CHAPTER 2

THE GOVERNMENT OF THE HONG KONG SPECIAL ADMINISTRATIVE REGION

CAPITAL WORKS RESERVE FUND

GOVERNMENT SECRETARIAT

Works Bureau

GOVERNMENT DEPARTMENTS

Drainage Services Department
Territory Development Department
Food and Environmental Hygiene Department
Highways Department
Civil Engineering Department

The Government's efforts to control flooding in urban areas

Audit Commission
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THE GOVERNMENT'S EFFORTS TO CONTROL FLOODING IN URBAN AREAS

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THE GOVERNMENT'S EFFORTS TO CONTROL FLOODING IN URBAN AREAS

Summary and key findings

A. **Introduction.** In urban areas, many stormwater drainage systems were built many years ago, with their capacities designed to meet the flow requirement at that time. Rapid development and changes in land use have made the land surface less pervious to water. This resulted in more rainwater flowing into the stormwater drainage systems. Serious flooding which occurred in West Kowloon in 1997 and 1998 highlighted the deficiencies in some of the urban stormwater drainage systems (para. 1.1).

B. **Audit review.** Audit recently reviewed the Government's efforts to control flooding in urban areas, with particular reference to West Kowloon. Audit found that the Government had put in considerable efforts in implementing flood control measures for West Kowloon. However, the results are not entirely satisfactory and there is room for improvement in some project management aspects as summarised in paragraphs C to G below.

C. **Drainage Master Plan Study.** In 1994, the Drainage Services Department (DSD) commissioned a Drainage Master Plan study for the planning of the drainage improvement works for West Kowloon. In November 1995, the DSD accepted the study's recommendation to implement a three-staged drainage improvement scheme. However, in November 1997, during the detailed design of the stage 2 improvement works, another consultant found that the planned improvement works were inadequate to meet the design standard for flood protection because there was an omission of flow data in the hydraulic model used for the study. As a result, additional cost and time had been incurred for a re-run of the Drainage Master Plan study and for the search of alternative flood control measures for West Kowloon (paras. 2.6 to 2.10 and 2.13).

D. **Potential overflow from Kowloon reservoirs.** According to the DSD's Stormwater Drainage Manual, the drainage design for the Lai Chi Kok catchment should cope with the potential overflow from the neighbouring Kowloon reservoirs. At the time of completion of the Drainage Master Plan study for West Kowloon in November 1995, the drainage design for the potential overflow had still not been completed because the overflow issue remained unresolved. The DSD only instructed its consultant to address the overflow issue in September 1997. There was a delay of almost two years in resolving the overflow issue (paras. 2.12, 2.17 and 2.18).

E. **Checking of the design of complex flood control schemes.** The Tai Hang Tung Flood Storage Scheme and the Kai Tak Transfer Scheme proposed by the DSD for resolving the flooding problem in Mong Kok were complex in nature. Based on an audit check in 1999, Audit informed the DSD that there were errors and discrepancies in the hydraulic models used for the design of these

flood control schemes. There was also room for improvement in the then proposed design for the Tai Hang Tung Flood Storage Scheme which was intended for flood protection for Mong Kok. The DSD has taken into account Audit's views and improved the design of the Scheme. The DSD has also tightened up the checking of the hydraulic models for designing the Mong Kok drainage system and developed the expertise in-house for checking similar complex drainage design work in future (paras. 3.12 to 3.19).

F. **Delay in handing over of new culverts in the West Kowloon Reclamation.** With the implementation of the West Kowloon Reclamation project in 1990, existing trunk drains in the West Kowloon hinterland areas had to be extended to the new seafront. The culvert extension works managed by the Territory Development Department (TDD) had been completed by phases from 1993 to 1996. However, because of inadequate consultation at the planning stage of the works, the TDD subsequently had difficulties in meeting the DSD's taking-over requirements. As a result, there was delay in the handing over of the completed culverts to the DSD for proper maintenance. Meanwhile, silt gradually built up in some of the culverts. The proper functioning of the Cherry Street culvert, in particular, was affected during the heavy rainstorms in 1997. After the flooding events in 1997, urgent desilting works using an expensive method were carried out to reduce the risk of flooding (paras. 4.2 and 4.20 to 4.27).

G. **Mechanical gully cleansing of highways.** The Food and Environmental Hygiene Department's mechanical gully cleansing service helps to ensure that the road drainage system is functioning to its design capacity. While in 1985 the Food and Environmental Hygiene Department (FEHD) observed that its six-weekly gully cleansing frequency for highways could not match with the actual cleansing requirements, no follow-up review of the frequency of cleansing was undertaken. Based on an analysis of the flooding complaint statistics, Audit found that the mechanical gully cleansing frequency remained unsatisfactory (paras. 5.8, 5.16 and 5.17).

H. **Audit recommendations.** Audit has made the following major recommendations:

(a) the Director of Drainage Services should:

(i) carry out thorough checking of key parameters and calculations used in works planning and design, such as those used in the hydraulic models for the Drainage Master Plan studies, before the works plans and designs are accepted for implementation (para. 2.16(a));

(ii) take prompt action to resolve significant works issues, such as those relating to flood prevention design, which have public safety and financial implications (para. 2.19(a)); and

(iii) when checking the design of complex projects, critically examine the models or methods used and, if there are limitations, conduct further verifications by means of other models or methods (para. 3.20);

(b) the Secretary for Works should:

(i) remind all works departments to monitor closely the planning of works to ensure that there is adequate consultation among the parties concerned about the arrangement for handing over of completed works (para. 4.28(a)); and

(ii) consider promulgating procedures, similar to those applicable to the Airport Core Programme projects, requiring works departments to effectively coordinate with each other so as to resolve any interdepartmental works issues within a finite period (para. 4.28(c)(i)); and

(c) the Director of Food and Environmental Hygiene should:

(i) urgently carry out a critical review of the frequency of gully cleansing of highways at night to ascertain the actual requirement before finalising arrangements for contracting out the service (para. 5.20(a)); and

(ii) in carrying out the review, make due reference to the flooding complaint statistics and draw on the Highways Department's experience so as to devise an optimal cleansing schedule and reduce cost (para. 5.20(b)).

I. **Response from the Administration.** The Administration has generally agreed with the audit recommendations (paras. 2.24 to 2.26, 3.21, 4.29 to 4.31 and 5.22).

PART 1: INTRODUCTION

1.1 Stormwater drainage systems are part of the essential infrastructure in Hong Kong. They serve to protect life and property from flooding. In urban areas, many stormwater drainage systems were built many years ago, with the capacities designed to meet the flow requirement at that time. Due to rapid development and changes in land use over the years, natural land has been paved and become impermeable. Rainwater can no longer dissipate naturally through ground infiltration. This has resulted in an increase in surface runoff, thus overloading the stormwater drainage systems. In 1997 and 1998, a number of serious flooding incidents occurred in West Kowloon (see photographs 1 and 2 on the centre pages). These flooding incidents highlighted the deficiencies in some of the urban stormwater drainage systems. This report focuses on such deficiencies and does not cover flooding problems in other parts of Hong Kong.

1.2 The Drainage Services Department (DSD) is responsible for planning, designing, constructing, operating and maintaining the stormwater drainage systems (Note 1). In addition, the DSD is responsible for setting stormwater drainage standards. In 2000-2001, the recurrent expenditure of the DSD's stormwater drainage programme is estimated to be $368 million.

1.3 Based on a territory-wide consultancy study, in 1990 the Government endorsed a flood prevention strategy to deal with the flooding problems in Hong Kong. The DSD is currently implementing the strategy through a three-tier plan. The plan includes:

(a) ***Planning and legislative measures.*** These measures include:

(i) Drainage Master Plan studies for formulating both long-term and short-term measures to upgrade the drainage system to cope with development needs;

(ii) Drainage Impact Assessment requirements for assessing the drainage impact caused by new development; and

(iii) the enactment of the Land Drainage Ordinance (Cap. 446) in 1994 which empowers the Director of Drainage Services to gain access to private land for the maintenance of main watercourses designated under the Ordinance;

Note 1: *The Territory Development Department is responsible for drainage planning and implementation in new reclaimed land as part of its responsibility for the provision of land and supporting infrastructure (see paragraph 2.4 below).*

(b) ***Long-term structural measures.*** These measures aim to bring the stormwater drainage systems up to the strategic flood protection standards through an extensive programme of civil engineering works; and

(c) ***Short-term improvement and management measures.*** These ongoing measures include local drainage improvement works, maintenance activities to identify and remove drain blockages and surveillance activities to ensure that the capacity of the drainage system is preserved (Note 2).

Audit review

1.4 Audit has recently conducted a review of the economy, efficiency and effectiveness with which the Government has implemented the flood prevention strategy in urban areas, with particular reference to West Kowloon where there has been serious and frequent flooding. The review focussed on the following issues:

(a) the adequacy of management control over the Drainage Master Plan study for the overall planning of drainage improvement works for West Kowloon (see Part 2 below);

(b) the adequacy of management control over the detailed design of key flood control schemes planned for resolving the flooding problem in Mong Kok (see Part 3 below); and

(c) the adequacy of planning and coordination of the maintenance arrangements for urban stormwater drains (see Parts 4 and 5 below).

1.5 Audit has sought advice and assistance from an engineering consultant in this review. The audit has revealed that the Government has put in considerable efforts to tackle the flooding problem of urban areas in a structured manner. For West Kowloon, the Government has been actively implementing flood control measures under the Public Works Programme, as summarised in Table 1 below. However, the audit has also found that there is room for improvement in some project management aspects.

Note 2: *Apart from the DSD, the Highways Department and the Food and Environmental Hygiene Department (formerly the Urban Services Department) also have responsibility for maintaining the urban road drainage system (see Part 5 below).*

Table 1

Summary of approved public works projects for the planning, design and construction of West Kowloon stormwater drainage improvement works

Public Works Programme Projects	Approved project estimate ($ million)	Date of funding approval	Commencement date	Completion date
West Kowloon Stormwater Drainage Improvement Study (see paragraph 2.6 below)	15.9	June 1994	June 1994	November 1995
West Kowloon stormwater drainage improvement:				
(a) stage 1 — site investigation and detailed design (see paragraph 2.7(a) below)	11.5	March 1996	April 1996	May 1997
(b) stage 1 works (see paragraph 2.7(b) below)	464.0	June 1997	April 1998	January 2003 (planned)
(c) stage 2 — site investigation and detailed design (see paragraph 2.7(c) below)	68.0	April 1997	June 1997	May 2000
(d) stage 2 phase 1 works (see paragraph 3.10 below)	1,762.9	June 1999	December 1999	2004 (planned)
(e) stage 2 phase 2 and part of stage 3 works (see paragraph 3.17 below)	1,767.2	June 2000	January 2001 (planned)	2007 (planned)
Total	**4,089.5**			

Source: The DSD's records

PART 2: DRAINAGE MASTER PLAN STUDY FOR WEST KOWLOON

2.1 This part examines the Drainage Master Plan study for West Kowloon. The study was the first of a series of Drainage Master Plan studies undertaken by the DSD in accordance with its flood prevention strategy. The audit has revealed that there are lessons to be learnt in conducting similar studies in future.

Stormwater drainage system of West Kowloon

2.2 West Kowloon is a major residential and commercial area. Its drainage system covers an area of some 1,500 hectares (ha), extending from Tsim Sha Tsui in the south, to Lai Chi Kok in the west and to Kowloon Tong in the east. The upper part of the drainage system lies in a steep and relatively suburban area above Lung Cheung Road. The lower part lies in a relatively flat and densely populated area which has recently been extended by the West Kowloon Reclamation. The Kowloon group of reservoirs adds an indirect catchment area of some 680 ha. A map showing the major stormwater catchments of West Kowloon is at Figure 1 on the centre pages.

2.3 The trunk drains in West Kowloon had been extended and modified over the years as West Kowloon was being developed. The drains were originally open nullahs but many have now been decked or replaced by box culverts. In October 1990, a preliminary study carried out by the DSD revealed that many trunk drains in the area were inadequate in capacity.

2.4 In 1990, the Government implemented the West Kowloon Reclamation project. The trunk drains in the West Kowloon hinterland areas (i.e. areas adjacent to the new reclamation) had to be extended to the new seafront. In November 1991, the Territory Development Department (TDD), which was responsible for the reclamation works, completed a hydraulic model analysis of the drainage system for the West Kowloon Reclamation and the hinterland areas. The objective of the analysis was to identify measures necessary to mitigate the adverse effects on the existing drainage system due to the extension of the culverts through the reclamation. The TDD subsequently carried out works to improve the hinterland drainage system and to extend the culverts across the new reclamation. Audit found that there were problems in the handing over of the completed culverts from the TDD to the DSD for maintenance. Details are given in paragraphs 4.1 to 4.28 below.

2.5 In 1994, the DSD commissioned a Drainage Master Plan study entitled "West Kowloon Stormwater Drainage Improvement Study (WKS)" for West Kowloon. The study was necessary because the improvement works carried out by the TDD included only the upgrading of those trunk drains affected by the reclamation.

West Kowloon Stormwater Drainage Improvement Study

2.6 The WKS, commenced in June 1994, had an approved project estimate of $15.9 million. Under the WKS, the DSD's consultant (hereinafter referred to as Consultant A) was engaged to carry out investigation, hydraulic model analysis and preliminary design of the drainage system for West Kowloon. A computerised hydraulic model was used to determine whether there were drainage deficiencies. The hydraulic model was also used to develop a Drainage Master Plan as a blueprint for the necessary improvement works to meet the design standard of a once-in-two-hundred-years rainstorm (Note 3). The WKS was completed and accepted by the DSD in November 1995. The study identified the need to upgrade about 103 kilometres (or some 64%) of the existing stormwater drains. The study recommended that necessary improvement works, estimated to cost $2.5 billion, should be carried out for West Kowloon. The improvement works were to be implemented in three stages, as follows:

(a) ***Stage 1 works.*** The works involved the upgrading of some 9 kilometres of drains which were found to be critically under-capacity and located beneath roads where some sewerage improvement works had already been planned for. The works were targeted for completion by 2003;

(b) ***Stage 2 works.*** The works involved the upgrading of 56 kilometres of drains which were found to be critically under-capacity but fell outside the boundary of the stage 1 works. The works were targeted for completion by 2004; and

(c) ***Stage 3 works.*** The works involved the upgrading of some 38 kilometres of drains which were moderately under-capacity. The works were targeted for completion by 2007.

