

**Information Paper for LegCo**  
**Panel on Planning, Lands and Works**

**Causes of Flooding in the New Territories in June 2001**

**INTRODUCTION**

An investigation report has been prepared by the Drainage Services Department (DSD) on the causes of the flooding in the New Territories and Tsuen Wan which occurred in June 2001. This paper summarizes the findings of the report and the follow-up actions by the Administration to minimize the risk of recurrence of similar flooding in the future.

**BACKGROUND**

2. Hong Kong experiences very heavy rainstorms at times due to the sub-tropical climate. The annual average rainfall is about 2200 millimeters, one of the highest among the cities in the Pacific Rim. During these rainstorms, there are high risks of flooding occurring in the low-lying areas, natural flood plains and known flooding blackspots in the territory.

3. The Administration has been very concerned about flooding and has since early 90's committed significant resources to tackle the problem in the New Territories. Nevertheless, the implementation of the extensive flood prevention programme takes time to complete. We have already completed about \$3 billion of works in the downstream sections of major rivers and channels, providing initial relief to flooding. As a result, the previous flood prone areas such as those in the vicinity of Tin Shui Wai, Shan Pui River in Yuen Long and Lo Wu have been relieved of flood risks. We are now actively carrying out about \$2 billion of river training works in the midstream sections of the major rivers in the New Territories including Kam Tin River in Yuen Long, and River Beas and River Indus in Sheung Shui. Furthermore, various drainage improvement projects are under active planning and design. These projects include the Yuen Long bypass floodway, the San Tin eastern and western channels, and the Regulation of Shenzhen River Stage III.

4. June 2001 has been the wettest month of June in the hundred years' record of the Hong Kong Observatory. The monthly rainfall amounted to 1083.6 mm, about three times the normal monthly figure of 376.0 mm. The persistent downpour necessitated the issuance of the Rainstorm Warning Signal on 14 days of the month, 5 of which were the Red Warning Signal. The Rainstorm Warning Signal was issued for nine consecutive days from 5 June to 13 June, the longest period on record since the revised Rainstorm Warning System became operational in 1998.

5. The smaller yet prolonged rainfall at the beginning of June had increased the catchment soil saturation and therefore increased the volume of flood water generated in the subsequent severe rainstorms. The most severe rainfall occurred in the morning of 9.6.2001 resulting in flooding in the rural areas of the New Territories and Belvedere Garden in Tsuen Wan. The periods of heavy rainfall generally occurred in the morning and coincided with the high tide which prevented the stormwater runoff from discharging quickly to the sea. The rate of dissipation of the flood was also deferred by the rising tide.

## **INVESTIGATION BY DSD**

6. An investigation into the causes of the flooding in June 2001 was carried out by the DSD. It was based on the hydraulic performance of the drainage system under the prevailing rainfall and tide conditions, and included an assessment of the effect of any construction activities in the vicinity of the flooding locations. The flooding locations covered by the investigation are: Tin Ping Shan in Sheung Shui, Ngau Tam Mei in Yuen Long, Kam Tin, Pok Wai in Yuen Long, Belvedere Garden in Tsuen Wan, Kau Lung Hang and Yuen Leng in Tai Po, and other eight locations in the North District. A drawing showing these locations is annexed.

7. The investigation report has been reviewed by the Independent Reviewer, Professor Joseph Hun-wei Lee, Redmond Professor of Civil Engineering and Dean of Engineering of The University of Hong Kong, in respect of its objectivity, reasonableness of the approach and methodology, and the validity of the conclusions. He is satisfied with the conclusions and considered that the methodology and findings of the report were scientifically based, objective and credible. The executive summary of the

investigation report and the statement (English version only) made by Professor Joseph Hun-wei Lee are also annexed.

## **CAUSES OF FLOODING AND FOLLOW-UP ACTIONS**

### **Principal Causes**

8. In the New Territories, the flooding incidents that occurred in June 2001 were mainly in the low-lying areas of known flood risk, e.g. the River Indus floodplain and Ngau Tam Mei area. The river channels in these areas are inadequate to convey the flood flow under heavy rain and have long been recognized as flood-prone. Large scale drainage improvement works are being implemented to solve the flooding problem. Before the completion of these improvement measures, flooding will still occur under adverse weather.

