



Environmental Protection Department
環境保護署

**Agreement No. CE 37/2006 (DS)
Review of West Kowloon and Tsuen Wan
Sewerage Master Plans - Feasibility Study**

Executive Summary

April 2010



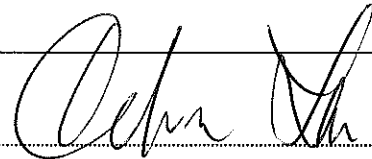
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Executive Summary

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Report Authorized For
Issue By:



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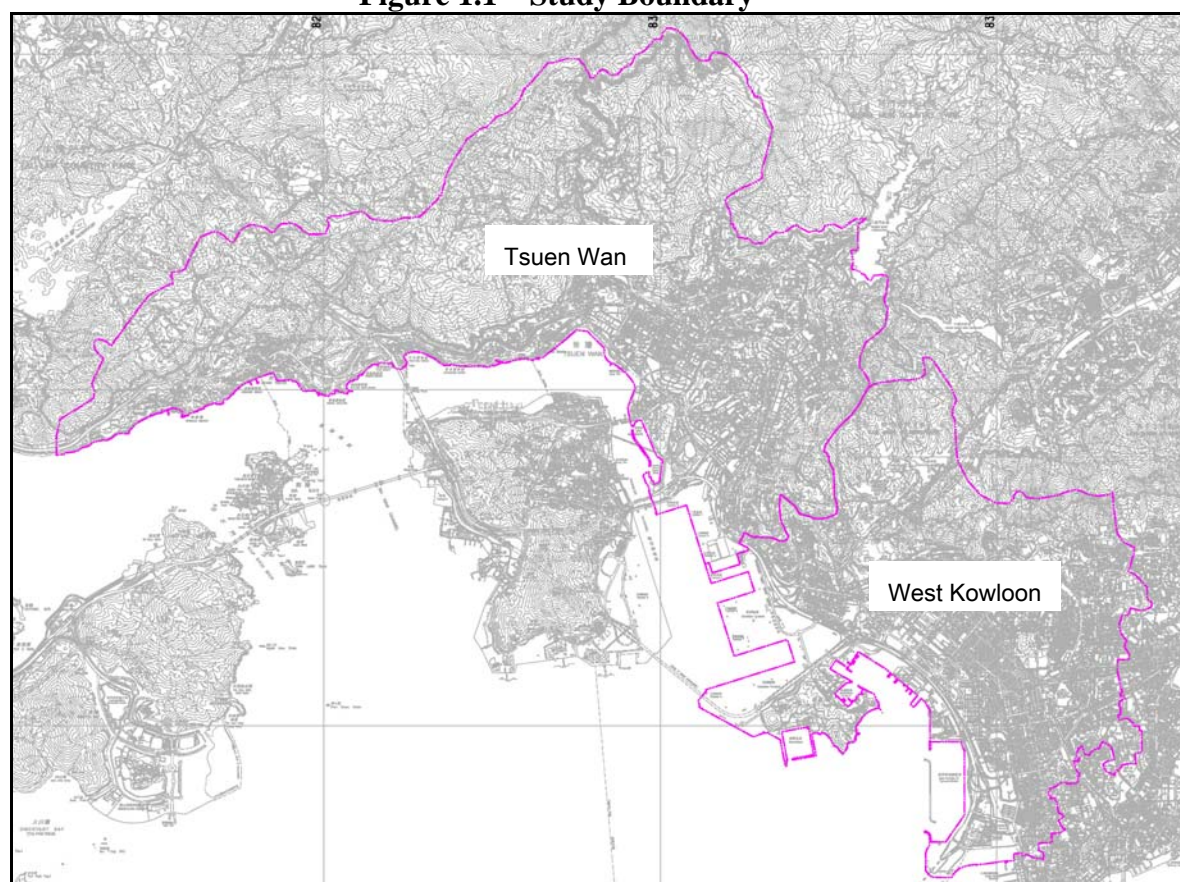
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1. INTRODUCTION

1.1 Background

- 1.1.1 Black & Veatch Hong Kong Limited (B&V) was commissioned by the Environmental Protection Department (EPD) of the Hong Kong Special Administrative Region in February 2007 to carry out a feasibility study to review the West Kowloon and Tsuen Wan Sewerage Master Plans (SMPs). The Study Boundary is provided in **Figure 1.1**.

Figure 1.1 – Study Boundary



- 1.1.2 Since completion of the previous SMP studies in the early 1990s, considerable changes, including alteration on economical structure, redevelopments of old residential or commercial areas, new residential developments, introduction of major new developments, such as the West Kowloon Cultural District, have been taking place in the Study Area.
- 1.1.3 Despite progressive completion of sewerage works, signs of pollution persist in the stormwater drainage system, coastal water and beaches. The water quality in the Study Area does not fully comply with the Water Quality Objectives, as established by EPD, for many years. As a result, the establishment of appropriate sewage infrastructure provisions, new strategies to tackle stormwater pollution and a review of the sewerage

system and sewage treatment facilities have been deemed necessary to cater for the future population growth within the Study Area.

- 1.1.4 This Executive Summary provides an overview of tasks that had been completed under the Review of West Kowloon and Tsuen Wan Sewerage Master Plans – Feasibility Study. In addition, a summary of findings and recommendations of proposed works, along with a prioritised implementation programme and cost estimates are provided.