Implementation of the three stages of drainage improvement works recommended by the WKS

2.7 In November 1995, the DSD Steering Group for the WKS (Note 4) accepted the final report of the WKS. The WKS recommendations were implemented, as follows:

Note 3: *According to the Stormwater Drainage Manual, the recommended design standard of a once-in-two-hundred-years rainstorm may not be achievable for some lowlying areas. The finally adopted design standard for West Kowloon trunk drains is for a once-in-fifty-years rainstorm (see paragraph 3.6 below). A table showing the equivalent rainfall intensities for a 60-minute rainstorm of various return periods is at Appendix A.*

Note 4: *The function of the DSD Steering Group for the WKS was to provide guidance to the consultants and to monitor the progress of the study. The Steering Group was chaired by an Assistant Director of the DSD and had representatives from the TDD, the Highways Department and the Environmental Protection Department.*

(a) in April 1996, the DSD appointed an engineering consultant (hereinafter referred to as Consultant B) to carry out site investigation and detailed design for the West Kowloon stormwater drainage improvement stage 1 works at an approved project estimate of $11.5 million;

(b) in June 1997, the DSD obtained the approval of the Finance Committee of the Legislative Council (LegCo) to upgrade the West Kowloon stormwater drainage improvement stage 1 works to Category A of the Public Works Programme at an approved project estimate of $464 million; and

(c) in June 1997, the DSD appointed another engineering consultant (hereinafter referred to as Consultant C) to carry out site investigation and detailed design for the West Kowloon stormwater drainage improvement stage 2 works at an approved project estimate of $68 million.

Identification of problems during detailed design of the stage 2 works

2.8 According to the consultancy briefs for the detailed design of the stages 1 and 2 works, Consultants B and C were required to review the design concepts and parameters, specifications and codes of practices adopted and recommendations made in the WKS to ensure that they were still appropriate in the light of any changed circumstances. The reviews were known as adoptive reviews. In September 1997, in the course of the adoptive review for the stage 2 works, Consultant C found that:

(a) there was an omission of flow data in the hydraulic model used in the WKS (see paragraphs 2.9 and 2.10 below); and

(b) the preliminary drainage design for the Lai Chi Kok catchment could not cope with the potential overflow from the Kowloon group of reservoirs (see paragraphs 2.11 and 2.12 below).

Omission of flow data in the hydraulic model of the WKS

2.9 **During a review of the hydraulic model of the WKS, Consultant C found that the runoff data for the upland area of five catchments were missing from Consultant A's hydraulic model. The area with missing runoff totalled about 292 ha.** Table 2 below shows the extent of flow data omission by individual catchment.

Table 2

Catchment areas omitted from Consultant A's runoff calculation

Catchment	Total area defined in the hydraulic model	Area omitted from runoff calculation	Percentage of area omitted from runoff calculation
	(A)	**(B)**	**(C) = (B) / (A) × 100%**
	(ha)	**(ha)**	
Lai Chi Kok	107	85	**79%**
So Uk	199	76	**38%**
Cheung Sha Wan	97	22	**23%**
Mong Kok	526	102	**19%**
Shek Kip Mei and Tai Kok Tsui	165	7	**4%**
Total	**1,094**	**292**	**27%**

Source: Consultant A's Report on Review of West Kowloon Stormwater Drainage Models of November 1997 and Consultant C's Adoptive Review Report of November 1997

2.10 **In November 1997, Consultant C reported that because of the above-mentioned omission of flow data, the design for the stages 1 and 2 works recommended in the WKS could not provide adequate flood protection for Mong Kok in the event of a once-in-twenty-years rainstorm. Even after the completion of all the three stages of drainage improvement works, the trunk drainage system could not meet the design standard of a once-in-two-hundred-years rainstorm (see paragraph 2.6 above).** At the request of the DSD, in November 1997, Consultant A reviewed his hydraulic model. The review confirmed that there was omission of flow data in the catchment areas as identified by Consultant C. Consultant A's assessment was that the impact of the omitted flow data in terms of an underestimation of flood volume was not significant except for the Lai Chi Kok catchment. However, he agreed that additional improvement works were required in order to eliminate flooding under a once-in-two-hundred-years rainstorm.

The preliminary drainage design for the Lai Chi Kok catchment could not cope with the potential overflow from the Kowloon group of reservoirs

2.11 According to the Stormwater Drainage Manual (SDM) of the DSD, where part of a drainage basin is a Water Supplies Department (WSD) catchment, the stormwater drainage should be designed in such a way that it could cope with the greater of the following runoff:

(a) the maximum runoff assuming the absence of the WSD catchment; and

(b) the runoff from the catchment excluding the WSD part of the catchment, plus the estimated overflows from the catchwaters and reservoir spillways as provided by the WSD.

2.12 In September 1997, Consultant C found that there was inadequate drainage capacity in the Lai Chi Kok catchment to cope with the potential overflow from the neighbouring Kowloon group of reservoirs as required by the SDM. Consultant C considered that this unresolved design issue should be addressed because in the worst case scenario, the enormous volume of overflow from the Kowloon group of reservoirs, discharged into Lai Chi Kok at high speed, could have catastrophic consequences.

Audit observations on the omission of flow data in the hydraulic model of the WKS

2.13 **After the DSD accepted the final report of the WKS in November 1995, the three-staged drainage improvement works recommended in the WKS were subsequently found to be inadequate to meet the design standard because of the omission of flow data. As a result, it was necessary to revise the drainage improvement strategy for West Kowloon, particularly the stages 2 and 3 works proposed in the WKS (Note 5). Additional cost was incurred and extra time was spent in the re-run of the Drainage Master Plan study and the search for alternative flood control measures for West Kowloon.** The cost of the additional professional services was $5.1 million. The expected time for completion of all the drainage improvement works for West Kowloon will also be deferred from 2007 (as stated in the WKS — see paragraph 2.6(c) above) to 2010, i.e. the expected commissioning date of the Lai Chi Kok Transfer Scheme for rectifying the flow data omission problem (see paragraph 3.5 below for details).

Note 5: *In May 1997, the detailed design for the stage 1 works was completed. The DSD therefore proceeded with the construction of the stage 1 works in April 1998 with some modifications to suit the revised scope of the stages 2 and 3 works.*

2.14 In reviewing the incident of the omission of flow data, Audit noted that there is room for improvement in the DSD's vetting of Consultant A's work, as follows:

(a) **in late 1995, when the DSD received the hydraulic model of the WKS from Consultant A, the DSD did not detect the flow data omission in the hydraulic model. The flow data omission was only found by Consultant C in November 1997 during his review of the WKS hydraulic model kept by the DSD; and**

(b) **the DSD accepted the WKS Final Report in November 1995. However, in July 1996, i.e. some eight months after, the DSD had not yet carried out a check on the hydraulic model. This was because the DSD was unable to run the hydraulic model of the WKS in the DSD's computer due to the incompatibility of computer software.**

2.15 Since 1996, the DSD has embarked on seven Drainage Master Plan studies for other flood prone areas throughout Hong Kong. In July 2000, six of the seven Drainage Master Plan studies had been substantially completed and one was still ongoing. Audit considers that there is a lesson to be learnt from the incident of flow data omission in the WKS. There is scope for the DSD to tighten up its checking of the work submitted by consultants.

Audit recommendations on the omission of flow data in the hydraulic model of the WKS

2.16 **Audit has *recommended* that the Director of Drainage Services should:**

(a) **carry out thorough checking of key parameters and calculations used in works planning and design, such as those used in the hydraulic models for the Drainage Master Plan studies, before the works plans and designs are accepted for implementation; and**

(b) **where it is necessary to use the computer to check the work submitted by the planner or designer of the works, ensure that the DSD is equipped with the necessary computer hardware and software, which should be compatible with those used by the planner or designer of the works.**

Audit observations on the potential overflow from the Kowloon group of reservoirs

2.17 In the course of the WKS in 1994 and 1995, Consultant A reviewed the SDM requirements for the potential overflow from the Kowloon group of reservoirs in the drainage design of the Lai Chi Kok catchment. Consultant A considered that it was impractical to provide a very large drainage capacity for the potential overflow because of insufficient working space, high capital cost and conflict with other projects. Instead, Consultant A proposed a management solution to deal with the potential overflow, i.e. by controlling the operational water level of the reservoirs through the WSD. However, the WSD considered the proposal impracticable. At the time of completion of the WKS in November 1995, the design issue of the potential overflow from the Kowloon group of reservoirs remained unresolved. Subsequently, there was delay in resolving this design issue, as follows:

(a) **between November 1995 and 1996, the DSD did not further explore with the WSD the feasibility of managing the water level of the reservoirs as a means of flood control (Note 6). Moreover, in April 1996 and in June 1997 when the DSD commissioned Consultants B and C to carry out the detailed design for the stages 1 and 2 works respectively, the DSD did not specifically ask for a follow-up investigation to address the problem of overflow from the reservoirs. The DSD also did not perform a quantitative assessment of the risk of potential overflow; and**

(b) **in September 1997, Consultant C found and advised the DSD that there was inadequate drainage capacity in the Lai Chi Kok catchment to cope with the potential reservoir overflow. Thereupon, the DSD instructed Consultant C to address the overflow issue.**

2.18 In March 1998, the DSD commissioned a quantitative assessment of the risk of flood damages due to overflow from the Kowloon group of reservoirs. The assessment confirmed that the risk was unacceptable. On the advice of Consultant C, the DSD agreed that interim mitigation measures should be implemented to protect life and to reduce flood loss, pending the commissioning of the Lai Chi Kok Transfer Scheme in 2010. **In Audit's view, if timely follow-up action on the overflow issue had been taken immediately by the DSD after the completion of the WKS in November 1995, the Lai Chi Kok Transfer Scheme would have been planned earlier (instead of almost two years later) and the delay in resolving the design issue could have been obviated.**

Note 6: *In response to the DSD's enquiry, in October 1998 the WSD reiterated its stance of 1995 (see paragraph 2.17 above) that it was impracticable to control the water level of the Kowloon group of reservoirs to provide the necessary volume for flood attenuation.*

Audit recommendations on the potential overflow from the Kowloon group of reservoirs

2.19 **Audit has *recommended* that the Director of Drainage Services should:**

(a) **take prompt action to resolve significant works issues, such as those relating to flood prevention design, which have public safety and financial implications; and**

(b) **monitor closely design work done by consultants to ensure that design requirements laid down in the DSD's manuals are complied with.**

Consultant's performance reporting system

2.20 The engagement and monitoring of Consultant A followed the Engineering and Associated Consultants Selection Board (EACSB — Note 7) procedures. According to the procedures, the department responsible for managing an EACSB approved consultancy study (i.e. the DSD in the case of the WKS) has to submit periodical appraisal reports on a consultant's performance during the term of the study. Based on these reports, the EACSB maintains a central record of consultants' past performance which will be taken into consideration in the future selection of consultants for a new assignment.

Audit observations on consultant's performance reporting system

2.21 The EACSB's prescribed consultant's performance appraisal form requires the department responsible to assess a consultant's performance in respect of his methodology and analysis for the investigation/feasibility stage of work. According to the Guidance Note for the completion of consultant's performance reports as promulgated in EACSB Circular No. 3/95 of May 1995, one of the assessing criteria is whether the consultant has taken into consideration all relevant factors in his analysis. The flow data, which had been omitted in Consultant A's hydraulic model of the WKS (see paragraphs 2.9 and 2.10 above), were therefore a relevant factor in assessing the consultant's performance.

2.22 **During the WKS consultancy, the DSD submitted to the EACSB a total of six performance reports on Consultant A (the final performance report was submitted in April 1997). However, at the time of writing the performance reports, the DSD had no knowledge of the problem of omission of flow data as it was only identified in late 1997. In the circumstances, the EACSB's record did not fully reflect Consultant A's performance in the**

Note 7: *The EACSB is chaired by the Director of Civil Engineering and its terms of reference include, among other things, the review of the performance of the engineering and associated consultants.*

WKS and the usefulness of the EACSB's record could be undermined. In this connection, Audit noted that the Director of Drainage Services had expressed similar concerns. In January 1999, the DSD reviewed the overall assessment made in the final performance report of Consultant A. The DSD considered that it might be prudent to update the EACSB's record to reflect the additional information about the omission of flow data. In response to the DSD's enquiry, the Secretary for the EACSB confirmed that, under the existing EACSB procedures, there was no mechanism for adding supplementary information to performance reports which had already been submitted.

Audit recommendations on consultant's performance reporting system

2.23 **Audit has *recommended* that the Director of Civil Engineering (as the chairman of the EACSB) should, in consultation with the Secretary for Works, consider:**

(a) **introducing procedures for updating a consultant's performance report record after the issue of the final performance report if material information about his performance is available subsequently;**

(b) **reminding works departments not to issue the final performance report until they have reviewed all relevant aspects of the consultant's performance; and**

(c) **reminding works departments that a satisfactory final performance report should not be issued until they are fully satisfied with all aspects of the consultant's performance. If the consultant's performance is found to be unsatisfactory, appropriate action should be taken against the consultant.**

Response from the Administration

2.24 The **Director of Drainage Services** has said that:

Omission of flow data in the hydraulic model of the WKS

(a) in general, he agrees with the audit recommendations on the omission of flow data in the hydraulic model of the WKS mentioned in paragraph 2.16 above;

(b) there is a limit on the level of details to be checked, especially in the feasibility study stage. In fact, consultants have to be employed because of the lack of the necessary staff

resources or expertise. There is always an adoptive review requirement in the design stage to check the parameters and calculations used in the feasibility study. In the present case, the omission of flow data in the feasibility study stage was identified in adoptive review in the design stage. It proves that the adoptive review is a very effective checking mechanism;

(c) the expenditure of $5.1 million on additional professional services mentioned in paragraph 2.13 above was not only to rectify the flow data omission problem in the WKS, but also to review and develop the most cost-effective and practical engineering solution to improve the drainage system of West Kowloon. He considers that a significant percentage of the $5.1 million is attributable to this latter purpose. Nevertheless, the DSD is seeking legal advice on the possibility of recovering from Consultant A such part of the additional expenditure that may be ascribed to the flow data omission problem; and

Potential overflow from the Kowloon group of reservoirs

(d) he supports the audit recommendations on the potential overflow from the Kowloon group of reservoirs mentioned in paragraph 2.19 above. As an interim measure, the DSD and the WSD have agreed to make use of some storage capacity of the Kowloon group of reservoirs to reduce the potential overflow. The necessary modification works at the reservoirs are underway and will be completed before the rainy season of 2001.