9. The investigation by the DSD has concluded that the principal cause of the flooding in June 2001 was the inadequacy of drainage capacity under the effects of heavy rainfall. In some cases, the heavy rain was coupled with high tide, or with the tide rising during the subsidence of the flood flow. The high tide prevented the smooth discharge of flood flow to the sea and created a backing-up of the flood water.

10. Furthermore, the prolonged rainfall also aggravated the situation. The preceding rainfall saturated the catchment and reduced the infiltration into the soil. The stormwater runoff was increased, and a larger flood volume was generated.

11. Under such adverse circumstances, the flooding blackspots would be flooded even if no construction activities were in their vicinity. However, on the River Indus floodplain and areas in Ngau Tam Mei and Kam Tin, construction of river improvement works were being actively carried out. These construction projects unavoidably involved temporary works and flow diversions, some of which could have different degrees of influence on the capacity of the drainage systems. Details of individual locations are discussed and summarized below.

## **Tin Ping Shan and Sheung Shui**

12. Flooding occurred in the Tin Ping Shan and Fu Tei Au areas in Sheung Shui in June 2001. The most severe flooding occurred on 9.6.2001, and there was also flooding to similar areas on 10.6.2001 and 27.6.2001 but to a lesser extent.

13. The major floodplains in Sheung Shui are the Lo Wu areas near the confluence with the Shenzhen River, the Fu Tei Au and Ho Sheung Heung areas at the Lower Indus, the Tin Ping Shan area to the upstream of Man Kam To Road, and the Kwan Tei area at the Upper Indus. They are flood-prone and have been classified as major flooding blackspots in the North District. With some of the drainage improvement projects and rehabilitation works largely completed, the flooding situation in Lo Wu, Ho Sheung Heung and Kwan Tei has been improved. However, for the Tin Ping Shan and Fu Tei Au areas where the construction of major drainage improvement works are yet to be completed, heavy rainfall will still cause severe flooding.

14. The most serious flooding occurred on 9.6.2001. DSD concluded from a computer modelling analysis of the drainage system that the heavy rainfall coupled with the rising tide on 9.6.2001 morning would have caused severe flooding to the Fu Tei Au and Tin Ping Shan floodplains even if no construction activities were taking place. This is because the existing rivers have insufficient capacity to cope with the flood water arising on that day. There have been nine flooding events in Tin Ping Shan since 1996. It is noted that both the rainfall and the high tide conditions on 9.6.2001 were more severe than in any of the eight other events.

15. Investigation was carried out on the following two works contracts of the Territory Development Department (TDD) to establish whether they had aggravated the flooding situation on 9.6.2001:

- (a) Contract No. FL 20/97: Shek Wu Hui Development Package 4 – River Training in Area 30B; and
- (b) Contract No. FL 23/99: Main Drainage Channels for Fanling, Sheung Shui and Hinterland – River Training Works for Upper River Indus.

16. Investigations by DSD were carried out using computer modelling to assess the possible effects of the works. A base-line scenario was therefore established whereby the depth of flooding was calculated by computer modelling assuming that none of the works under Contract No. FL 20/97 and Contract No. FL 23/99 had been in existence. These theoretical base-line flood levels were then compared with actual flood levels recorded on site. It was found that the actual flood levels in the Tin Ping Shan area on 9.6.2001 were slightly higher than the situation simulated in the base-line scenario. The increase in flood depth was generally less than 120 mm.

17. Based on the computer modelling methodology adopted in the investigation of the overall flooding situation within the River Indus catchment, it is not possible to come to a definitive conclusion as to whether or not this relatively small increase in depth of flooding, as compared with the base-line scenario, was solely attributable to the contract works on site. Notwithstanding this, it is possible to conclude, however, that if there were an adverse effect, it would not have been significant.