1.2 Objectives of the Study

- 1.2.1 The aim of the Study is to provide a sewerage master plan (SMP) for the progressive improvement of the existing wastewater collection and disposal systems in West Kowloon and Tsuen Wan. In addition, this project also aims to investigate and assess the water pollution in the Study Area. The main objectives of the Study are listed below:

- a. To collate and review planning and development information to build-up sewage flows and pollution loads in the Study Area;
- b. To investigate and assess the integrity of the existing sewerage systems, particularly for the foul system in Old Urban Tsuen Wan area, and recommend mitigation measures;
- c. To assess the adequacy of the existing and planned sewerage systems and sewage treatment and disposal facilities in the Study Area;
- d. To investigate, identify and assess the water pollution problems and the associated odour problems in the stormwater drainage system and coastal water bodies in the Study Area; and to identify and recommend mitigation measures so that the Water Quality Objectives (WQOs) can be met and sensitive uses of the water bodies can be sustained;
- e. To review sewerage provision to unsewered areas;
- f. To develop a new Sewerage Master Plan for the provision of adequate sewerage, sewage treatment and disposal facilities; and
- g. To develop Geographic Information System (GIS) and InfoWorks hydraulic model of the existing and planned/recommended sewerage systems.

2. LAND USE AND POPULATION

2.1 Background

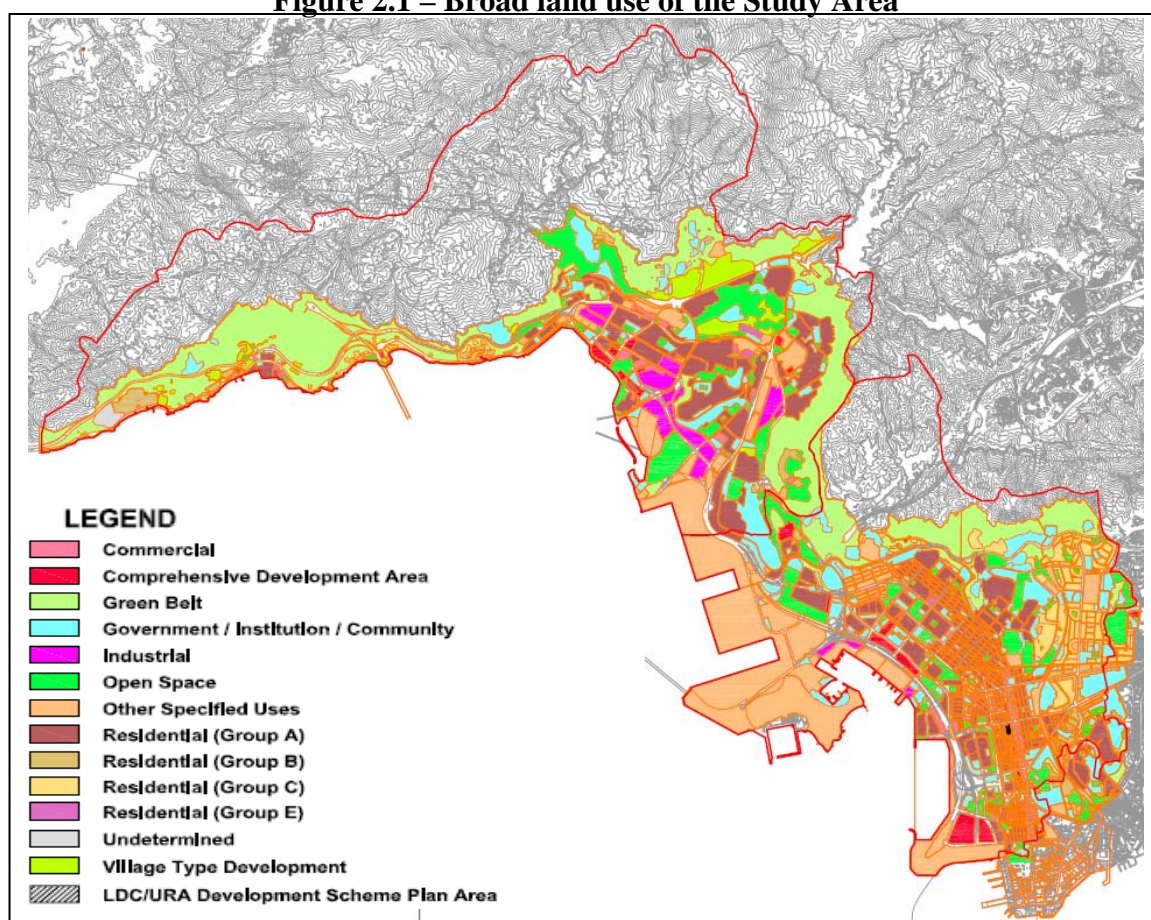
2.1.1 The Study Area comprises a total of approximately 67.2 km². Sewage generated within the study area is collected by Harbour Area Treatment Scheme (HATS), with an exception of areas in Ting Kau, Sham Tseng and Tsing Lung Tau, in which sewage is conveyed to Sham Tseng Sewage Treatment Works for treatment prior to discharge via a submarine outfall.

2.2 Broad Land Uses

2.2.1 The broad pattern of existing land use in the Study Area is illustrated in **Figure 2.1**. The area is dominated by residential land uses interspersed with large pockets of Government, Institution and Community (GIC) uses.

