澳地區 TSEUNG KWAN O AREA AFFECTED BY UNUSUAL SETTLEMENT	drawn S K WONG	initial 	date 24-11-99	scale 1 : 20 000	office NT EAST DEVELOPMENT OFFICE
	checked C POON	initial 	date 24-11-99	drawing no. TKZ0059/1	 TERRITORY DEVELOPMENT DEPARTMENT
	approved D J CLIMAS	initial 	date 24-11-99		

堆石海堤  
Rubble SeaWall



回填材料  
Fill

沙質覆蓋層  
Sand Blanket

土工布  
Geotextile

海洋沉積土  
Marine Deposits

豎向排水管  
Vertical Drains

沖積層  
Alluvium  
(Clay and/or silt and/or sand)


已風化岩層  
Completely Decomposed  
Tuff

凝灰岩層  
Tuff (Bedrock)

drawing title

將軍澳填海工程示意圖

Illustration of Reclamation  
in Tseung Kwan O

drawn	initial	date	scale	office
M K LEE	M.K.	15.11.99	1 : 650	NT EAST DEVELOPMENT OFFICE
checked	initial	date		
K C LEUNG	K.C.	19.11.99	drawing no.	 TERRITORY DEVELOPMENT DEPARTMENT
approved	initial	date	TKZ0064	
K C NG	K.C.	19.11.99		