18. While these two contracts have implemented temporary works and flow diversions on site, it is noted that substantial improvements to the drainage system including local river widening and addition of bypass channels have been carried out under the contracts. It is considered that these factors, taking an overall view of the contract works, may have wholly or largely mitigated any potential adverse effects of the current works. Notwithstanding this, TDD has taken the following actions to further improve the interim flow capacity of Upper River Indus before completion of the whole of the works :

- (a) TDD has re-sequenced the outstanding channel works underneath KCRC Bridges 35 and 36 and near Bridge No. 3 at Fu Tei Au Road under Contract No. FL 20/97. These works have been suspended and will only resume after the rainy season in November 2001. All temporary works in the river channel (including earth bunds, scaffolding and working platforms) have been removed. Near full flow capacity at

Bridge No. 3 and much improved flow in the two outlets under the KCRC Bridges will be provided in the interim during the remaining rainy season. The outstanding works are scheduled for completion in early 2002.

- (b) TDD has excised some critical works from Contract No. FL 23/99 for re-tendering. The excised works constitute about 43% of the remaining works under Contract No. FL 23/99. TDD has commenced works of the new contract on 14 September 2001. With the combined resources of the two Contractors, it is targeted to complete the critical channel works in Upper River Indus to provide a flow capacity for a 1-in-10 year return period rainstorm in the rainy season of 2002. All channel works are scheduled for completion by early 2003.

### **Ngau Tam Mei, Yuen Long**

19. In the Ngau Tam Mei area, the only significant flooding during June 2001 was the 9.6.2001 event. In the morning of 9.6.2001, a heavy rainstorm occurred in the North and Northwest New Territories including Ngau Tam Mei. Flooding occurred in the low-lying areas in Ngau Tam Mei including Wai Tsai Tsuen and Yau Tam Mei Tsuen. In a small low-lying part of Wai Tsai Tsuen between Ngau Tam Mei Road and the existing watercourse, about twenty village houses were flooded to a depth of up to 1.5 m. In Yau Tam Mei Tsuen, flood depth was about 0.5 m to 1 m. A total area of about 4 ha along the existing watercourses in Ngau Tam Mei was inundated.

20. The hydraulic performance of the existing drainage system in Ngau Tam Mei is poor. Flooding would occur in a rainstorm with a return period of less than 2 years, and Wai Tsai Tsuen and Yau Tam Mei Tsuen are both listed as flooding blackspots.

21. The rainstorm in Ngau Tam Mei on 9.6.2001 had a return period of 1-5 years at the lower catchment and a return period of up to 30 years at the upper catchment. Based on the computer modelling analysis by DSD, flooding would be expected in the low-lying areas of Wai Tsai Tsuen and Yau Tam Mei Tsuen even without any construction works in the vicinity.

22. After examining the situation in the area and not having found any other potential causes, the investigation by DSD concluded that the combined effect of the works being carried out under:

- (a) DSD's Contract No. DC/98/10: Construction of Main Drainage Channels for Ngau Tam Mei, Phase 1 (Contract E); and
- (b) TDD's Contract No. YL 48/99: Main Drainage Channel for Ngau Tam Mei, Phase 2

might have aggravated the flooding by causing an increase in flood depths of less than 750 mm in a small low-lying part of Wai Tsai Tsuen between Ngau Tam Mei Road and the existing watercourse and in the downstream portion of Yau Tam Mei Tsuen near Castle Peak Road. It should be noted that as a result of the works carried out prior to 9.6.2001, the flood risk and the flood damage in the downstream areas of Chuk Yuen Tsuen and Yau Mei San Tsuen have already been reduced in comparison to previous years.

23. To mitigate the flood risk, the river embankments and haul roads within the two construction sites have been suitably lowered in levels. Bypass channels have been provided to divert the flood flow in order to minimize the change to the regime of floodplain flow. Furthermore, emergency telephone hotlines have been established to strengthen the tie with local villagers. If adverse weather is anticipated, standby plant and labour would be provided round the clock on site to deal with emergency situation.

### **Kam Tin**

24. Flooding incidents were reported in the Kam Tin area at Tsat Sing Kong and Tai Kong Po. The most severe flooding was reported on 9.6.2001.

25. Tsat Sing Kong and Tai Kong Po are relatively low-lying on the northern side of the Kam Tin River. Both villages are flooding blackspots and susceptible to flooding. The existing river and tributaries near the villages do not have adequate drainage capacity to convey the flow under

the severe rainstorm event on 9.6.2001 and it was verified by the computer model that overflow would occur at these watercourses. The area would be subject to flooding even if there was not any construction works along the Kam Tin River or blockage of drainage facilities.