2.2.2 The central area of West Kowloon and Tsuen Wan is dominated by urban development. However, urban development is interrupted in the north with large tracts of steeply sloped land zoned “Green Belt” (GB).

Figure 2.1 – Broad land use of the Study Area



- 2.2.3 The study area is part of the densely-populated areas in Hong Kong with mixed land use of residential, commercial, and industrial area. The major economic activities in Yau Tsim Mong district are commerce, supplemented by tourism and light manufacturing.
- 2.2.4 A comprehensive, bottom-up approach, as agreed by the Planning Department, is adopted to derive population for the Study Area in the years of 2006, 2011, 2016, 2021, 2030 and the ultimate development scenarios (UDS). The figures in the base year 2006 represent the existing population and employment with the Study Area. Based on the base year data and relevant control total figures, the population estimation for the design scenarios will be allocated pro-rata to each street block, as well as individual buildings. For the ultimate scenario, it is assumed that all developments will be developed/re-built with maximum intensity, i.e. maximise the permissible domestic and non-domestic gross floor area (GFA) stipulated under the OZPs.
- 2.2.5 The West Kowloon catchment covers approximately 25.6 km² with a population and employment figures of 749,422 and 434,399 in the year of 2006, respectively. Sewage generated from the West Kowloon catchment is collected at the Cheung Sha Wan Sewage Pumping Station (SPS), and subsequently discharged to Stonecutter Island Sewage Treatment Works (SCISTW).
- 2.2.6 The Tsuen Wan catchment covers approximately 41.6 km², with a population and employment figures of 593,708 and 314,476 in the year of 2006, respectively. Sewage generated from the Tsuen Wan catchment is collected and discharged into Kwai Chung Primary Treatment Works at Kwai Yu Street and conveyed to SCISTW via the sewage conveyance system. Sewage generated from Ting Kau, Sham Tseng and Tsing Lung Tau is conveyed to Sham Tseng Sewage Treatment Works for treatment and disposal.
- 2.2.7 The total population and employment figures for the six development scenarios are summarized in **Table 2.1** and as shown in **Figures 2.2 and 2.3**.

Table 2.1 Development Scenarios

Broad Area	2006		2011		2016	
	Population	Employment	Population	Employment	Population	Employment
West Kowloon	749,422	434,399	841,640	485,720	916,502	515,131
Tsuen Wan	593,708	314,476	613,096	360,909	607,697	382,059
Sub-total	1,343,130	748,875	1,454,736	846,629	1,524,198	897,190
Total	2,092,005		2,301,365		2,421,388	

Broad Area	2021		2030		UDS	
	Population	Employment	Population	Employment	Population	Employment
West Kowloon	941,116	518,359	899,528	511,664	1,258,350	661,172
Tsuen Wan	604,301	372,738	612,364	326,013	794,371	558,277
Sub-total	1,545,417	891,097	1,511,892	837,677	2,052,721	1,219,449
Total	2,436,514		2,349,569		3,272,170	