2.25 The **Secretary for Works** welcomes the audit recommendations and has agreed that:

General

(a) the planning and design processes for drainage projects should be improved and that key parameters and calculations used in works planning and design should be verified correct before the works plans and designs are accepted for implementation; and

Consultant's performance reporting system

(b) the EACSB should, in consultation with him, introduce procedures for updating a consultant's performance report even after the issue of the final performance report if material information about the consultant's performance is available subsequently.

2.26 The **Secretary for the Treasury** has said that:

Omission of flow data in the hydraulic model of the WKS

(a) she is concerned that a major omission of flow data in the hydraulic model of the WKS should have gone undetected for two years after the acceptance of the final report of the WKS. She trusts that appropriate steps are being put in place to avoid future recurrences and to establish whether there are grounds for a claim against the consultant for any additional costs due to the omission of the flow data; and

Consultant's performance reporting system

(b) she is concerned that the consultant's performance report did not reflect the incident of flow data omission in the WKS. She considers that where a report is found to be substantially wrong, after completion, the record should be amended accordingly. She will support any clarification to this effect in the EACSB procedural manual.

2.27 The **Director of Civil Engineering** has said that the EACSB will:

Consultant's performance reporting system

(a) review, in conjunction with the Secretary for Works, the existing procedures for reporting a consultant's performance and reinforce the communication with works departments for updating the consultant's performance record even after the issue of the final performance report; and

(b) issue reminders to works departments that they should not:

(i) issue the final performance report until they have reviewed all relevant aspects of the consultant's performance; and

(ii) issue a satisfactory final performance report until they are fully satisfied with all aspects of the consultant's performance.

PART 3: REVISION OF THE DRAINAGE IMPROVEMENT STRATEGY FOR WEST KOWLOON

3.1 This part examines the revision of the drainage improvement strategy for West Kowloon as a result of the problems identified by Consultant C in late 1997 as mentioned in paragraphs 2.9 to 2.12 above. Despite the substantial work involved in revising the drainage improvement strategy, the DSD is committed to resolving the flooding problem of Mong Kok by 2004. According to the revised strategy, two key flood control schemes were planned for resolving the flooding problem in Mong Kok. The audit has revealed that there are lessons to be learnt in checking complex flood control schemes.

Re-run of the Drainage Master Plan study for West Kowloon

3.2 As a result of the omission of flow data and the need to cater for the potential overflow from the Kowloon group of reservoirs (see paragraphs 2.9 to 2.12 above), Consultant C considered it necessary to extend the scope of the stages 2 and 3 works (see Note 5 of paragraph 2.13 above) so as to meet the design standards. An extension of the scope of pipe upgrading works of stages 2 and 3 in the built-up area of West Kowloon would have a significant impact on traffic and pedestrian flow. Therefore, alternative flood control measures had to be considered. In March 1998, the DSD instructed Consultant C to carry out the following additional tasks:

(a) to re-run the Drainage Master Plan study for West Kowloon;

(b) to develop a flow interception and transfer scheme to divert the runoff from the Kowloon group of reservoirs and from the catchment omitted from the original WKS design for discharge outside West Kowloon; and

(c) to review the use of storage tanks and other means to reduce drainage upgrading works so as to minimise road openings and disturbance to the public.

Revision of drainage improvement strategy

3.3 In August 1998, Consultant C reported to the DSD the findings of his review of the drainage improvement strategy for West Kowloon, as follows:

(a) by adopting a flow interception and transfer scheme and a flood storage scheme, the length of drains to be upgraded in stages 2 and 3 could be reduced from about 90 kilometres to about 60 kilometres. The overall concept was that these schemes would focus on reducing the flood levels along trunk drains so as to eliminate overland flooding to adjacent areas;

(b) the flood protection standards should be relaxed such that the trunk drains and branches would be designed for no flooding under a once-in-fifty-years and a once-in-ten-years rainstorm respectively;

(c) the drainage improvement works should be completed catchment by catchment with priorities accorded to the worst flooding blackspots; and

(d) the most cost-effective strategy for improving the drainage system in West Kowloon would involve the implementation of the following specific flood control schemes:

(i) the Kai Tak Transfer Scheme and Tai Hang Tung Flood Storage Scheme for the Mong Kok area; and

(ii) the Lai Chi Kok Transfer Scheme for the Lai Chi Kok area (Note 8).

Kai Tak Transfer Scheme and Tai Hang Tung Flood Storage Scheme

3.4 For the flooding problem in Mong Kok, Consultant C reported that the bottleneck in the drainage system was the inadequate capacity in the decked nullah under Nullah Road (see Figure 2 on the centre pages for a layout plan showing the trunk drains of the Mong Kok drainage system). However, it was impracticable to construct new culverts to provide the additional capacity because of physical and traffic constraints. To resolve the flooding problem in Mong Kok, Consultant C's proposal was to reduce the quantity of stormwater flow to the bottleneck area of this drainage system (Note 9). This could be achieved by implementing:

(a) ***The Kai Tak Transfer Scheme.*** The Scheme was to intercept and transfer the flow from the Waterloo Road culvert to the Kai Tak Nullah (Note 10); and

(b) ***The Tai Hang Tung Flood Storage Scheme.*** The Scheme was to store up temporarily the peak flow along the Tai Hang Tung culverts in a large underground tank. The water stored would be pumped back to the drainage system when the water level in the downstream drain had receded.

Based on his hydraulic model runs, in July 1998 Consultant C informed the DSD that, with the implementation of the Kai Tak Transfer Scheme and the Tai Hang Tung Flood Storage Scheme, the decked nullah along Nullah Road would be able to provide drainage capacity to cope with a once-in-fifty-years rainstorm.

Note 8: *This scheme was based on the idea of routing stormwater to the sea near Stonecutters Island.*

Note 9: *There are two main tributaries in the Mong Kok catchment: one runs along Waterloo Road and Boundary Street while the other runs along Tai Hang Tung Road. They merge into an open nullah next to the Mong Kok Stadium. This nullah is decked throughout the downstream area.*

Note 10: *The Kai Tak Transfer Scheme was intended to take advantage of the spare capacity in the existing Kai Tak Nullah.*

Lai Chi Kok Transfer Scheme

3.5 For the Lai Chi Kok catchment, Consultant C proposed the construction of the Lai Chi Kok Transfer Scheme to intercept runoff from the upstream suburban hinterland in West Kowloon and to transfer the runoff to the sea near Stonecutters Island. Apart from reducing the extent of pipe upgrading works required in the congested urban areas, this scheme would intercept potential overflow from the Kowloon group of reservoirs and cater for the flow data omission in the WKS. The scheme is targeted for completion in 2010.

Relaxation of the design standards for flood protection

3.6 In August 1998, the DSD approved Consultant C's proposal to adopt a pragmatic approach to applying the design standards for flood protection. This was necessary because strict adherence to the standards in the SDM would involve very extensive and expensive works and would cause traffic disruption. The design standards finally adopted for the West Kowloon flood protection works were as follows:

(a) there would be no stormwater overflow from the trunk drains in the event of a once-in-fifty-years rainstorm; and

(b) there would be no stormwater overflow from the branch drains in the event of a once-in-ten-years rainstorm.

3.7 In November 1998, the DSD informed the Works Bureau of its revised drainage improvement strategy for West Kowloon and its implementation plan, as follows:

(a) ***Stage 2 phase 1 works.*** The works included drainage upgrading works in the whole of West Kowloon with the exception of the upstream areas of Yau Yat Tsuen, Kowloon Tong and Ho Man Tin;

(b) ***Stage 2 phase 2 works.*** The works were for the implementation of the Tai Hang Tung Flood Storage Scheme and the Kai Tak Transfer Scheme to resolve the flooding problem in Mong Kok (see paragraph 3.4 above);

(c) ***Stage 3 works.*** The works were for the drainage upgrading works in Yau Yat Tsuen, Kowloon Tong and Ho Man Tin; and

(d) ***The Lai Chi Kok Transfer Scheme.*** The Scheme was then under a preliminary project feasibility study (Note 11) and would be dealt with under a separate item in the Public Works Programme.

Note 11: *The purpose of a preliminary project feasibility study is to ensure that the preliminary feasibility of a project is established before the project may be included in Category C of the Public Works Programme.*

Implementation of the revised drainage improvement strategy

3.8 In April 1999, the Works Bureau informed the DSD of its intention to present the revised drainage improvement strategy for West Kowloon to LegCo Members in their Planning, Lands and Works Panel meeting of May 1999 before the DSD sought funding approval to upgrade the stage 2 phase 1 works to Category A of the Public Works Programme. In this connection, in April and May 1999, the DSD obtained from Consultant C information on the flood protection levels achievable under each stage of the works.

3.9 In May 1999, the LegCo Panel on Planning, Lands and Works was informed of the revised drainage improvement strategy for West Kowloon. In the information paper presented to the LegCo Panel, it was stated that the flooding problem currently experienced in Mong Kok would basically be resolved by completing the stage 2 phase 1 works and the stage 2 phase 2 works (see paragraph 3.7(a) and (b) above). In the discussion of the Panel information paper, Members were informed that the flood storage scheme and the transfer schemes together could cope with a once-in-fifty-years rainstorm.

3.10 In June 1999, the Administration invited the Public Works Subcommittee (PWSC) to recommend to the Finance Committee for upgrading the stage 2 phase 1 works to Category A. In the PWSC paper, Members were informed that the flooding problem currently experienced in Mong Kok would be resolved by completing the stage 2 phases 1 and 2 works. In the discussion of the PWSC paper, Members were informed that, after the completion of the proposed works, the capacity of the drainage system would be able to cope with a once-in-fifty-years rainstorm. In June 1999, the Finance Committee approved the funding of $1,762.9 million for the stage 2 phase 1 works.

Audit's review of the hydraulic models for the Mong Kok catchment

3.11 The Tai Hang Tung Flood Storage Scheme and the Kai Tak Transfer Scheme proposed under the stage 2 phase 2 works for resolving the flooding problem in Mong Kok were complex in nature. The DSD had placed reliance on the hydraulic models (used by Consultant C for his ongoing design work) to provide assurance of the flood protection levels achievable by the proposed schemes. In August 1999, Audit carried out a review of the hydraulic model files.

Design criteria not fully met as shown by hydraulic model files

3.12 **In September 1999, based on the hydraulic model files provided by the DSD, Audit found that the performance of the Mong Kok drainage system would not be entirely satisfactory even after the implementation of the proposed works. There was still room for improvement in the then proposed design of the drainage improvement works in order to fully meet the design criteria, as shown in Table 3 below.**

Table 3

Expected performance of the Mong Kok drainage system

Design Criteria	System performance after completion of Stage 2 works (see paragraph 3.7(a) and (b))	Stage 3 works (see paragraph 3.7(c))	Lai Chi Kok Transfer Scheme (see paragraph 3.7(d))
No stormwater overflow from trunk drains in a once-in-fifty-years rainstorm (see paragraph 3.6(a))	**Criterion not met** (overflow of 2,040 cubic metres (m^3) stormwater from trunk drains was expected)	**Criterion not met** (overflow of 8,750 m^3 stormwater from trunk drains was expected)	**Criterion not met** (overflow of 4,710 m^3 stormwater from trunk drains was expected)
No stormwater overflow from branch and trunk drains in a once-in-ten-years rainstorm (see paragraph 3.6(a) and (b))	**Criterion not met** (overflows of 15,410 m^3 and 190 m^3 stormwater from branch and trunk drains respectively were expected)	**Criterion not met** (overflows of 820 m^3 and 470 m^3 stormwater from branch and trunk drains respectively were expected)	**Criterion not met** (overflows of 360 m^3 and 320 m^3 stormwater from branch and trunk drains respectively were expected)
Reduction of stormwater level to below 6.7 mPD at Point A in the Nullah Road culvert in a once-in-fifty-years rainstorm (Note)	**Criterion not met** (water level at Point A could reach 7.27 mPD)	**Criterion not met** (water level at Point A could reach 7.92 mPD)	**Criterion not met** (water level at Point A could reach 7.24 mPD)

Source: *Hydraulic model files provided by the DSD in August 1999*

Note: *The criterion adopted by Consultant C for evaluating the performance of various proposed flood storage options was based on the stormwater level for a critical point (referred to as Point A — see Figure 2 on the centre pages) in the Nullah Road culvert at the intersection with Flower Market Road. The reduction of the stormwater level at Point A to below the threshold of 6.7 mPD (Note 12) was considered necessary because above this threshold, overland flooding would occur. In the past, the overland flooding had contributed greatly to flooding in Mong Kok.*

Note 12: *mPD stands for metres principal datum. It is the level to which all land surveys in Hong Kong are referenced.*

Errors and discrepancies in hydraulic models

3.13 **In addition, Audit also found errors and discrepancies in the pipe sizes and the storage tank configuration of the Tai Hang Tung Flood Storage Scheme in the DSD's hydraulic model files given to Audit for review.** In view of this finding, in September 1999 Audit sought clarification from the DSD. The DSD informed Audit that the hydraulic model files were prepared to give an indication of the flood protection levels achievable under the staged improvement works. These hydraulic model files were prepared from data in other hydraulic models and in this process some errors had been made. Consultant C had prepared numerous hydraulic models to assess the performance of the drainage system. This process, which was then ongoing, confirmed that the proposed schemes were the best schemes for achieving the design standards for flood protection for Mong Kok.

Further problems found in the revised hydraulic models

3.14 In October 1999, the DSD provided a set of revised hydraulic model files for Audit's review. Audit found that, while these revised hydraulic model files showed improvement in the performance of the drainage system after completion of the proposed flood control schemes, the hydraulic model files showed that the design criteria would still not be fully met. Details are shown in Table 4 below.