26. Within the general area, there is a works site for a DSD contract for the construction of Main Drainage Channels for Yuen Long and Kam Tin Stage II – Kam Tin San Tsuen to Wang Toi Shan Section (Contract D: No. DC/98/04).

27. The flooding in Tsat Sing Kong was very local at a temporary pipe bridge constructed by the contractor. There was no flooding at the Tsat Sing Kong village upstream but the vehicular access was disrupted. The flooding situation in Tsat Sing Kong was alleviated as compared with previous flooding incidents with similar rainfall intensity. This was mainly due to the partial commissioning of the main drainage channel under the contract and a substantial increase in flood storage provided in the drainage channel. The construction works had not aggravated the flooding situation in the area.

28. The flooding at Tai Kong Po was mainly due to the inadequate capacity of the existing watercourse combined with blockage of an existing box culvert caused by large amounts of soil, debris, boulders and vegetation being washed down from immediately upstream. This box culvert is outside the works site of the DSD contract. The construction works had no adverse impact on the hydraulic performance of the existing watercourse and had not aggravated the flooding situation in the area.

29. The whole channel of the Kam Tin River within the DSD contract has already been fully excavated and the hydraulic performance of the Kam Tin River has significantly improved. In addition, a grille has been installed in front of the temporary bridge at Tsat Sing Kong to catch the flowing debris. Frequent inspection would be carried out by DSD to identify any blockage of drains and any blockage would be removed immediately. Hence, the flood risk of Kam Tin has been greatly reduced.

### **Pok Wai, Yuen Long**

30. During the severe rainstorm in the early morning of 7.6.2001, Pok

Wai was flooded covering an area of about 3 ha to a depth of about 500 – 900 mm.

31. Pok Wai village is low-lying and is a well-known flooding blackspot which would have been flooded under this sort of heavy rainfall. A flood pumping scheme for completion in August 2002 is being implemented by DSD under Contract No. DC/98/12 titled “Village Flood Protection Works for Pok Wai and Stormwater Intercepting Drain for Wang Chau” to permanently resolve the flooding problem. During construction, the contract requires the contractor to provide interim flood protection measures to increase the flood protection level at Pok Wai.

32. DSD’s investigation found that the contractor had formed a temporary earth embankment to prevent ingress of flood water from outside the village and provided on site a number of temporary pumps for discharging stormwater collected from within the village to the nearby channels. However, it is evident that part of the embankment was not maintained at the correct height to protect the village from ingress of floodwater. Furthermore, the contractor did not operate the temporary pumps at the early stage of the rainstorm. If the protective embankment had been maintained to the required level and the pumps were put into operation at 4:00 am that morning, the flood depth would have been reduced to about 100 mm and confined to the car park area.

33. After the incident, the contractor has maintained the protective embankment to the required level. The contractor has arranged his duty staff to be on site at all times to deal with emergency situations and to ensure that the pumps are always readily operational. The contractor has also provided more pumps to increase the flood protection level of the village. With these improvement measures, there were no further flooding incidents at Pok Wai during the subsequent rainstorms in June 2001.

### **Belvedere Garden, Tsuen Wan**

34. On 9.6.2001, heavy rain fell in Tsuen Wan resulting in very large quantities of muddy water flowing down a streamcourse from the upland catchment above Belvedere Garden. Some of the water overshot from the streamcourse, thus flooding adjacent areas. However, the majority of the flow continued down the streamcourse but could not enter the underground

drainage system because the drainage catchpit at Fat Yip Lane next to Belvedere Garden was blocked. Large amounts of boulders and debris being washed down from the streamcourse had caused the blockage. The flood water carrying mud and debris overflowed to flood parts of Castle Peak Road opposite to Belvedere Garden and also ran down the steep Lai Chi Road with high velocity to eventually flood Hoi On Road.

35. The same location flooded again during the heavy rain events on the 11th, 12th, 23rd & 27th June 2001.

36. The drainage catchpit at Fat Yip Lane is located at the toe of a small, steep, largely natural catchment in Ha Fa Shan above Belvedere Garden. There are three main streams flowing down the catchment which eventually enter the catchpit.