Figure 2.2 – Total Population and Employment Figures in West Kowloon

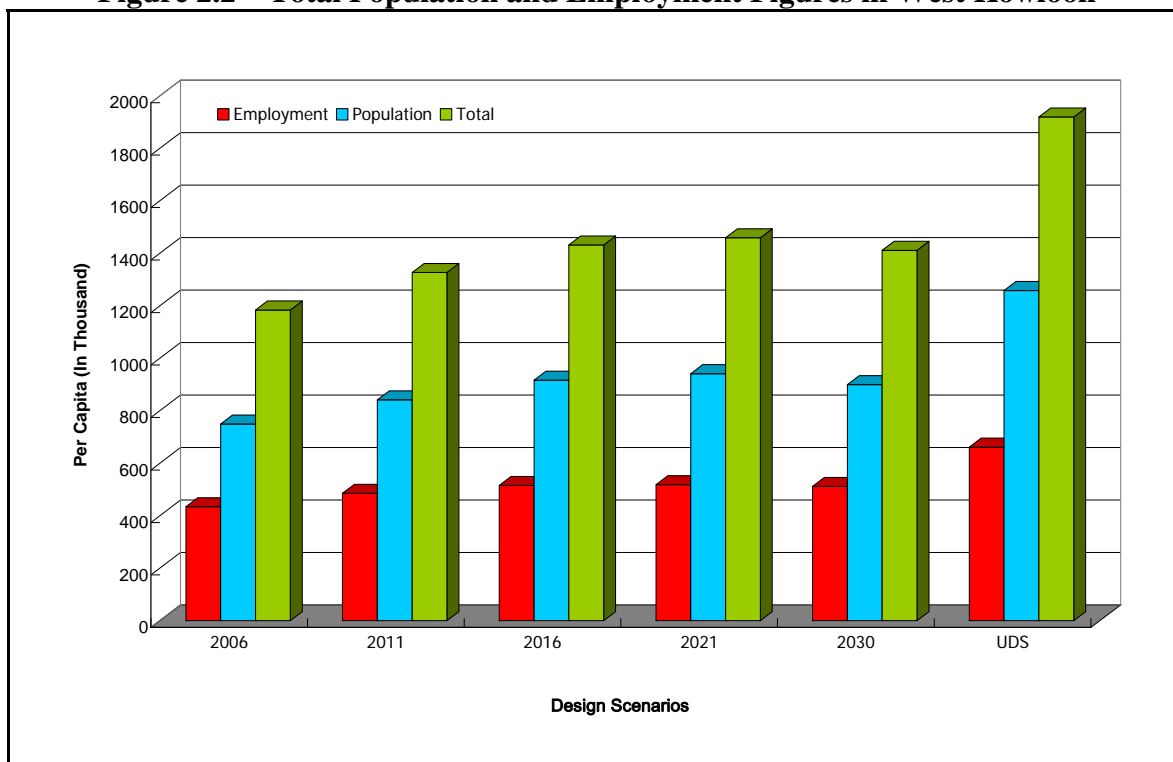
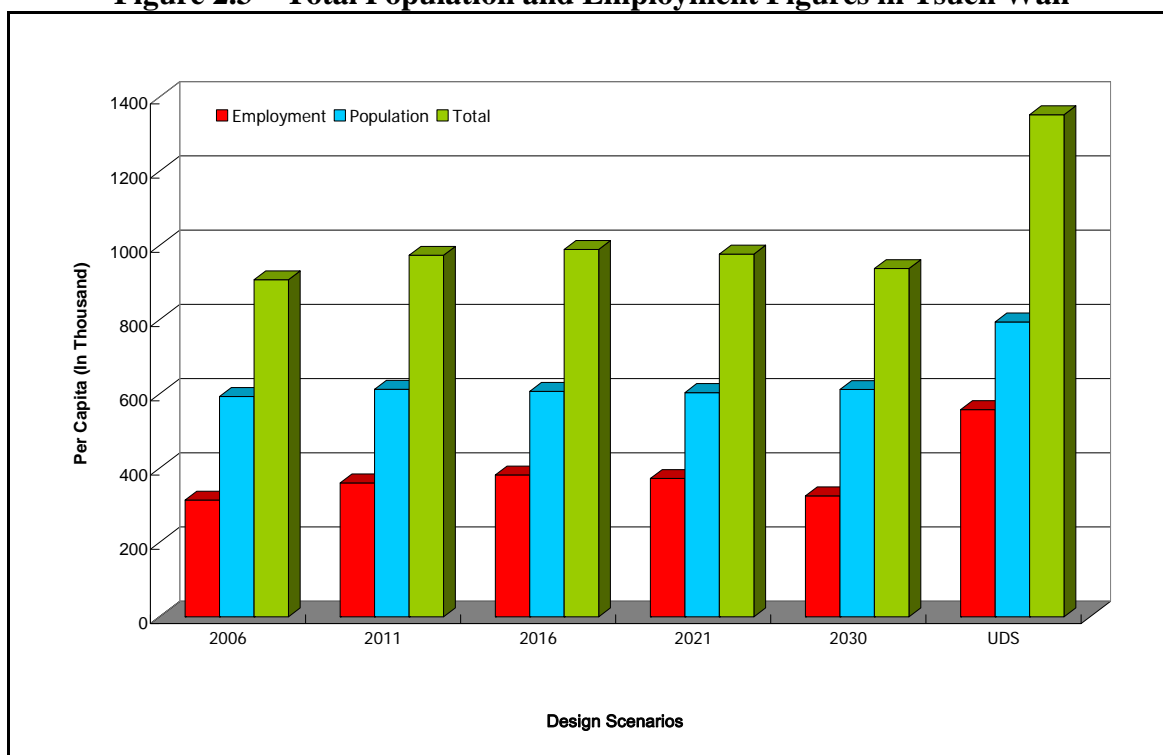


Figure 2.3 – Total Population and Employment Figures in Tsuen Wan



3. FINDINGS OF FIELD INVESTIGATION SURVEY

3.1 Introduction

3.1.1 Field investigation and surveys were carried out to assess physical conditions of the sewerage and stormwater drainage systems, as well as to provide data for flow assessment and hydraulic modelling. The types of site investigation and surveys are listed below:

- Rainfall survey;
- Flow monitoring survey;
- Manhole, CCTV, and man-entry survey;
- Inflow and infiltration surveys;
- Discrete water sampling and pollution load survey; and
- Walkover survey.

3.2 Rainfall Survey

3.2.1 A total nos. of 16 rain gauges were installed in early September 2007 to identify days with and without recorded rainfall events for verification and calibration of the hydraulic model.

3.3 Flow Monitoring Survey

3.3.1 Flow monitoring survey was carried out in 5 phases at 96 strategic locations over periods ranging from 1 week to 6 months in order to investigate the flow condition of dry weather and wet weather flows in the sewerage and/or stormwater drainage systems. Diurnal profiles of sewage flow from different land use types are also established.

3.3.2 Flow monitors are installed to assess operational performance of the existing DWFIs in West Kowloon. The monitoring results indicated that the interception efficiency is considered low (<40%). Tidal influence and debris accumulation are the two major reasons, leading to their low efficiency.

3.4 Manhole, CCTV, Dye-Tracing and Man-entry Survey

3.4.1 Manhole survey is carried out to obtain supplementary information for update of the hydraulic model. Expedient connections (ECs) and surcharge manhole can also be identified by manhole survey. The sewerage and stormwater drainage systems in the Study Area contain approximately 8,679 and 4,693 manholes in West Kowloon and Tsuen Wan, respectively. In total, manhole surveys were carried out at 6,338 nos. of manholes in the Study Area, in which 5,338 and 1,000 manholes were located in West Kowloon and Tsuen Wan, respectively.

