8 SEWERAGE IMPACT AND SEWAGE TREATMENT IMPLICATIONS

8.1 Introduction

8.1.1 This section describes the assessment of the impacts on the existing sewerage system in the study area resulting from the planned development, and recommends appropriate mitigation measures where adverse impacts are identified. The new sewerage network within the study area arising from the proposed development is also presented. The guidelines for evaluating and assessing the sewerage impact of the Project on the public sewerage and sewage treatment as given in Section 6.5 in Annex 14 of the EIAO-TM are considered in the assessment.

8.2 Development Proposals and Future Population

8.2.1 Assessment of new sewerage system requirements for the WDII development is based on the proposed land uses as presented in RODP. Population estimates based on the land uses presented in the RODP should be reviewed and, if necessary, updated in the later detailed design stage of the proposed sewerage works for WDII when more detailed planning information is made available from the concerned parties by that time.

8.2.2 In order to collect the sewage flows from all the new developments, each of these areas will be provided with a terminal manhole connecting to the proposed sewerage networks. For those developments with designated access or service roads, the terminal manholes will be located within the development area fronting the entrance point. Where the access to some development areas is unknown at this stage, the location of the terminal manhole will be subject to change when more information is available in the detailed design stage or appropriate tapping points to be provided for future connections.

8.3 Design Criteria and Assumptions

Unit Flow Factors

8.3.1 The major population patterns within the study area are commercial and residential. The unit flow factors to be adopted for these two categories follow the suggested value from the DSD Sewerage Manual Part 1 as below:

Commercial:		
Employed population	=	$0.06m^3$/head/day
Commercial activities	=	$0.29m^3$/head/day
		$0.35m^3$/head/day
Residential	=	$0.37m^3$/head/day

Peaking Factors

8.3.2 Peaking factors to be adopted are given in **Table 8.1**. They follow the suggested values from the DSD Sewerage Manual Part 1, with the allowance for stormwater flow.

Table 8.1 Peaking Factors

Population Range	Peaking Factor (including Stormwater Allowance)	Peaking Factor (excluding Stormwater Allowance)
<1,000	8	6
1,000 to 5,000	6	5
5,000 to 10,000	5	4
10,000 to 50,000	4	3
>50,000	$\frac{7.3}{N^{0.165}}$	$\frac{5.2}{N^{0.165}}$

Design Parameters and Constraints

8.3.3 Pipe material: vitrified clay pipes to BS EN295 will be used for sewer smaller than 900mm in diameter while precast concrete pipes to BS 5911 will be used for pipe diameters greater than or equal to 900mm. Other suitable pipe materials in accordance with the Sewerage Manual could be used where appropriate to take account of different site conditions such as the expected occurrence of differential settlement etc. Protective lining such as bitumen or epoxy should be provided for precast concrete pipe to be used in sewage works.

8.3.4 The roughness coefficient (ks) to be adopted for different pipes and conditions are as follows:

(i)	Surface roughness (ks) for all existing pipes	:	3.0mm
(ii)	Surface roughness of proposed pipes (Vitrified Clay)	:	0.6mm
(iii)	Surface roughness of proposed pipes (Precast Concrete)	:	1.5mm

8.3.5 The sewers are designed based on the following limiting conditions:

Table 8.2 Minimum Pipe Gradients for Sewer Design

Pipe Diameter (mm)	Minimum Gradient (1 in -)	Capacity (l/s)	Velocity (m/s)
150	175 (101)	13.3 (17.7)	0.75 (1.0)
225	295 (170)	30.0 (39.8)	0.75 (1.0)
300	430 (244)	53.0 (70.7)	0.75 (1.0)
375	570 (324)	82.8 (110.4)	0.75 (1.0)
450	717 (407)	119.3 (159.0)	0.75 (1.0)
525	869 (494)	162.4 (216.4)	0.75 (1.0)
600	828 (468)	212.0 (282.6)	0.75 (1.0)
675	962 (544)	268.4 (357.7)	0.75 (1.0)
750	1,099 (621)	331.4 (441.6)	0.75 (1.0)
825	1,208 (701)	406.3 (534.4)	0.76 (1.0)
900	1,188 (782)	515.3 (636.0)	0.81 (1.0)

(Values for new sewers in brackets.)