Table 4

Expected performance of the Mong Kok drainage system based on the DSD's revised hydraulic model files of October 1999

	System performance after completion of		
Design Criteria	**Stage 2 works (see paragraph 3.7(a) and (b))**	**Stage 3 works (see paragraph 3.7(c))**	**Lai Chi Kok Transfer Scheme (see paragraph 3.7(d))**
No stormwater overflow from trunk drains in a once-in-fifty-years rainstorm (see paragraph 3.6(a))	**Criterion not met** (overflow of 3,160 m^3 stormwater from trunk drains was expected)	**Criterion not met** (overflow of 2,270 m^3 stormwater from trunk drains was expected)	**Criterion not met** (overflow of 1,960 m^3 stormwater from trunk drains was expected)
Reduction of stormwater level to below 6.7 mPD at Point A in the Nullah Road culvert in a once-in-fifty-years rainstorm (see Note of Table 3)	Criterion met (water level at Point A could reach 6.51 mPD)	**Criterion not met** (water level at Point A could reach 6.89 mPD)	Criterion met (water level at Point A could reach 6.56 mPD)

Source: Revised hydraulic model files provided by the DSD in October 1999

Photograph 1

Flooding in West Kowloon in 1997
(paragraphs 1.1 and 4.17 refer)

Source: The DSD's flooding report

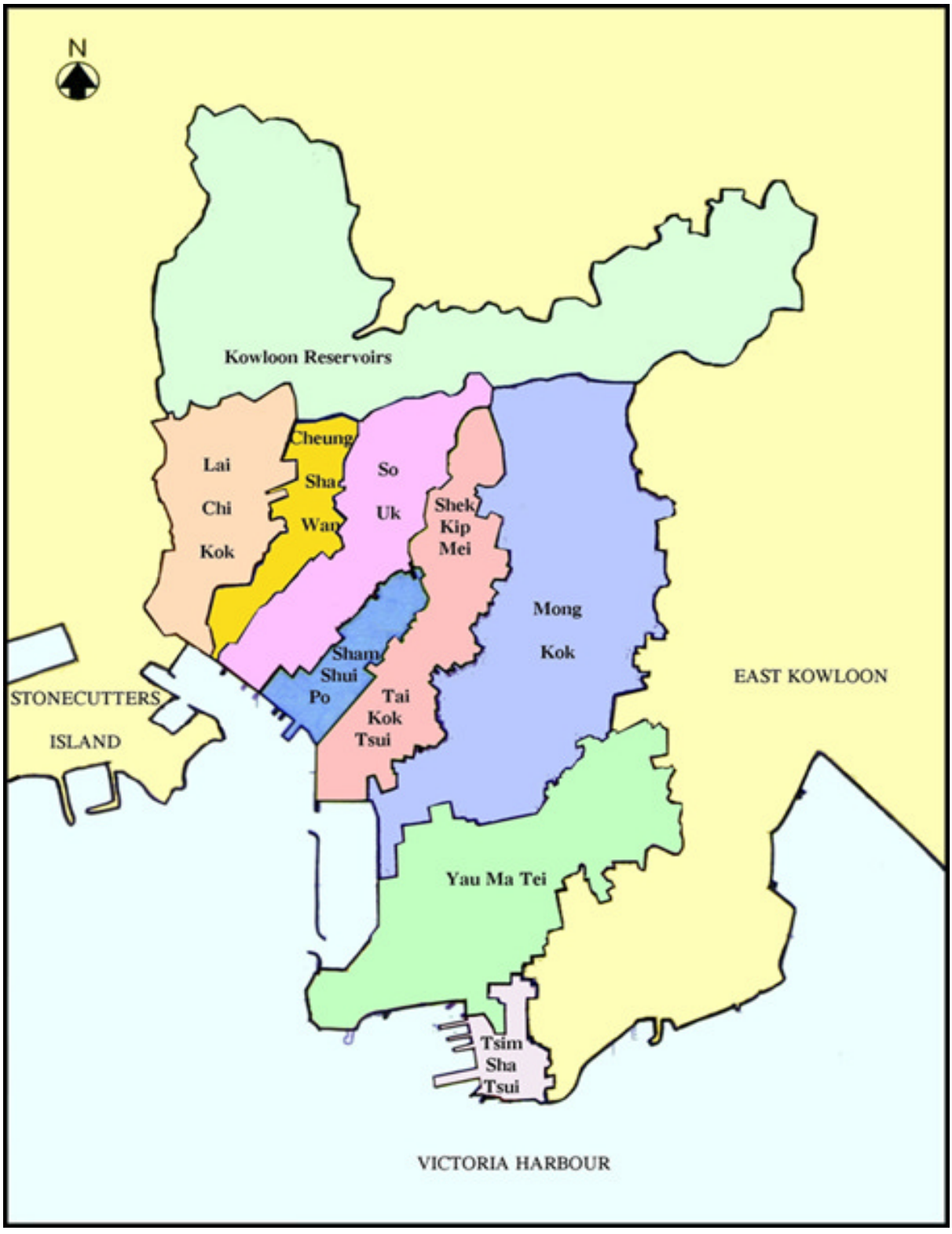
Photograph 2

Flooding in West Kowloon in 1997
(paragraphs 1.1 and 4.17 refer)

Source: The DSD's flooding report

Figure 1

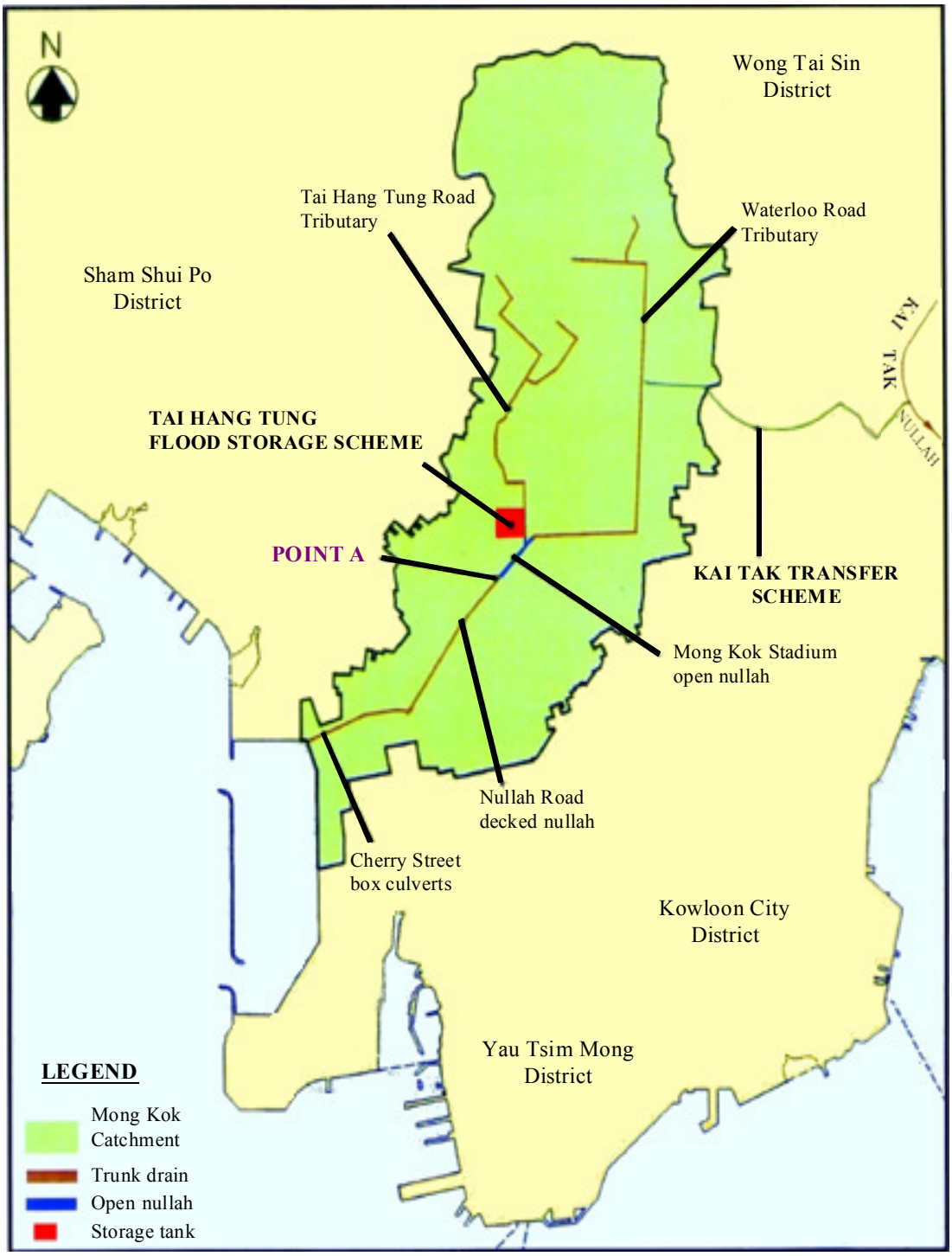
The catchments of the West Kowloon stormwater drainage system
(paragraph 2.2 refers)



Source: *The DSD*

Figure 2

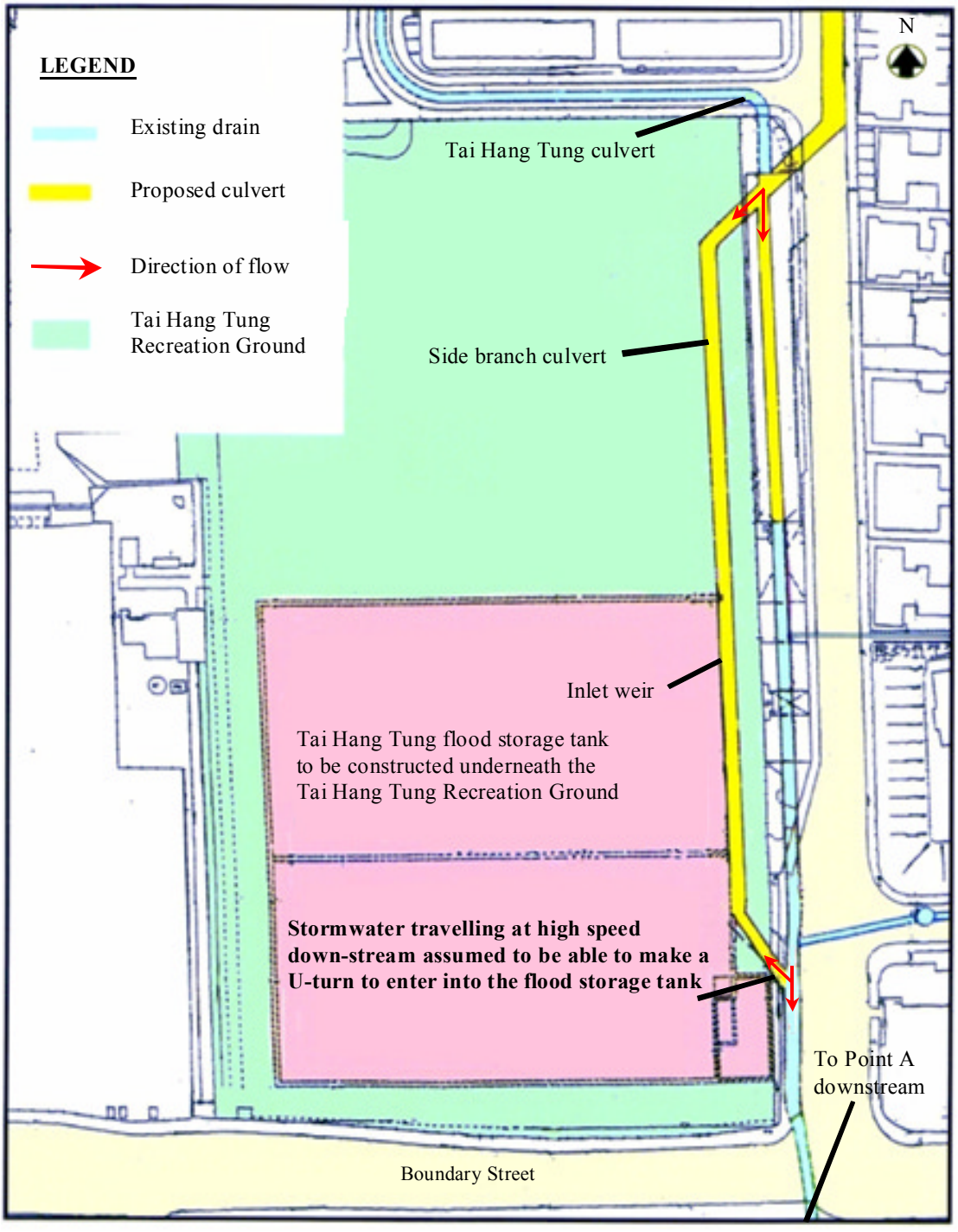
Trunk drains of the Mong Kok catchment
(Paragraph 3.4 and Note of Table 3 in Paragraph 3.12 refer)