3.4.2 Based on site inspection, ECs are mainly located in old residential areas while manhole surcharges often occur in the 150mm sewers along rear lanes where local restaurants are located.

- 3.4.3 Dye Tracing tests are carried out to assess the connectivity between the stormwater drainage and sewerage systems. 8 nos. of cross-connections were identified during the site investigation owing to existence of uncharted linkage pipes and/or system defects.

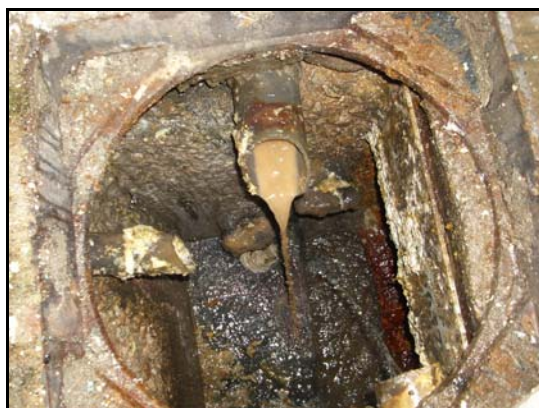


Photo 1 – Example of ECs in storm drain manhole in Tsuen Wan



Photo 2 – Example of ECs in storm manhole in West Kowloon



Photo 3 – Cross connection between stormwater drainage and sewerage systems (Fu Yung Street in Tsuen Wan)

- 3.4.4 A total length of 4,231m sewer / stormwater drainage pipes were surveyed by CCTV, however, only 1,668m, about 40%, were surveyed successfully due to site constraints. Most of the sewers are classified as non-critical sewers. Rehabilitation for these sewers is not recommended as it is anticipated to be cost ineffective, unless numerous failures occur in a very confined area.



Photo 4 – General View of Sewer during CCTV Survey

- 3.4.5 Some ECs or cross connections are constructed in the middle of sewer between manholes and cannot be easily located by manhole surveys or dye tracing tests. Therefore, CCTV surveys were used to identify the exact location.



Photo 5 – Cross connection identified by CCTV method

- 3.4.6 Manhole entry surveys were carried out in box culverts to identify location of cross connections. In addition, water sampling was carried out at the branches along the box culvert to assess the upstream pollution loading.



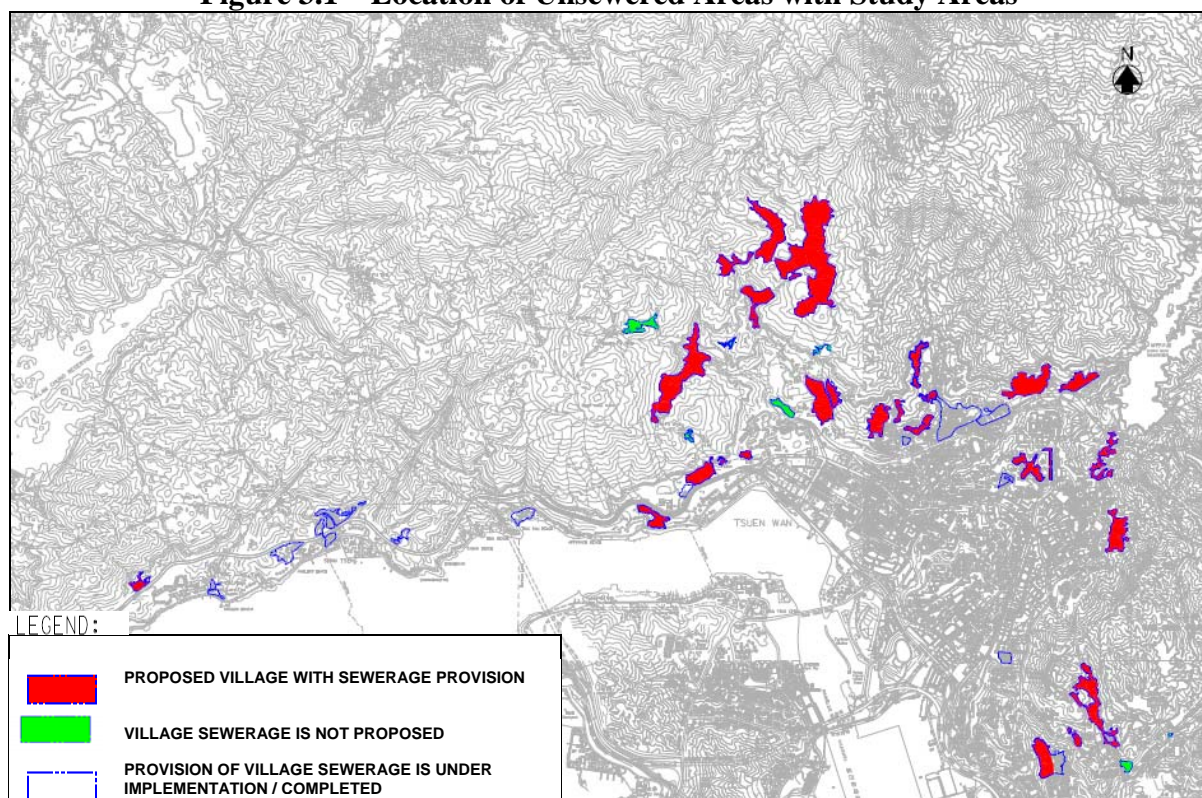
Photo 6 – Water sampling at the branch along the Box Culvert