37. In the upstream section of the catchment, there is a catchwater which was built along the mid-level of Ha Fa Shan to collect rainfall from the catchment. It cuts across many natural streams running down the hillside and was designed to intercept the flow and convey the water to the Tai Lam Chung Reservoir. But in the case of severe rainstorms, the design allows for excessive flow to overflow from the catchwater to the stormwater drainage system by a series of specially designed overflow weirs at appropriate locations along the catchwater. There are two such overflow weirs along the section of catchwater above Belvedere Garden which, if the flow in the catchwater exceeds its carrying capacity, will discharge water to one of the streams and eventually to the drainage catchpit at Fat Yip Lane.

38. DSD's investigation concluded that the flooding incidents at Belvedere Garden were due to a combination of factors as summarized in the following paragraphs.

39. There was a substantial rise in water level along a section of the catchwater above Belvedere Garden. As a result, very large and exceptional quantities of water were discharged from the catchwater's overflow weirs to the natural streamcourse leading to the underground drainage system at Fat Yip Lane.

40. In this connection it was reported that erosion debris originating from the hillside above the catchment had been deposited in the catchwater washing down under the temporary steel decking and struts over the catchwater associated with slope upgrading works in progress at the time under Civil Engineering Department's Contract No. GE/99/18 – "10 Year Extended Landslip Preventive Measure Project, Phase I, Package A – Ground Investigation and Landslip Preventive Works for Slope in Hong Kong Island South, Kowloon and the New Territories – Batch A – Tai Lam Chung Catchwater". The aim of these works is to prevent failure of substandard slope which could result in total blockage of the catchwater and hence more serious flooding to the areas below.

41. When the very large and exceptional flow from the catchwater ran down the natural streamcourse, erosion occurred. Such a large flow would have carried with it any boulders and debris in its path to eventually block the downstream underground drainage system.

42. Due to the blockage of the drainage catchpit, the majority of the flow could not enter the underground drainage system but found its way along the roads, causing flooding.

43. The relatively short time intervals between the successive heavy rainstorms in June 2001, which did not allow sufficient time for the complete clearance and desilting of the downstream stormwater drainage system, may have also contributed to aggravate the situation.

44. DSD concluded that, if there had been no such large flow from the catchwater and the catchpit had not been blocked, then the drain at Fat Yip Lane as well as the downstream box culvert should have had sufficient capacity to cater for the rainstorms on the 9th, 11th, 12th and 27th June 2001. There may have been some minor flooding on 23.6.2001 when the rainstorm exceeded a 60-year return period and the capacity of the drainage system would have been exceeded.

45. Sections of the temporary decking over the catchwater were progressively removed following the flooding incidents in June 2001. The decking was completely removed by 18.8.2001 following the completion of upgrading works to three of the five catchwater slopes under the Landslip Preventive Measures (LPM) contract. Upgrading works for the

remaining two slopes will be carried out in the coming dry season. DSD has implemented a number of short-term measures as follows to reduce the chance of flooding due to blockage of the drainage system:

- (a) clearance of boulders and debris along the natural watercourse between Tuen Mun Road and Fat Yip Lane and the provision of shotcreting for surface protection;
- (b) provision of a boulder trap and the raising of the sidewall along the cascade channel immediately upstream of Fat Yip Lane; and
- (c) construction of additional drainage inlets in Fat Yip Lane and Castle Peak Road.

46. The drainage system near Belvedere Garden has a capacity of about 1-in-20 year in general. DSD has planned to improve the performance of the system to 1-in-50 year design standard and also to upgrade the natural streamcourse between Tuen Mun Road and Fat Yip Lane. Investigation is in progress and we plan to start work in the coming year.

### **Kau Lung Hang and Yuen Leng, Tai Po**

47. Flooding occurred in the Kau Lung Hang catchment in Tai Po (River Indus Basin) during very heavy rainstorms in June 2001. The most severe flood occurred on 9.6.2001 and to a lesser extent on 10.6.2001, 12.6.2001 and 27.6.2001. Flooding was concentrated mainly in the following areas which are generally considered to be flooding blackspots:

- (a) Main access road adjacent to the railway;
- (b) Yuen Leng Village;
- (c) Road under the railway at Kau Lung Hang; and
- (d) Kiu Tau.