Source: The DSD

Figure 3

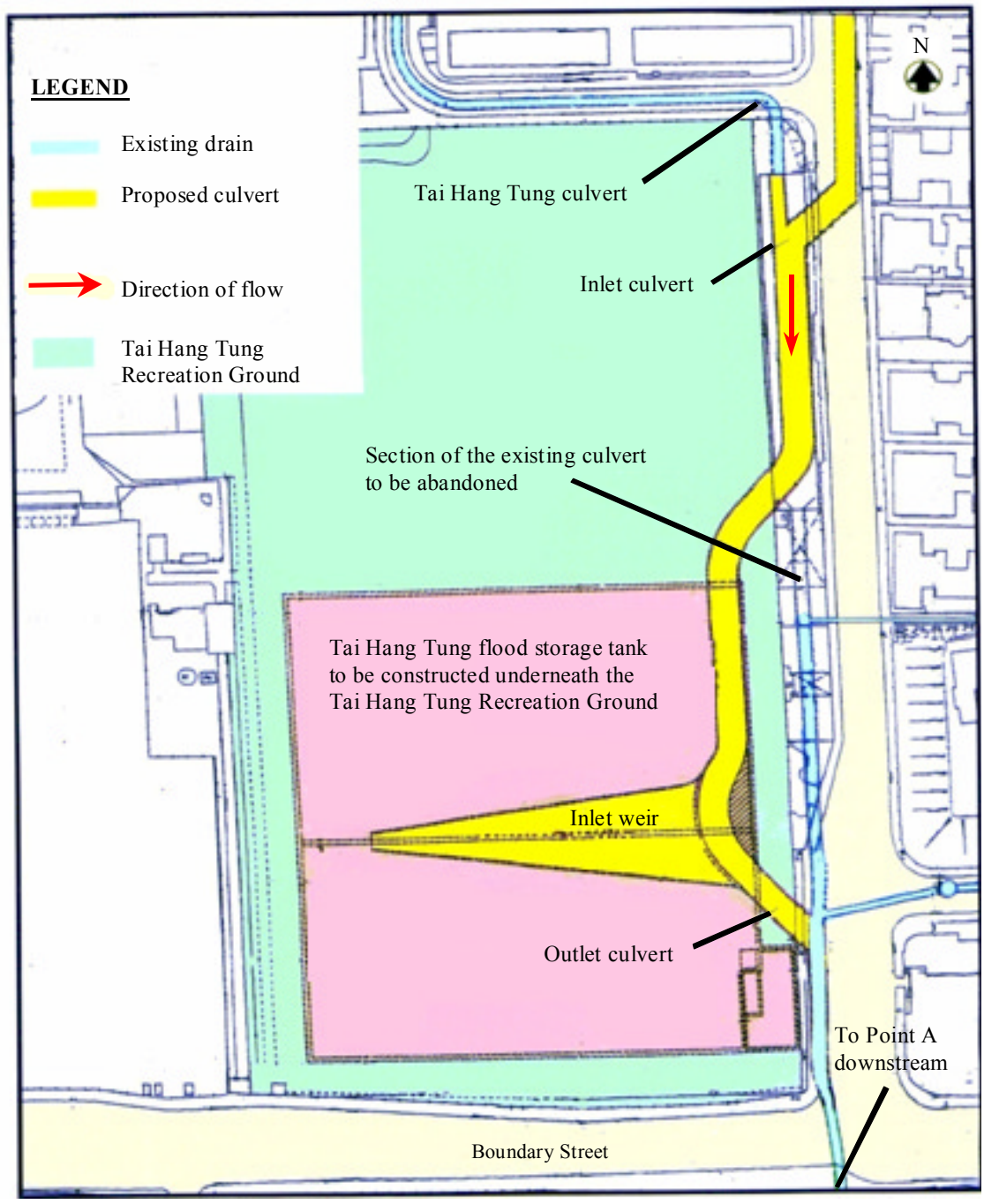
The DSD's original design layout of the Tai Hang Tung flood storage tank of July 1999 (paragraph 3.15 refers)



Source: The DSD's sketch of tank inlet culvert of July 1999

Figure 4

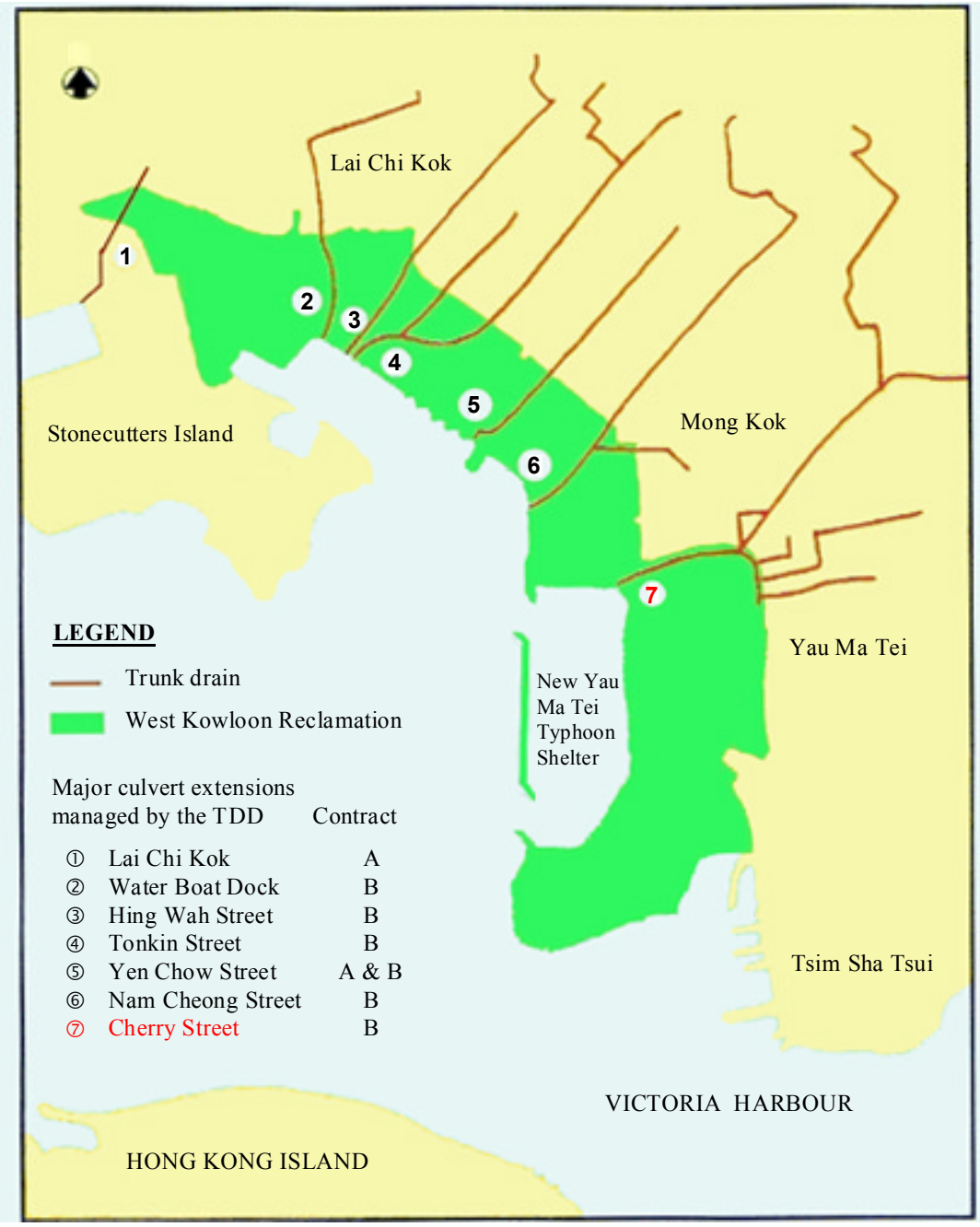
The DSD's revised design layout of the Tai Hang Tung flood storage tank of early 2000 (paragraph 3.17 refers)



Source: The DSD's Preliminary Report of November 1999 and the DSD's Design Memorandum of March 2000

Figure 5

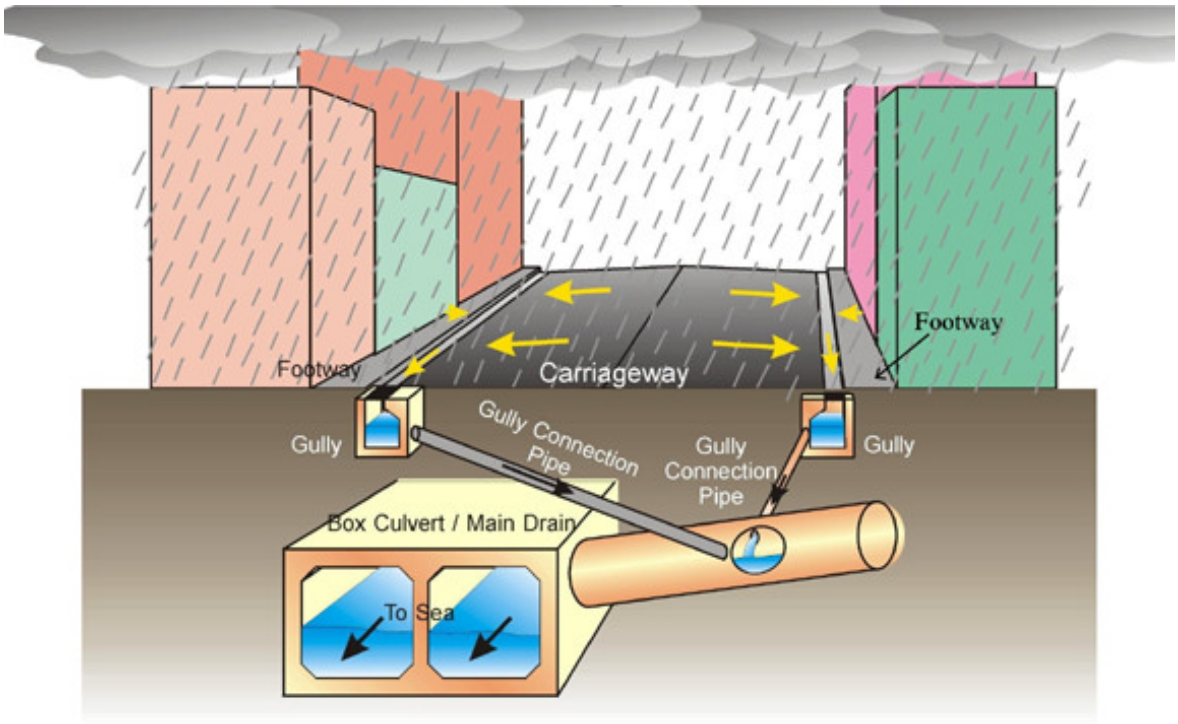
Major culvert extensions in the West Kowloon Reclamation managed by the Territory Development Department (paragraph 4.2 refers)



Source: The TDD and the DSD

Figure 6

Typical layout of an urban road drainage system
(paragraph 5.2 refers)



Source: *The DSD*

Note: *The FEHD is responsible for the clearing of refuse and silt trapped in gully pits.*
The HyD is responsible for the maintenance of gully pits and gully connection pipes.
The DSD is responsible for the maintenance of box culverts and main drains.

3.15 **After a review of the revised hydraulic model files given to Audit in October 1999, Audit found that the criterion, that the water level at Point A in the Nullah Road culvert would be reduced to below or close to the targeted level of 6.7 mPD, would be unlikely to be met in reality.** This was because in order to reduce the water level at Point A, the flow from the upstream Tai Hang Tung culvert had to be conveyed smoothly and efficiently to the Tai Hang Tung storage tank (see paragraph 3.4 above). **According to the then proposed design (see Figure 3 on the centre pages), a side branch culvert would be built parallel to the existing culvert on the eastern side of the Tai Hang Tung Recreation Ground to carry part of the flow from upstream to the Tai Hang Tung flood storage tank. However, according to such a design, the flow travelling at high speed along the existing culvert would have to make a U-turn before it could enter the storage tank. A flow calculation based on the SDM did not support such a U-turn flow which was assumed in the hydraulic model.**

3.16 In late October 1999, Audit drew the DSD's attention to the above observations and suggested that further refinement to the hydraulic model should be carried out in order to achieve a more effective design. For the Tai Hang Tung Flood Storage Scheme, which was dependent on the effectiveness of the inlet/outlet design in conveying flood water into the storage tank, extra effort would be required to ensure that the criterion in the hydraulic model would be met in reality. In this connection, a simulation by physical modelling should be carried out to verify the hydraulic model results. The DSD agreed to take Audit's observations and recommendations into account in the detailed design of the Tai Hang Tung Flood Storage Scheme.

3.17 In November 1999, the DSD informed Audit that Consultant C had revised the inlet/outlet design for the Tai Hang Tung flood storage tank, resulting in an overall improvement in the performance of the drainage system. As can be seen from the revised layout of the Tai Hang Tung flood storage tank at Figure 4 on the centre pages, the stormwater flow from upstream would be conveyed by a new culvert to the inlet of the storage tank. A section of the existing culvert parallel to the new culvert would be abandoned. In this way, the problem with the assumed U-turn flow from the existing culvert, as mentioned in paragraph 3.15 above, could be resolved. The latest hydraulic model results showed that there would be no stormwater overflow from trunk drains in the event of a once-in-fifty-years rainstorm. The DSD subsequently further verified the hydraulic model results using physical modelling. In June 2000, the Finance Committee approved the funding of $1,767.2 million for the stage 2 phase 2 and part of the stage 3 works to proceed.

Audit observations on the checking of hydraulic models

3.18 The Tai Hang Tung Flood Storage Scheme and the Kai Tak Transfer Scheme proposed by the DSD for resolving the flooding problem in Mong Kok were complex in nature. During the design stage of these schemes, the DSD had attempted to assess the effectiveness of these schemes based on some checks on the reasonableness of the volume of flow. The DSD also carried out spot checks of the hydraulic models in August 1999. However, based on the audit checks carried out in August and October 1999, Audit found that there were undetected errors and discrepancies in the hydraulic models used for the then ongoing design of these schemes. There was also room for

improvement in the then proposed design for the Tai Hang Tung Flood Storage Scheme in order to fully meet the design flood protection standard for Mong Kok.

3.19 The DSD has taken into account Audit's views and improved the design of the Tai Hang Tung Flood Storage Scheme. In February 2000, the DSD commissioned an expert of a tertiary institution to verify the hydraulic model results using physical modelling as recommended by Audit (see paragraph 3.16 above). The expert was also tasked to develop a framework for training the DSD's engineering staff in the judicious use of hydraulic models and the checking of the hydraulic model results. Audit welcomes the positive action taken by the DSD in stepping up the checking of the hydraulic models and developing the expertise in-house for checking similar complex drainage design work in future.

Audit recommendation on the checking of hydraulic models

3.20 **Audit has *recommended* that the Director of Drainage Services should, when checking the design of complex projects, critically examine the models or methods used and, if there are limitations, conduct further verifications by means of other models or methods.**

Response from the Administration

3.21 The **Director of Drainage Services** has said that:

(a) he is supportive of the audit recommendation on the checking of hydraulic model files. In the present case, the hydraulic model results for the complex Tai Hang Tung Flood Storage Scheme and Kai Tak Transfer Scheme have been verified by physical model tests;

(b) in October 1999, the detailed design of the Tai Hang Tung Flood Storage Scheme had only commenced for three to four months. According to the implementation programme, Consultant C was required to submit the Final Preliminary Report in December 1999. Therefore, it would be expected that the details of the hydraulic model files reviewed by Audit would still be subject to further refinement. Nevertheless, he appreciates that Audit's comments and observations were useful; and

(c) the concept of using a physical model to verify the actual hydraulic behaviour of the Tai Hang Tung Flood Storage Scheme was already discussed in the consultancy monthly progress meeting before Audit brought out the issue in late October 1999.

PART 4: MAINTENANCE OF NEW DRAINAGE WORKS IN THE WEST KOWLOON RECLAMATION

4.1 This part examines the handing over of new drainage works in the West Kowloon Reclamation for maintenance. The audit has revealed that there is room for improvement in the project planning and management to avoid delay in handing over completed drainage works for proper maintenance.