3.5 Discrete water sampling and pollution load survey

- 3.5.1 Water sampling results demonstrated that water pollution is an area-wide problem in West Kowloon, while the water pollution sources in Tsuen Wan are relatively localised. The contribution proportion from the pollution sources of cross connections, ECs and non-point sources are approximately 40%, 30% and 30%, respectively.
- 3.5.2 Pollution in the stormwater drainage system in Hong Kong has been a long running problem. Dry weather flows enter into the stormwater drainage system through various pathways. Based on results from the site investigation and surveys, the various pollution sources are classified into the following categories:
- Existence of connection pipe diverting partial flow from sewerage system to stormwater drain system;

- b. Expedient connections from buildings to adjacent stormwater drainage manhole;
 - c. Connection from buildings' foul terminal manhole to stormwater drainage manhole;
 - d. Pipe and/or manhole defects in sewerage/storm drainage system; and
 - e. Sewage discharge from unsewered areas.
- 3.5.3 Other non-point sources include rear-lane activities, temporary discharge from construction site, etc. Although each of these non-point sources contribute less significant pollution to the receiving waters, these sources are often difficult to locate and tackle.
- 3.5.4 Water sampling was also carried out in the unsewered areas (see **Figure 3.1**), and the Tsuen Wan beaches. The water sampling results are used to prioritize unsewered villages for provision of public sewerage.

Figure 3.1 – Location of Unsewered Areas with Study Areas



4. HYDRAULIC MODELLING

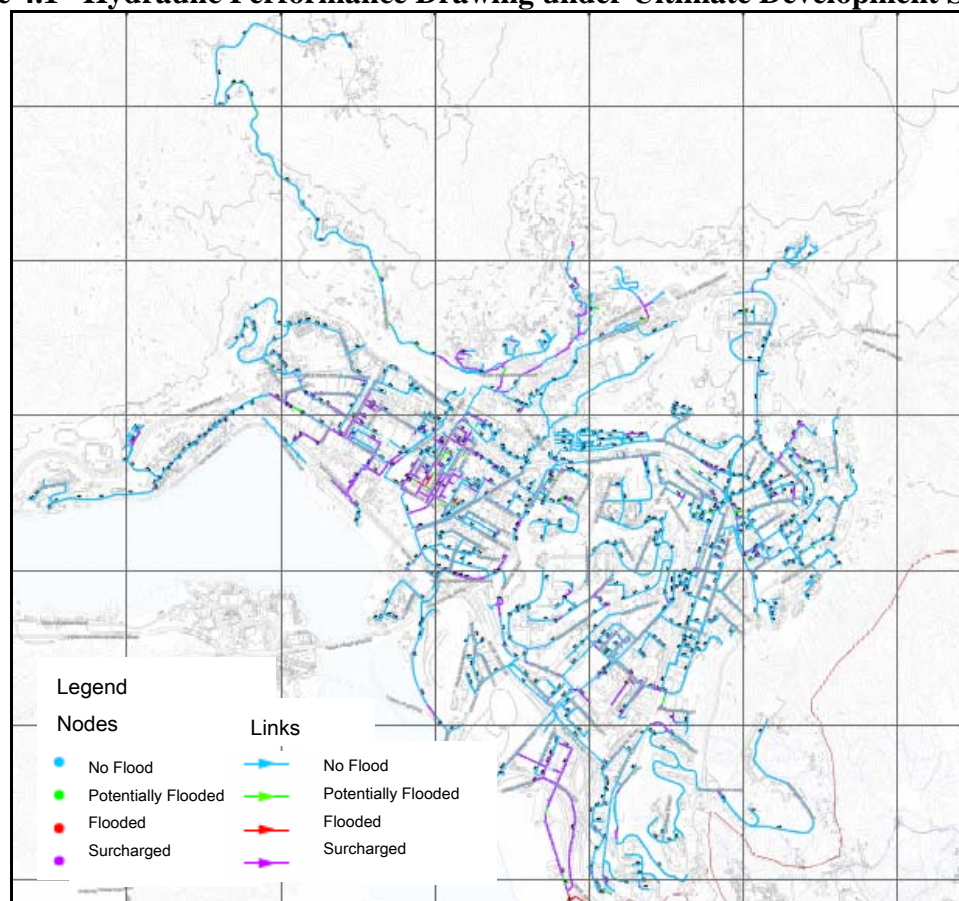
4.1 Introduction

- 4.1.1 A hydraulic model had been developed for assessment on adequacy of the sewerage system under the various design horizons, including years 2006, 2011, 2016, 2021, 2030 and the ultimate development. The hydraulic performance due to changes in existing and future sewage flows within the study area is examined.
- 4.1.2 InfoWorks CS version 8.0 was adopted for the purpose of hydraulic modelling under this Study. Two hydraulic models had been built, each representing the two main catchments of Tsuen Wan and West Kowloon.
- 4.1.3 The hydraulic model had adopted unit flow factors for future design scenarios as established in accordance with EPD's Guidelines for Estimating Sewage Flows for Sewage Infrastructure Planning. In addition, the model had been fully verified and calibrated in accordance with Guidelines for Model Verification set out in Water Research Centre's (WRC) Code of Practice for the Hydraulic Modelling of Sewer Networks for both dry weather condition and storm event.