48. The investigation concluded that the flooding occurred because of the insufficient capacity of the main drainage networks to cope with the very heavy rainfall that occurred on each of these occasions and the relatively low-lying topography of some of the areas within the catchment.

There were no major construction or development works in the vicinity of the Kau Lung Hang catchment. In the long run, DSD will improve the downstream portion of Yuen Leng River, the Kau Lung Hang Stream and the Ma Wat River under PWP Item 112CD “Drainage Improvement in Northern New Territories Package A”. DSD will continue with the regular inspection and preventive maintenance work to maintain the flow capacity of the rivers.

### **Other Areas in the North District**

49. There were other areas in the North District, Lok Ma Chau and San Tin flooded during the heavy rainstorms in June 2001. A total of eight areas were investigated and most of them were found to be either previously identified flooding blackspots or areas known to be susceptible to flooding.

50. For the flooding at Ta Kwu Ling, Man Kam To, Ma Tso Lung, Ping Kong, Lok Ma Chau, Ki Lun Tsuen and Luk Mei Tsuen in San Tin, DSD concluded that the causes were due to the heavy rainfall that had occurred, the low-lying topography of the locations, and the inadequate flood conveyance capacity of the local and/or downstream drainage systems.

51. For the flooding case at Hang Tau in Sheung Shui, the recorded rainfall exceeded the capacity of the drainage system. According to the local villagers, the flood extent was less than that experienced in the past, indicating that the recently completed drainage rehabilitation works had helped in mitigating the effects of flooding. As for the flooding case at Ha Pak Tsuen in Sheung Shui Wai, the flooding was found to be minor and localised, and was probably caused by temporary blockage of internal village drains.

52. None of the eight flooding cases mentioned above were related to construction activities in the vicinity of the flooded areas.

### **CONCLUSION**

53. The flooding events in June 2001 were mainly due to the

inadequacy of drainage capacity under the combined effects of heavy rainfall and other factors. We are deeply concerned about the disruption and distress brought about to the residents.

54. We have put in a lot of effort to tackle the flooding problems and will continue with our utmost effort to do so. We have a comprehensive programme of drainage improvement works under various stages of planning, design and construction in order to alleviate the flooding situation in the territory. Wherever we can, we carry out short term and first aid measures that can lessen the effects of flooding.

55. We are also looking into ways to speed up the major drainage improvement works and have stepped up our site control of drainage works and site contingency/emergency management. Upon completion of the river training projects for the mid-stream of the main river courses in 2003, our drainage system will provide much better protection against severe rainstorms and prevent the recurrence of widespread regional flooding in the Northern New Territories.

56. As regards compensation, we will request the relevant contractors to follow up any claims submitted from these residents suffered losses as a result of the flooding in accordance with the contract provisions.