New drainage works in the West Kowloon Reclamation

4.2 As mentioned in paragraph 2.4 above, with the implementation of the West Kowloon Reclamation project in 1990, trunk drains in the West Kowloon hinterland areas had to be extended to the new seafront. The TDD, as the project manager of the West Kowloon Reclamation, is responsible for the construction of seven major culvert extensions under two main capital works contracts (hereinafter referred to as Contract A and Contract B — see Figure 5 on the centre pages). The culvert extension works were completed by stages from 1993 to 1996. However, it had taken a long time for the TDD and the DSD to agree on the handing-over arrangement for most of the culverts (Note 13). During this time, some of the culverts were not properly maintained. As a result, silt gradually built up in some of the culverts (Note 14). The performance of the Cherry Street culvert, in particular, was affected during the heavy rainstorms in 1997. Desilting works were then carried out urgently using expensive methods. The details are given in paragraphs 4.3 to 4.28 below.

Interdepartmental consultation

Planning stage

4.3 In 1990 and 1992, the TDD consulted the DSD about the design of the new drainage works under Contract A and Contract B. However, the consultation at that stage did not cover the handing-over arrangements of the drainage works which were very large in size and had to be completed in sections at different times. According to the Civil Engineering Manual then in force (Note 15), when separate parts of a project were completed at different times but the department responsible for maintenance would not take over the works until they were fully completed or functional, it was important to make suitable arrangements for taking care of the completed works.

Note 13: *According to records of New Airport Projects Coordination Office, as of April 1997, the DSD had only taken over the Lai Chi Kok culvert and part of the Yen Chow Street culvert constructed under Contract A. All the other six culverts constructed under Contract B were not yet taken over.*

Note 14: *Large stormwater drainage systems within reclamation are more prone to siltation due to the flat gradient.*

Note 15: *In 1993, the Civil Engineering Manual was replaced by the Civil Engineering Department's Project Administration Handbook for Civil Engineering Works which has similar provisions about the caring of completed works not yet taken over by the department responsible for their maintenance.*

Construction stage

4.4 In May 1993, when a section of the Yen Chow Street culvert constructed under Contract A was near completion, the TDD's consultant for the West Kowloon Reclamation project (hereinafter referred to as Consultant D) discussed with the DSD the handing-over arrangement. In August 1993, on the understanding that that section of the Yen Chow Street culvert would function by the date of its handing over, the DSD agreed to take over its maintenance responsibilities. Consultant D then suggested that the DSD should also take over the maintenance of other culverts constructed under Contract B once the works sites were handed back to the Government for other Airport Core Programme (ACP) projects. However, in September 1993, the DSD informed the TDD and Consultant D that the handing over of culverts constructed under Contract B had to be considered separately upon receipt of details. The DSD also informed the TDD that:

(a) it was not the usual practice for the DSD to take over the maintenance responsibilities of culverts which were not in operation; and

(b) if the culverts were within the works sites of some ongoing contracts, the DSD would not take over their maintenance responsibilities as there would be management and control problems, including:

(i) lack of control over heavy construction plants above the culverts;

(ii) difficulties of identifying the causes of damage to the culverts;

(iii) lack of control over spoil and debris being eroded and washed down into the culverts; and

(iv) difficulties of ensuring free access for inspection and desilting.

4.5 There was no indication from the TDD and Consultant D at that time that there could be difficulties in meeting the DSD's taking-over requirements. In November and again in December 1993, the DSD wrote to the TDD and Consultant D reiterating its position that the DSD would not accept maintenance responsibilities of completed culverts if they lay within other active work sites. The DSD urged for a clarification of the matter. However, the TDD and Consultant D did not respond to the DSD's letters. In December 1994, the DSD reminded the TDD and Consultant D that the DSD was still waiting for their clarification of its taking-over requirements raised in September 1993.

Difficulties in meeting the DSD's taking-over requirements

4.6 At a meeting with the DSD in January 1995, the TDD and Consultant D mentioned the following difficulties in meeting the DSD's taking-over requirements:

(a) regarding the DSD's requirement of having no other active works near the culverts, the TDD indicated that, due to the tight programme to complete the West Kowloon Reclamation and other related ACP projects, the works sites where the culverts were constructed had to be handed over immediately to other users (such as other government departments or the Mass Transit Railway Corporation). These users might occupy the sites for years until completion of their works. It was contractually impossible for the TDD's drainage works contractors to maintain the completed culverts after the completion of their contracts; and

(b) regarding the DSD's requirement of unobstructed free access, the TDD would try to identify and inform the DSD of the access to the culverts when they were handed over to the DSD. The TDD would also remind the departments working in the vicinity of the culverts to provide access to the DSD and to notify the DSD of any change of the access arrangement.

4.7 The TDD requested the DSD to reconsider and withdraw its taking-over requirements. Nevertheless, the DSD considered that the TDD's proposed arrangement could not guarantee unobstructed free access to the culverts.

4.8 In June 1995, New Airport Projects Coordination Office (NAPCO — Note 16) advised the DSD to take over the drainage works duly certified complete by the Engineer for the contract even if such certification was for sectional completion only. NAPCO said that according to the General Conditions of Contract, the contractors' responsibility for the completed culverts would cease 28 days after the substantial completion of the works. Once the drainage works were certified complete by the Engineer for the contract, the taking over of the culverts was an issue among government departments. NAPCO also assured the DSD that the contractors of the ACP related projects working in the vicinity of the culverts were required by their contract conditions to provide maintenance access to the DSD.

4.9 In July 1995, the DSD reiterated its concern over the availability of free and unhindered access for normal maintenance and suggested that the TDD should maintain the completed culverts in its other ACP contracts. However, the TDD considered that the DSD's suggested arrangement was not cost-effective and could detract the resources of the ACP contractors from meeting their critical deadlines. The discussions over the taking-over issue were to no avail.

Increased risk of flooding due to accumulation of silt in the culverts

4.10 **In February 1996, NAPCO expressed concern over the risk of flooding in West Kowloon due to the gradual accumulation of silt in the new culverts. While the departments concerned agreed that a clean-up operation was urgently needed to reduce the risk of flooding, there was no agreement on who would be responsible for undertaking the work.** NAPCO

Note 16: *NAPCO was the executive arm of the Airport Development Steering Committee (ADSCOM) with responsibility for the overall management of project implementation and coordination. NAPCO gave advice and guidance to departments about the resolution of interface issues for ACP projects. With the completion of all ACP projects, NAPCO was disbanded in March 1999.*

considered that these drainage issues had dragged on for too long. With the wet season approaching, NAPCO urged the TDD to resolve the issues urgently with the DSD.

4.11 In a survey of March 1996, the TDD found that the depth of silt in the culverts constructed under Contract B was generally below 500 millimetres but in some locations the depth was up to 1,500 millimetres. In April 1996, on the advice of NAPCO, the TDD prepared a paper to seek the directive of the Subcommittee of the ADSCOM of the ACP (SCACP — Note 17) in order to resolve the issues. However, after discussion between NAPCO and the DSD, it was agreed that an approach to the SCACP was not necessary at that stage and that further discussion between the concerned parties might be more fruitful.

4.12 After meetings with NAPCO and the TDD, in May 1996 the DSD agreed to take over the completed culverts for maintenance if the following conditions were met:

(a) the heavy silt in the new culverts should be removed so that the overall siltation level would be no more than 20% (e.g. silt depth of not more than 600 millimetres for a 3-metre deep culvert (Note 18));

(b) the culverts and manholes should be protected from further ingress of silt or sand from the works sites on the reclamation; and

(c) the DSD should be given adequate access to carry out further desilting and maintenance work.

4.13 Due to the extensive scope of the desilting works, it was expected that the DSD's term maintenance contractor would have to carry out the works in phases. In May 1996, the TDD suggested that of those culverts with heavy silt, priority should be given to the Cherry Street culvert because it provided drainage to a very large area and flooding had occurred in Mong Kok. In September 1996, the DSD informed the TDD that the DSD would only carry out desilting works for the Yen Chow Street culvert. However, after further discussion with the TDD, the DSD agreed that the desilting works of other box culverts were to follow pending the outcome of discussion with the TDD's reclamation contractor.

Little progress made in 1996 in arranging for desilting works

4.14 In January 1997, NAPCO expressed concern over the little progress made in arranging for the desilting works. In reviewing the position, NAPCO noted that a small area of the culverts constructed under Contract B was being desilted by the contractor as part of the works under a

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Note 17: *SCACP was a standing executive committee chaired by the Secretary for Works for monitoring and resolving technical works-related problems that could not be resolved at the lower level. Problems unresolved by the SCACP would be referred to ADSCOM for decision.*

Note 18: *The DSD normally only accepts new culverts with no more than 10% siltation level.*

supplementary agreement (Note 19). However, there was still no detailed planning for completing the desilting works to meet the DSD's taking-over requirements (i.e. no more than 20% siltation level). NAPCO attributed the lack of progress to the extensive resources required for the desilting works and the wish of the TDD and the DSD to avoid such costs.

4.15 **NAPCO commented that the culvert siltation problem was due to a lack of satisfactory handing-over arrangements between the TDD and the DSD, and that an interim clean-out process should have been included in the construction works contracts to remove the silt.** It was agreed among NAPCO, the TDD and the DSD that the TDD would arrange the contractor for Contract B to carry out desilting works for all the culverts in the West Kowloon Reclamation to meet the DSD's taking-over requirement. In March 1997, Consultant D instructed the works contractor for Contract B to desilt the culverts in order of priority. **However, Consultant D did not give instructions to carry out desilting works for the Cherry Street culvert because the contractor said that the works could not be completed before the expiry of the maintenance period in April 1997.**

4.16 In April 1997, the TDD requested the DSD to consider whether its term contractor could be employed to take up the desilting of the Cherry Street culvert. However, no agreement on the desilting arrangement was reached before the rainy season of 1997. According to a survey conducted by the TDD's Chief Resident Engineer in February 1997, the siltation level of the Cherry Street culvert ranged from 9% to 31% at that time.

Flooding in West Kowloon in 1997

4.17 In June and July 1997, there were several serious flooding incidents in West Kowloon (see photographs 1 and 2 on the centre pages). In a subsequent review of these flooding incidents, the DSD and Consultant C found that the siltation in the new culverts of the West Kowloon Reclamation, especially the Cherry Street culvert, was one of the contributing factors (Note 20):

(a) in June 1997, the DSD informed the Works Bureau that the serious flooding around the Mass Transit Railway station at Prince Edward Road on 4 June 1997 would not have occurred or would have been less severe if the culvert, located downstream of Cherry Street, had been properly desilted and the additional box culverts along Mong Kok Road and Palm Street under the hinterland drainage improvement works had been completed;

Note 19: *Under the supplementary agreement of Contract B dated August 1996, the contractor was responsible for desilting of sections of the culvert that had not yet been issued with a partial completion certificate, and those sections issued with completion certificate but located adjacent to its drainage discharge point for which the contractor was also liable for removing the silt.*

Note 20: *The other contributing factors to the flooding events included heavy rainfall, inadequate drainage capacity and blockage of gullies by rubbish and construction waste. After the flooding events, the DSD stepped up preventive cleansing of the main drains and gullies, and requested other departments to step up inspection of construction sites and to take enforcement action against illegal dumping of construction waste. The HyD installed additional gullies and improved the gully system to prevent the ingress of rubbish at the flooding blackspots.*

(b) in August 1997, the DSD reported to the Works Bureau that, for the flooding along Nathan Road near the Prince Edward Road Mass Transit Railway station on 2 July 1997, the culvert, located downstream of Cherry Street (through the new reclamation), was not operating at its design capacity as it had yet to be desilted (Note 21); and

(c) **in December 1997, in his investigation report of the flooding incidents of 1997, Consultant C said that one of the causes of the flooding was the presence of a significant amount of silt in the main drainage system located downstream of Nathan Road. Based on divers' inspection reports, siltation levels which ranged from 30% to 40% at the Cherry Street culvert were recorded on 27 June 1997. The high siltation levels had significantly reduced the capacity of the trunk drains.**

Urgency of desilting works precluded the use of economical method

4.18 After the serious flooding events in West Kowloon, in early July 1997, the Secretary for Works convened a meeting with the DSD and the TDD to discuss preventive measures. It was agreed that all culverts in the West Kowloon Reclamation should be desilted as soon as possible to prevent flooding. Top priority should be given to desilting the main culvert located downstream of Cherry Street.

4.19 From June 1997 to March 1998, the DSD issued works orders to its term maintenance contractor to carry out the necessary desilting works. In October 1997, the Director of Drainage Services instructed that the desilting works should proceed at full speed for completion before the rainy season of 1998. The urgency of the works precluded the DSD's term maintenance contractor from employing the traditional method as prescribed in the term contract, or other economical desilting method which required a long lead time in preparation. The term maintenance contractor had to adopt a tailor-made desilting method, using divers and suction pumps so as to ensure the timely completion of the desilting works. In June 1998, the DSD accepted the term maintenance contractor's claim that such desilting works were a variation for which a new contract rate was applicable. After negotiation, in December 1999, the DSD and the term contractor finally agreed the rates for the desilting works. Based on the agreed rates, the cost of the desilting works was estimated to be $37 million. This was $26 million more than the estimated cost of $11 million if the original term contract rate had been used.

Audit observations on handing-over arrangements for new drainage works

Inadequate planning for handing over of new drainage works

4.20 At the planning stage of the new drainage works in the West Kowloon Reclamation, there was no agreement between the TDD and the DSD on the handing-over arrangements of the drainage works. Moreover, no provision was made in the construction works contracts for the maintenance of the completed sections of the drainage works to cater for the situation that the DSD

Note 21: *The DSD had consulted the TDD before the issue of the flooding report to the Works Bureau.*

would not take over the works for maintenance until they were fully completed or functional (see paragraph 4.3 above).

4.21 Audit noted that in 1997, the TDD considered that the handing-over arrangements could be improved if consultation between the TDD and the DSD was adequate at the planning stage. In August 1999, the TDD issued a technical memorandum emphasising the importance of adequate consultation with the DSD and of obtaining the DSD's agreement on handing-over arrangements at the planning stage of the works. Audit welcomes the TDD's positive action in this regard. Audit considers that all works departments should also learn from the experience in this case.