4.2 Hydraulic Assessment

- 4.2.1 Three criteria have been used for assessment of the sewerage system:
- a) Flooded – where sewage floods out of the manhole;
 - b) Potentially Flooded – where the top water level is less than 500 mm below the cover level and hence, due to accuracy of the model, may possibly be flooded;
 - c) Surcharged – where the sewer is surcharged but the top water level is more than 500mm below the cover level and hence flooding is unlikely.
- 4.2.2 Based on results from the hydraulic models, most sewerage and sewage treatment facilities in the Study Area have demonstrated adequate capacity to cater for the anticipated sewage flows under the various future design scenarios, with the exception of Sham Tseng Sewage Treatment Works. Sewerage improvement works are recommended for approximately 5% and 10% of local sewers in Tsuen Wan and West Kowloon, respectively.
- 4.2.3 An example of the hydraulic performance drawing under the ultimate development scenario for Tsuen Wan is provided in **Figure 4.1**.

Figure 4.1 –Hydraulic Performance Drawing under Ultimate Development Scenario



5. SEWERAGE MASTER PLANNING

5.1 Sewerage Master Plan for Tsuen Wan

5.1.1 A summary of short term proposed works to address the adequacy of the sewerage system and water pollution of the stormwater drainage system in Tsuen Wan is listed as follows:

- Sewer Upgrade;
- Rectification of cross connections;
- Provision of 4 numbers of Dry Weather Flow Interceptors;
- Rectification of identified expedient connections;
- Replacement of 150mm diameter sewers by 225 mm diameter sewers;
- Desilting of sediments in the box culverts;
- Provision of temporary sewage collection systems for unsewered areas;
- Provision of UV disinfection system at selected drainage outlet in Tsuen Wan beaches;
- Provision of odour removal system, as a pilot scheme at Ma Tau Pa Road Box Culvert;
- Provision of internal lining at sewer crossings; and
- Implementation of water quality monitoring programme for the box culverts.

5.1.2 A summary of long term proposed works in Tsuen Wan is listed as follows:

- Provision of biofilm streamer system at Ma Tau Pa Road Box Culvert pending on results from the pilot scheme at DSD Container Port Road Maintenance Port of Cheung Sha Wan;
- Provision of penstock as dry weather flow interceptor at Tai Ho Road and other box culverts pending on results from the pilot scheme at the northern outfall of New Yau Ma Tei Typhoon Shelter;
- Sewerage provision to unsewered areas; and
- Redevelopment of old residential areas.

5.2 Sewerage Master Plan for West Kowloon

5.2.1 A summary of short term proposed works to address the adequacy of the sewerage system and pollution of the stormwater drainage system in West Kowloon is listed as follows:

- Sewer upgrade;
- Rectification of identified expedient connections;
- Provision of odour removal system, as a pilot scheme at Cherry Street Box Culvert;
- Desilting of sediments at the box culverts;
- Provision of internal lining at sewer crossings.
- Provision of a DWFI at Austin Road West;
- Improvement of existing DWFI;

- Provision of temporary sewage collection system for unsewered areas;
- Pilot scheme of the proposed DWFI at the outlet of the Cherry Street Box Culvert (located at northern outfall of NYMTTS); and
- Pilot scheme of biofilm streamer system at DSD Container Port Road Maintenance Port of Cheung Sha Wan.

5.2.2 A summary of long term proposed works for West Kowloon is listed as follows:

- Replacement of 150mm diameter sewers to 225mm diameter sewers;
- Sewerage provision to unsewered areas; and
- Redevelopment of old residential areas.

5.3 Impacts of Sewerage Master Plans Implementation

Environmental Impact Assessment

5.3.1 Potential environmental impacts including noise, air, water, ecology, cultural heritage, landscape and visual impacts and waste disposal, arising from the construction and operation of the proposed sewerage system are considered in relation to the surrounding community, environment and future land uses. Based on the preliminary assessment, the environmental impacts can be mitigated by implementation of appropriate measures during construction and operation stage. Some of the proposed works will be carried out within country parks and will be classified as Designated Projects under the Environmental Impact Assessment Ordinance. Detailed environmental studies will be carried out in the investigation/detailed design stage of the project.

Drainage Impact

- 5.3.2 Potential drainage impact may arise at the interconnection between the sewerage and stormwater drainage system, such as the proposed improvement works for DWFI and the biofilm streamer system. For improvement of existing DWFI, raising the weir level to avoid backflow of seawater from overloading the sewerage system may have potential drainage impacts, thus, flap valves and mechanical penstock are adopted to maintain existing downstream flow while improving the DWFI interception efficiency.
- 5.3.3 Other mitigation measures to ensure proper operation of the system include installation of fail-safe system, such as bypass stormwater drainage pipe, and flow monitor, etc. Detailed drainage impact assessment shall be conducted at investigation and detailed design stages prior to implementation of works.
- 5.3.4 In view of extensive existing water mains and installation within the study boundary, waterworks impact assessment should be carried out at investigation and detailed design stages prior to the implementation works in order to identify potential impact/interface and to propose mitigation measures to the existing water mains and installation within the Study Area.