**Works Bureau**  
**September 2001**

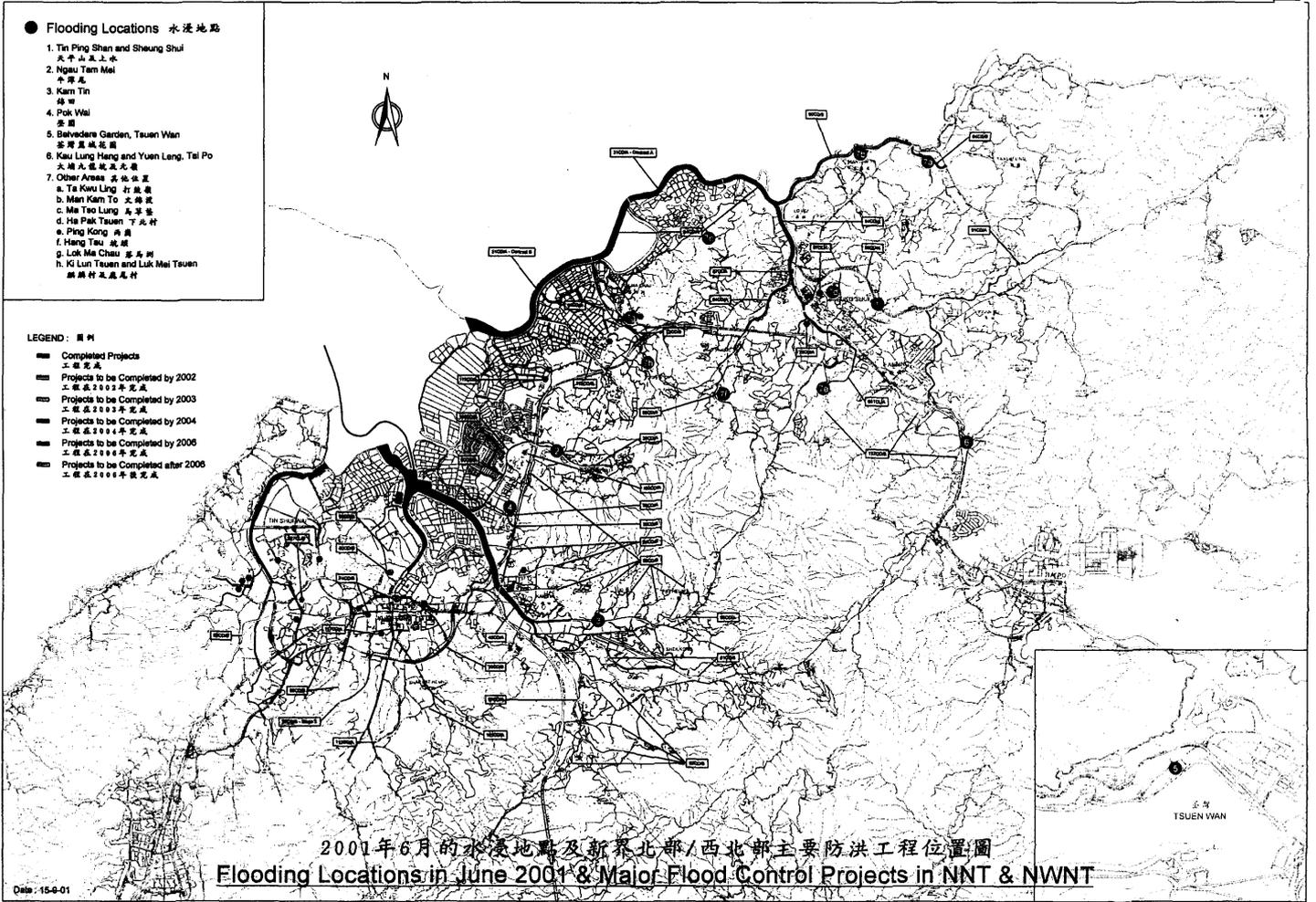
● Flooding Locations 水浸地點

1. Tin Ping Shan and Sheung Shui  
天平山及上水
2. Ngau Tam Mei  
牛潭尾
3. Kam Tin  
錦田
4. Pok Wai  
茶圍
5. Belvedere Garden, Tsuen Wan  
茶灣皇庭花園
6. Kau Lung Hang and Yuen Leng, Tai Po  
大埔九龍坑及元嶺
7. Other Areas 其他地區
  - a. Ta Kwi Ling 打鼓嶺
  - b. Man Kam To 文咸澳
  - c. Ma Tso Lung 馬草壩
  - d. He Pak Tsuen 下北村
  - e. Ping Kong 坪輦
  - f. Hang Tau 船灣
  - g. Lok Ma Chau 落馬洲
  - h. Ki Lun Tsuen and Luk Mei Tsuen  
麒麟村及鹿尾村



LEGEND: 圖例

- Completed Projects  
工程完成
- ▨ Projects to be Completed by 2002  
工程在2002年完成
- ▩ Projects to be Completed by 2003  
工程在2003年完成
- ▧ Projects to be Completed by 2004  
工程在2004年完成
- ▦ Projects to be Completed by 2006  
工程在2006年完成
- ▤ Projects to be Completed after 2006  
工程在2006年後完成



2001年6月的水浸地點及新界北部/西北部主要防洪工程位置圖

Flooding Locations in June 2001 & Major Flood Control Projects in NNT & NWNT

Date: 15-4-01