Monitoring the handing-over arrangements

4.22 Audit understands that the new drainage works were only part of the West Kowloon Reclamation project which was very large in scale. All the works contracts of this time-critical project had to be completed within a tight time schedule. The interface arrangements between various works contracts were very complex. The DSD informed the TDD and Consultant D of its taking-over requirements (see paragraph 4.4 above) in September 1993. At that time the TDD did not indicate any difficulties in meeting the DSD's requirements. Despite the DSD's further requests for confirmation of whether its requirements would be met, up to December 1994, the DSD had not received the TDD's confirmation. In the event, the TDD had difficulties in meeting the DSD's taking-over requirements. Audit considers that the TDD should have taken a more proactive role in overseeing the handing-over process and in liaising with the DSD to follow up the DSD's requirements first raised in 1993.

Delayed handing over of completed drainage works

4.23 ***Siltation problem due to lack of maintenance.*** Up to April 1997, the DSD had not yet taken over the six culverts constructed under Contract B. Due to the lack of maintenance, silt accumulated in some of these culverts. In March 1997, desilting works were finally ordered to meet the DSD's taking-over requirements. However, for the Cherry Street culvert, the desilting works could not be arranged in time for completion before the rainy season of 1997.

4.24 ***Flooding and high desilting costs.*** According to the DSD's reports about the two flooding incidents in Mong Kok of 4 June and 2 July 1997, the flooding occurred because the Cherry Street culvert could not operate at its design capacity as it had yet to be desilted (see paragraph 4.17(b) above). To reduce the risk of further flooding, urgent desilting works were arranged for all the culverts in the West Kowloon Reclamation using an expensive method. **The estimated cost of the desilting works was $26 million more than that if the original contract rate had been used.**

4.25 ***Resolution of interdepartmental works issues.*** Audit considers that the delayed handing over of completed drainage works in the West Kowloon Reclamation highlights the need for a more structured approach to resolving interdepartmental works issues. From 1994 to early 1997, the DSD, the TDD and NAPCO were unsuccessful in trying to resolve the handing-over problem themselves. No finite period was agreed for resolving the handing-over problem, beyond which an approach to SCACP would have to be made. In the event, the assistance of the SCACP was not sought.

4.26 In May 1998, the Works Bureau expressed concern that there were incidents of delay in the handing over of completed works. The Works Bureau issued a memorandum reminding all works departments experiencing difficulty in resolving interdepartmental disputes relating to the handing over of completed works should bring up the matter to the Works Bureau for resolution.

4.27 Audit considers that the Works Bureau's reminder to the works departments was timely and useful. Audit noted that there were also good practices for resolving interdepartmental works issues contained in the now defunct ACP project procedures. The salient point of these procedures was that interdepartmental works issues between different contracts should be assigned a finite period for resolution, as mutually agreed by the parties concerned. If a solution could not be reached within the stipulated period, the case should be referred to an appropriate higher level for a timely decision.

Audit recommendations on handing-over arrangements for new drainage works

4.28 **Audit has *recommended* that the Secretary for Works should:**

(a) **remind all works departments to monitor closely the planning of works to ensure that there is adequate consultation among the parties concerned about the arrangement for handing over of completed works;**

(b) **regularly remind all works departments of the need to monitor closely their works projects so as to ensure that interdepartmental issues, such as those concerning handing-over arrangement of completed works, are promptly resolved; and**

(c) **consider promulgating procedures, similar to those applicable to the Airport Core Programme projects, requiring:**

(i) **works departments to effectively coordinate with each other so as to resolve any interdepartmental works issues within a finite period; and**

(ii) **heads of works departments to report to the Works Bureau any unresolved issues among them so that concerted efforts can be made to promptly resolve the issues.**

Response from the Administration

4.29 The **Director of Territory Development** supports Audit's recommendations and has said that:

(a) adequate consultation should be made with the DSD on the handing-over arrangements in the planning and design stage of the works;

(b) the TDD should take a more proactive role in overseeing the handing-over process and liaising with the DSD; and

(c) if any interdepartmental work issues cannot be resolved at the departmental level, the case should be referred to a higher level for resolution and direction.

Concerning the discussion with the DSD on the taking-over requirement in 1994 as mentioned in paragraph 4.5 above, the Director of Territory Development has said that Consultant D and his site staff had numerous meetings with the DSD to discuss various matters. The TDD's staff involved at that time recalled that there were numerous dialogues and attempts to achieve a solution with the DSD. The fact that there was no written clarification on the taking-over requirements was due to the failure to reach a conclusive solution.

4.30 The **Secretary for Works** welcomes the audit recommendations and has agreed that all works departments should monitor closely their works projects so as to ensure that interdepartmental issues are promptly resolved. He has also said that he issued a circular memorandum in May 1998 to all works departments reminding them to strictly comply with the existing handing-over procedures for completed works as laid down in the Project Administration Handbook. The existing Lands and Works Branch Technical Circular No. 7/88 also provides guidance on managing and coordinating multi-disciplinary projects and on resolving interface and maintenance issues. To supplement the existing procedures, he will promulgate a new Works Bureau technical circular to remind works departments to resolve interdepartmental works issues at the earliest possible time. Any unresolved issues should be referred to a higher level, such as heads of departments and the Works Bureau, for an early resolution of the issues.

4.31 The **Secretary for the Treasury** has said that she endorses the action proposed by the Works Bureau and the relevant departments to improve inter-departmental communication in the handing over of completed works between departments. Failure to do so, in the case of the new drainage works in the West Kowloon Reclamation, had led to desilting costs which could otherwise have been avoided.

PART 5: MAINTENANCE OF URBAN ROAD DRAINAGE SYSTEM

5.1 This part examines the maintenance arrangement of the urban road drainage system. The audit has revealed that there is room for improvement in the coordination of emergency response to flooding events and in gully cleansing services of highways.

Organisational arrangements

5.2 A typical layout of an urban road drainage system is at Figure 6 on the centre pages. The DSD is responsible for the maintenance and management of all public stormwater drainage systems with the exception of those under other departments' responsibilities. The Food and Environmental Hygiene Department (FEHD) — formerly the Urban Services Department and the Highways Department (HyD) also play a significant role in maintaining specific components of the urban road drainage system. In general, the FEHD is responsible for clearing the refuse and silt trapped in the roadside gully pits. The HyD is responsible for the maintenance of gully pits and gully connection pipes. The Electrical and Mechanical Services Department (EMSD) provides maintenance services to the HyD for certain highway structures where pumps are used for drainage purposes.

5.3 On receipt of flooding complaints, the DSD would send an inspection team to the flooding spot to carry out remedial works to provide immediate relief to the flooding situation. Other relevant departments, including the HyD and the FEHD, would also respond to the flooding emergencies within their areas of responsibilities.

5.4 The present arrangement for the maintenance of different parts of the urban road drainage system calls for a high degree of coordination among departments concerned so that the whole drainage system is efficiently and effectively maintained to reduce the risk of flooding. There were incidents which showed that there was room for improvement in the coordination efforts among departments (see paragraphs 5.5 to 5.7 below) and in the deployment of staff resources to reduce the risk of flooding for highways (see paragraphs 5.8 to 5.21 below).

Flooding incident on West Kowloon Expressway

5.5 In the morning of 12 April 1999, a slip road of the Yaumatei Interchange of West Kowloon Expressway was flooded after a rainstorm. This slip road was one of the highways on which a pumping system was used for drainage purposes. Upon receipt of the flooding complaint referred by the Police Force, the DSD's maintenance staff arrived at the flooding spot around 7:10 a.m. They tried in vain to drain away the flood water. The flooding obstructed the peak hour traffic flow and caused a considerable traffic jam at the West Kowloon Expressway. An officer of the HyD who happened to pass by reported the incident to his office. The maintenance staff of the HyD and the EMSD arrived at 10 a.m. and found that the pump for draining floodwater was not

activated due to the failure of a sensor. The pump was then switched on manually and the flood water subsided in some 15 minutes. At a subsequent meeting among the DSD, the HyD, the EMSD and the Police Force, it was noted that **the DSD had no prior knowledge that the drainage system of the slip road had to be operated by a pumping system under the HyD's management. As a result, the DSD spent hours of futile efforts in attending to the flooding problem without seeking the HyD's assistance.** After the meeting, the HyD provided the DSD with a full list of roads and highway structures in the Kowloon region where pumps are needed to drain the stormwater and for which the HyD would be notified in the event of flooding.

Audit observation on the coordination of emergency response to flooding events

5.6 Audit noted that the HyD had not provided the DSD with lists of roadside drainage pumps for the Hong Kong and New Territories regions. Upon Audit's request, in late 1999, the HyD provided the DSD with similar information for the Hong Kong and New Territories regions.

Audit recommendation on the coordination of emergency response to flooding events

5.7 **To ensure an effective and efficient response to flooding events on roads, Audit has *recommended* that the Director of Highways should keep the DSD fully informed and updated on all newly built roads with special maintenance requirements so that the HyD would be able to give assistance in the event of flooding.**

Gully cleansing service

Operational arrangements for regular gully cleansing

5.8 Proper maintenance of the urban road drainage system is essential to ensure that the drainage system is functioning to its design capacity. The maintenance work includes routine inspection and cleansing. According to Works Bureau Technical Circular No. 8/2000 of March 2000, **the FEHD is responsible for regularly cleansing the roadside gully pits in connection with its street sweeping service, while the HyD is responsible for routine inspection and regularly cleansing the road drainage system, including the gully pits and the gully connection pipes** (Note 22).

Note 22: *In 1990, the division of work between the FEHD and the HyD was examined in the consultancy study for the development of the flood prevention strategy (see paragraph 1.3 above). It was considered that the FEHD should continue with the gully cleansing because road sweeping staff of the FEHD would otherwise be tempted to dump refuse into the gullies.*

5.9 The FEHD carries out roadside gully cleansing by means of either mechanical gully emptiers (Note 23) or manual labour. Mechanical gully emptiers are used for cleansing flyovers and fast traffic roads (hereinafter collectively referred to as highways) where manual cleansing is considered dangerous. Mechanical gully cleansing operations are mainly carried out at night time when the traffic is light (Note 24). Based on the FEHD's costing records of 1998-1999, Audit estimated that the total cost for the mechanical gully cleansing service at night was about $7.8 million a year. For other roads, manual labour is usually employed for cleansing the gullies as part of the normal street cleansing operation using portable equipment. In this review, Audit focussed on the mechanical gully cleansing at night because this is a dedicated operation for flood control. Comparison can be made with the HyD's cleansing of gully connection pipes which also uses a similar mechanical cleansing method.

FEHD's frequencies of mechanical gully cleansing of highways

5.10 According to the Environmental Hygiene Services Operational Manual (formerly the Cleansing Supervisory Staff Handbook) of the FEHD, the mechanical cleansing of gullies on highways should be carried out once in every six weeks (i.e. about eight times a year). Of the 122 highways covered by the mechanical gully cleansing programme, the FEHD follows the six-weekly cleansing cycle for 92 highways. For the remaining 30 highways, which have a single traffic lane or fast moving traffic, the FEHD cannot strictly follow the six-weekly cleansing cycle. The actual cleansing frequencies are two to three times a year.

5.11 The six-weekly cleansing cycle has been the established practice of the FEHD since late 1983. The following is a summary of the circumstances leading to the adoption of this cleansing cycle in 1983 and the subsequent development:

(a) before 1983, the FEHD's gully cleansing frequency for highways was four times a year. The frequency of cleansing was considered appropriate because there was hardly any pedestrian traffic and there was less litter on these highways;

(b) in 1983, the Highways Office of the then Engineering Development Department requested the FEHD to increase the frequency of cleansing gullies and to give priority to highways with frequent flooding complaints. Since September 1983, the FEHD has increased the frequency of cleansing **all** highways (except the 30 highways mentioned in paragraph 5.10 above) to the present level of once every six weeks; and

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Note 23: *A mechanical gully emptier is a specially designed vehicle, equipped with a powerful pump, to clear sludge from the gullies. A mechanical gully emptier is operated by a cleansing gang of five staff.*

Note 24: *At present there are seven mechanical gully cleansing routes, i.e. five for night operation and two for day operation. The two routes for day operation are to assist the district manual gully cleansing gangs to clear deep gully pits on a rotation basis.*

(c) in 1985, the Management Services and Audit Unit (MSAU) of the FEHD carried out a review of the mechanised cleansing service. The review found that two criteria existed for establishing the gully cleansing frequencies. The first criterion was the rate of accumulation of debris in the gullies. The second criterion was the risk of having stagnant water which promoted mosquitoes breeding (Note 25). The FEHD's operational staff was unable to specify what the mechanical gully cleansing frequencies should be and only relied on the established practice. (The Environmental Hygiene Services Operational Manual specified a six-weekly cleansing cycle but no reason was given for this.) **The MSAU's review found that a discrepancy existed between the cleansing cycle of once every six weeks and the actual requirement. There were indications that for some locations, the cleansing frequencies were too high. However, for some flooding blackspots identified by the HyD, they were not cleansed as often as they should have been. The MSAU recommended that in the long term, the accumulation of debris in the gullies should be measured so that the frequency of gully cleansing could be more accurately assessed. Although the FEHD management accepted the recommendation, no follow-up review of the frequency of cleansing was undertaken. The six-weekly cleansing cycle for the 92 highways has continued up to present.**

HyD's frequencies of gully cleansing of highways

5.12 According to the HyD's Maintenance Manual for Highway Structures, the frequency of cleansing the gully connection pipes for highways is four times a year. The cleansing requirement may be adjusted to suit the local condition. The actual cleansing frequencies, which are based on the results of the HyD's routine inspection of road drainage, vary from zero to nine times a year.

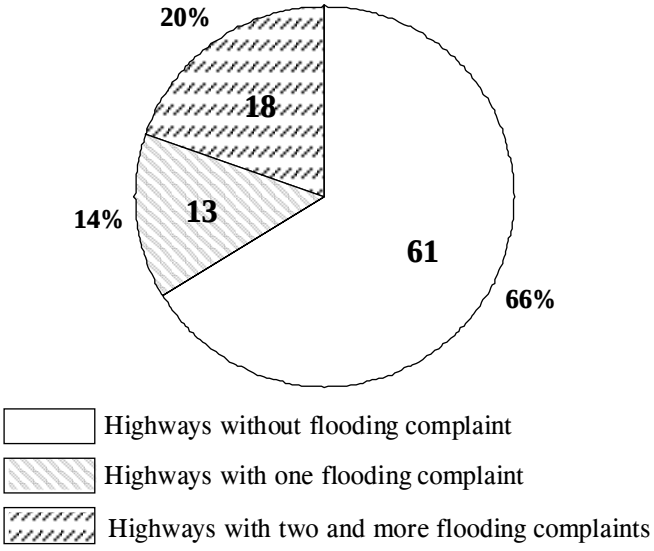
Flooding complaint statistics

5.13 Based on the flooding complaint records of the DSD and the HyD, Audit compiled statistics on the frequency of flooding complaints for the 122 highways from April 1997 to March 2000 (details at Appendix B). Bearing in mind that Hong Kong has experienced some very heavy rainstorms since 1997, these statistics provide useful information about the flood prone areas for these highways. The frequency of flooding complaints for the 92 highways cleansed by the FEHD at six-weekly interval, and that for the 30 highways cleansed by the FEHD two to three times a year (see paragraph 5.10 above) are shown in Figures 7 and 8 below respectively.