Traffic Impact Assessment

- 5.3.5 The proposed works in the urban areas, such as improvement of DWFIs, sewer replacement and upgrade and construction of DWFIs, would generally induce traffic impacts to the public, particularly at major road junctions. Trenchless construction method is recommended for pipe laying at heavy traffic roads, such as Tuen Mun Road, Castle Peak Road, and temporary traffic arrangement would be required, as necessary, in some local urban areas.
- 5.3.6 Construction of the sewerage system is proposed in the unsewered areas and the alignment would generally be along the existing footpaths. Therefore, vehicular traffic impact to these unsewered areas due to the proposed sewerage works during construction shall not be significant.
- 5.3.7 Detailed traffic impact assessment is to be carried out and temporary traffic management schemes are to be formulated in the investigation/detailed design stage of the project.

Land Requirement

- 5.3.8 According to the land status plan and information obtained from the Lands Department, the proposed works in the urban areas, such as biofilm streamer and sewer placement, are on Government land that is either granted to various government departments through Government Land Allocations (GLAs) or to private parties through short term tenancies/ permits/ licences. The proposed works for the unsewered areas may require land acquisition to implement the works. Detailed land requirement have to be further confirmed during the investigation and design stages.

5.4 Project Interface

- 5.4.1 Implementation of the proposed works will have project interfaces with some proposed projects to be implemented. Close coordination and detailed planning would be required to minimise potential conflicts and public disturbance.

6. IMPLEMENTATION PACKAGE AND COST ESTIMATION

6.1 Implementation Package

Package A: Sewerage Improvement Works

6.1.1 Stage I – Sewerage Improvement of Priority Works: this stage consists:

- Upgrade of sewers mainly in the downstream catchment with flood risks;
- Upgrade of Sham Tseng Treatment Works; and
- Provision of lining at sewer crossings.
- An advanced work is to be implemented for improvement works of DWFI No. 6A at Nullah Road as reference for detailed design of the remaining DWFI.

6.1.2 Stage II – Sewerage Improvement of Remaining Works: this stage consists:

- Upgrade of remaining sewers with flood risk mainly in the upstream catchment;
- 150mm sewer upgrade in Tsuen Wan;
- Improvement of existing DWFI in West Kowloon; and
- Provision of 1 no. of DWFI at Austin Road West in West Kowloon.

Package B – Pilot Scheme Implementation

6.1.3 Stage I - this stage consists of implementation of proposed pilot schemes which include:

- Catalytic Activated Carbon Odour Removal System at Ma Tau Pa Road Box Culvert and Cherry Street Box Culvert;
- UV disinfection system for beaches, and
- Provision of 4 numbers of DWFI in Tsuen Wan.

6.1.4 Stage 2 - this stage consists of implementing the following trial schemes:

- DWFI at the outlet of Cherry Street Box Culvert of NYMTTS;
- Biofilm Streamer System at Cheung Sha Wan Road Box Culvert; and
- Water quality and flow monitoring at Ma Tau Pa Road Box Culvert.

Package C – Sewerage Provision to Unsewered Areas

6.1.5 This package consists of implementation of temporary collector sewer, and sewerage provision to 23 unsewered areas within the study area of Tsuen Wan and West Kowloon.

6.2 Cost Estimate

6.2.1 The cost estimate for each proposed work has been prepared using the Estimating Using Risk Analysis (ERA) technique as set out in Works Branch Technical Circular. The ERA technique involves a base estimate on cost of the work item and average risk allowance, which yield to an average risk estimate.

Table 6.1 Cost Summary for Sewer Improvements

Proposed Works	Capital Cost (HK\$ Million)
<i>Tsuen Wan</i>	
Sewer condition improvement works	0.7
Sewer capacity improvement works	16.8
Sham Tseng Treatment Works Upgrade	9.4
150mm dia sewer replacement	2.4
Provision of internal lining	13.9
<i>West Kowloon</i>	
Sewer condition improvement works	0.9
Sewer capacity improvement works	59.2
Provision of internal lining	6.7

Note: 150mm Sewer replacement in West Kowloon is to be implemented alongside the West Kowloon redevelopment programme.

Table 6.2 Cost Summary for Pollution Mitigation Measures

Proposed Works	Capital Cost (HK\$ Million)
<i>Tsuen Wan</i>	
Provision of 4 nos. DWFIs	6.5
UV Disinfection System at Approach Beach, Anglers' Beach & Dragon Beach	1.5
CAC odour removal system at Ma Tau Pa Road Box Culvert	5.1
Biofilm Streamer System – pending on satisfaction of pilot scheme	252
<i>West Kowloon</i>	
Improvement works to DWFIs with mechanical float valves in West Kowloon	70.7
Provision of Austin Road West DWFI	3.16
DWFI at outlet of Cherry Street Box Culvert (NYMT Typhoon Shelter) - Pilot Scheme	346
Biofilm Streamer System Pilot Scheme	15.7
CAC Odour Removal System at Cherry Street Box Culvert	12.9

Noted: Rectification of cross-connections had been completed or currently under-going, therefore excluded from the cost estimate.

Table 6.3 Cost Summary for Provision of Sewers at Unsewered Areas

Unsewered Village	Capital Cost (HK\$ Million)
<i>Tsuen Wan</i>	383
<i>West Kowloon</i>	68.1

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