Note 25: *As mentioned in paragraph 5.11(b) above, the six-weekly cleansing cycle was introduced in 1983 for reducing the risk of flooding and not for pest control.*

Figure 7

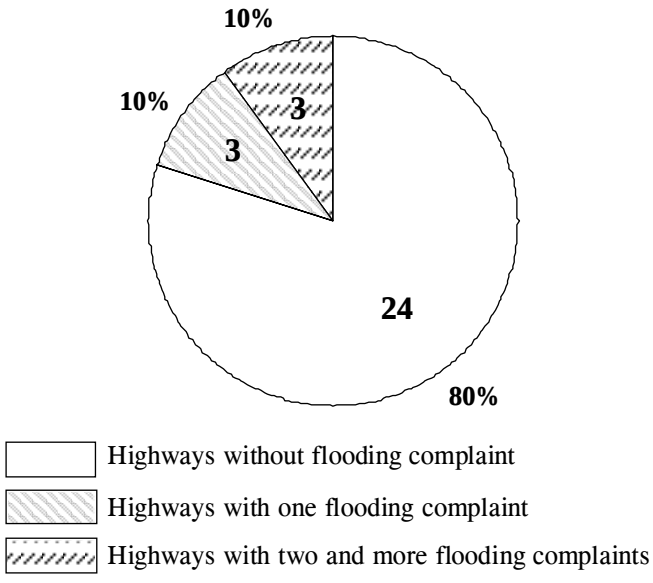
Frequency of flooding complaints from April 1997 to March 2000 for the 92 highways cleansed by the FEHD at 6-weekly interval



Source: Flooding complaint records of the HyD and the DSD

Figure 8

Frequency of flooding complaints from April 1997 to March 2000 for the 30 highways cleansed by the FEHD at 2-to-3-time-a-year interval



Source: Flooding complaint records of the HyD and the DSD

5.14 It can be seen from Figure 7 of paragraph 5.13 above that, of the 92 highways under the FEHD's six-weekly cleansing cycle, 61 highways (or 66%) did not have a single flooding complaint for three consecutive years. For these highways with no flooding complaints, it is questionable whether the six-weekly cleansing frequency is too high. For the remaining 31 highways with flooding complaints, 18 (or 20%) accounted for 85% of the total flooding complaints (see Appendix B). These figures suggest that the flood prone areas were concentrated in a small number of the highways for which the present rigid six-weekly cleansing cycle might not be adequate. These figures support the MSAU's observation in 1985 (see paragraph 5.11(c) above) that a discrepancy existed between the cleansing cycle of once every six weeks and the actual requirement.

5.15 A comparison of Figures 7 and 8 of paragraph 5.13 above provides further evidence that the FEHD's six-weekly cleansing frequency could be too high for those highways with no flooding complaints in three consecutive years. This is because, even under a lower frequency of cleansing of two to three times a year, 80% of the highways did not have a flooding complaint (see Figure 8 above). Similarly, for those highways cleansed under a six-weekly cleansing cycle, 66% of them did not have a flooding complaint (see Figure 7 above).

Audit observations on FEHD's frequencies of mechanical gully cleansing of highways

5.16 **In 1985, in its review of the mechanised cleansing services, the MSAU of the FEHD raised concern that a rigid six-weekly gully cleansing frequency was too high for some highways but was too low for some blackspots identified by the Highways Office (see paragraph 5.11(c) above).** The MSAU recommended a review of the gully cleansing frequency. However, a review of the gully cleansing frequency had not yet been carried out.

5.17 Based on an analysis of the flooding complaint statistics, Audit found that the present six-weekly gully cleansing frequency was too rigid and unsatisfactory. The six-weekly cleansing frequency was high because 61 highways (or 66%) did not have a single flooding complaint in the past three consecutive years (see paragraph 5.14 above). Flooding complaints were concentrated in a few highways. Furthermore, the statistics showed that highways having a lower frequency of cleansing did not have more flooding complaints than those having the six-weekly cleansing cycle. **This finding further suggests that the six-weekly cleansing frequency is too high for those highways which have had no flooding complaints for the past three consecutive years.**

5.18 Audit also examined the HyD's frequencies of cleansing gully connection pipes of the 92 highways for which the FEHD has applied a six-weekly cleansing cycle. Audit noted that the HyD applied the six-weekly cleansing cycle to only one of the 92 highways, having regard to the result of routine inspection of the road drainage. For the remaining 91 highways, the HyD applied a lower frequency of cleansing. Audit considers that the HyD's flexibility in gully cleansing sets a good example of the optimal deployment of staff resources to reduce the risk of flooding.

5.19 Audit understands that the FEHD has planned to contract out the mechanical gully cleansing service by 2000-2001. Based on the FEHD's plan of April 1999, the stipulated frequency of cleansing for the contractor would be once in every six weeks as at present. Audit considers that the FEHD should take urgent action to review the frequency of gully cleansing and to ascertain the actual requirement before finalising the contracting-out arrangements.

Audit recommendations on FEHD's frequencies of mechanical gully cleansing of highways

5.20 **Audit has *recommended* that the Director of Food and Environmental Hygiene should:**

(a) **urgently carry out a critical review of the frequency of gully cleansing of highways at night to ascertain the actual requirement before finalising arrangements for contracting out the service; and**

(b) **in carrying out the review, make due reference to the flooding complaint statistics and draw on the HyD's experience so as to devise an optimal cleansing schedule and reduce cost.**

5.21 **As a long-term measure to assist the Director of Food and Environmental Hygiene in carrying out periodic reviews of the gully cleansing frequencies in future, Audit has *recommended* that the Director of Drainage Services and the Director of Highways should supply the FEHD with statistics of flooding complaints on a regular basis.**

Response from the Administration

5.22 The **Director of Food and Environmental Hygiene** has said that she agrees with the audit recommendations mentioned in paragraph 5.20 above.

5.23 The **Director of Drainage Services** supports the audit recommendation mentioned in paragraph 5.21 above. He has said that joint departmental meetings are held frequently in each administrative district to discuss the flooding problems and to improve the mutual cooperation on resolving the problems. The supply of flooding complaint statistics can be included as an agenda item in these meetings.

5.24 The **Secretary for Works** welcomes the audit recommendation mentioned in paragraph 5.21 above and has agreed that the communication among the FEHD, the DSD and the HyD should be improved such that the Director of Food and Environmental Hygiene can make reference to the flooding complaint statistics so as to devise an optimal cleansing schedule to meet the actual requirement.

Appendix A
(Note 3 of
paragraph 2.6 refers)

Equivalent rainfall intensities for a 60-minute rainstorm of various return periods

Rainstorm of various return periods	**Equivalent rainfall intensity** (Note) **(mm/hour)**
A once-in-two-hundred-years rainstorm	156
A once-in-fifty-years rainstorm	132
A once-in-twenty-years rainstorm	116
A once-in-ten-years rainstorm	103

Source: *The Stormwater Drainage Manual*

Note: *Under the rainstorm warning system in Hong Kong, rainfall intensities exceeding 30 mm/hour, 50 mm/hour and 70 mm/hour correspond to amber, red and black signals respectively.*

Appendix B
(paragraphs 5.14 and 5.15 refer)

Flooding complaint statistics for 92 highways cleansed by the FEHD at six-weekly interval April 1997 to March 2000

Frequency of complaint	Number of highways involved	Percentage of total highways involved	Total number of complaints	Percentage of total complaints
0	**61**	**66%**	N.A.	N.A.
1	13	14%	13	15%
2 or more	**18**	**20%**	**76**	**85%**
Total	**92**	**100%**	**89**	**100%**

Source: Flooding complaint records of the HyD and the DSD

Flooding complaint statistics for 30 highways cleansed by the FEHD at two-to-three-time-a-year interval April 1997 to March 2000

Frequency of complaint	Number of highways involved	Percentage of total highways involved	Total number of complaints	Percentage of total complaints
0	**24**	**80%**	N.A.	N.A.
1	3	10%	3	23%
2 or more	3	10%	10	77%
Total	**30**	**100%**	**13**	**100%**

Source: Flooding complaint records of the HyD and the DSD

Chronology of key events

Drainage improvement works for West Kowloon

June 1994	The DSD commissioned Consultant A to carry out a Drainage Master Plan study entitled WKS for West Kowloon.
November 1995	The DSD accepted the final report of the WKS which recommended a three-staged drainage improvement works at an estimated cost of $2.5 billion.
April 1996	The DSD appointed Consultant B to carry out detailed design for stage 1 works.
April 1997	The DSD submitted the final performance report of Consultant A to the EACSB.
June 1997	The Finance Committee approved the upgrading of the stage 1 works to Category A of the Public Works Programme at an approved project estimate of $464 million.
June 1997	The DSD appointed Consultant C to carry out detailed design for the stage 2 works.
September 1997	Consultant C found that there was omission of flow data in the hydraulic model of the WKS and that the risk of potential overflow from the Kowloon group of reservoirs had not been catered for.
March 1998	The DSD instructed Consultant C to re-run the Drainage Master Plan study for West Kowloon.

August 1998	Consultant C recommended a revised drainage improvement strategy for West Kowloon. The strategy included the Kai Tak Transfer Scheme and the Tai Hang Tung Flood Storage Scheme for resolving the flooding problem in Mong Kok, and the Lai Chi Kok Transfer Scheme for addressing the risk of overflow from the Kowloon group of reservoirs.
January 1999	The DSD considered that it might be prudent to rectify the EACSB's record to reflect further information about Consultant A's performance in the WKS.
May 1999	The LegCo Panel on Planning, Lands and Works was informed of the revised drainage improvement strategy for West Kowloon.
June 1999	The Finance Committee approved the upgrading of the stage 2 phase 1 works to Category A at an approved project estimate of $1,762.9 million.
September 1999	Audit found that there were some errors and discrepancies in the hydraulic models for the design of the Tai Hang Tung Flood Storage Scheme. The design criteria were not fully met.
October 1999	Based on the revised hydraulic model files supplied by the DSD, Audit found that there was improvement in the performance of the drainage system after the proposed flood control schemes but the design criteria were still not fully met. The DSD was informed of the Audit findings and recommendations.
November 1999	The DSD informed Audit that Consultant C had revised the design for the Tai Hang Tung Flood Storage Scheme. The latest hydraulic model results showed an improvement in hydraulic performance.
June 2000	The Finance Committee approved the upgrading of the stage 2 phase 2 works and part of the stage 3 works to Category A at an approved project estimate of $1,767.2 million.

Maintenance of drainage works

1983	In response to the Highways Office's request for stepping up the mechanical gully cleansing frequency for highways with many flooding complaints, the USD adopted a six-weekly cleansing frequency for all the highways.
1985	The FEHD found in a management service review that the six-weekly gully cleansing frequency for highways could not match with the actual cleansing requirements.
1990	The TDD consulted the DSD about the design of new culverts in West Kowloon Reclamation under Contract A.
1992	The TDD consulted the DSD about the design of new culverts in West Kowloon Reclamation under another contract, Contract B.
September 1993	The DSD informed the TDD and Consultant D of the taking-over requirements for culverts under Contract B.
November/ December 1993	The DSD urged the TDD and Consultant D to clarify the taking-over requirements.
December 1994	The DSD reminded the TDD and Consultant D that their clarification of the taking-over requirements was still awaited.
January 1995	The TDD raised concern over difficulties to meet the DSD's taking-over requirements.
February 1996	NAPCO expressed concern over the risk of flooding in the West Kowloon area due to gradual accumulation of silt in the new culverts.
April 1996	NAPCO, the TDD and the DSD agreed to further discuss the handing-over problems without seeking the directive of the SCACP.

January 1997	NAPCO expressed concern over little progress made in arranging for the desilting works.
February 1997	Based on a survey conducted by the TDD's Chief Resident Engineer, the siltation level of the Cherry Street culvert was high, ranging from 9% to 31%.
March 1997	Consultant D instructed the contractor of Contract B to desilt the culverts in the West Kowloon Reclamation.
April 1997	No desilting works were carried out for the Cherry Street culvert because of the expiry of the maintenance period of Contract B.
June 1997	The DSD reported to the Works Bureau about the serious flooding incident of 4 June 1997 in West Kowloon.
July 1997	The Works Bureau agreed that all culverts in the West Kowloon Reclamation should be desilted. Top priority should be given to desilting the main culverts located downstream of Cherry Street.
August 1997	The DSD reported to the Works Bureau about the serious flooding incident of 2 July 1997 in West Kowloon.
October 1997	The Director of the Drainage Services instructed that the desilting works should proceed at full speed for completion before the end of the dry season.
June 1998	The DSD accepted the contractor's claim that the desilting works were a variation to the term maintenance contract for which new rates were applicable.
December 1999	The DSD agreed with the term maintenance contractor the rates for the desilting works of all West Kowloon Reclamation culverts.

Appendix D

Acronyms and abbreviations

ACP	Airport Core Programme
ADSCOM	Airport Development Steering Committee
DSD	Drainage Services Department
EACSB	Engineering and Associated Consultants Selection Board
EMSD	Electrical and Mechanical Services Department
FEHD	Food and Environmental Hygiene Department
Ha	Hectares
HyD	Highways Department
LegCo	Legislative Council
m^3	Cubic metres
MPD	Metres principal datum of Hong Kong
MSAU	Management Services and Audit Unit
NAPCO	New Airport Projects Coordination Office
PWSC	Public Works Subcommittee
SCACP	Subcommittee of the ADSCOM of the ACP
SDM	Stormwater Drainage Manual
TDD	Territory Development Department
WKS	West Kowloon Stormwater Drainage Improvement Study
WSD	Water Supplies Department