8.3.6 BS 8005 recommends the laying of sewers to a gradient giving a full-bore velocity of 1m/s at least daily. At such a gradient, 0.75m/s will be exceeded with any flow rate more than 20% of the full-bore flow. To avoid unnecessary expense and disruption to the community, existing sewers will be checked against the criterion of whether 0.75m/s can be exceeded at least daily when deciding on the need for replacement. No siltation has been allowed for the sewers in the assessment as self-cleansing velocities could be established to enable the sewage flow to self-cleanse the nominal amount of silt. This is a prevalent practice in other similar assessment to government authorities.

8.3.7 It is recommended to design the newly laid pipes to a higher standard. As such, the minimum self-cleansing velocity of 1m/s is to be adopted. While for new pipe to be laid in reclamation area, an even higher self-cleansing velocity (e.g. >1.5m/s) will be achieved as far as practicable to compensate for possible decrease in pipe gradient as a result of differential settlement. Allowance shall be made for initial gradient to take into account the occurrence of differential settlement. Reference shall also be made to CIRIA Report 141, "Design of Sewers to Control Sediment Problems".

8.4 Assessment of Impact

Existing Sewerage System

8.4.1 The key components of the existing sewerage system in the study area are as follows:

- local sewerage networks
- deep trunk sewers constructed under contract no. DC/95/05 of CW3
- upgraded Wan Chai East Sewage Screening Plant
- existing submarine sewage outfall from the Wan Chai East Sewage Screening Plant

8.4.2 The local sewerage networks which will collect the sewage flow from WDII comprise pipe sizes ranging from 150mm to 750mm in diameter was upgraded by Contract No. DC/95/08 and DC/95/09 of CW3. Upon completion of these two contracts, the local sewerage networks will be able to cope with the sewage flow in the year 2011. Contract DC/95/08 and DC/95/09 were completed in 2002 and end of 2004 respectively.

8.4.3 The deep trunk sewers constructed under contract No. DC/95/05 of CW3 was commissioned in early 2002. Sewage flows will be diverted to the deep trunk sewers through the connection works carried out by contract DC/95/09, which was completed by end of 2004.

8.4.4 The necessary sewerage works to facilitate the decommissioning of the Wan Chai West Sewage Screening Plant was included in contract DC/95/09.

8.4.5 The deep trunk sewer under contract no. DC/95/05 has been designed to allow considerable flows from the WDII development; it has been assumed that 176.4 l/s ADWF will be generated from WDII development. This higher flow estimate was based on the previous development scenario of WDII under which the extent of reclamation is larger. The updated sewage flow based on the latest and current development scenario of WDII under which the extent of the proposed reclamation has been reduced is detailed in **Table 8.3**.

8.4.6 The Wan Chai East Sewage Screening Plant was upgraded under Contract No. DC/95/06. The capacity of the upgraded plant can accommodate a flow of 4,613 l/s. The expansion works were completed by early 2002.

8.4.7 The Wan Chai East sewage outfall comprises twin 1,200mm diameter pipelines which extend northwards from the Wan Chai East Sewage Screening Plant. During the detailed design of CW3 Sewerage, the capacity of the outfall has been assessed to be 2,280 l/s.

Estimation of New Sewage Flows

8.4.8 Based on the latest WDII land use proposals as described in Section 2, the main developments affecting the sewage loading in the study area are shown below in **Table 8.3**. Using the appropriate unit flow factors and peaking factors, with an extra 10% contingency to account for the sewage discharges from the visitors and public toilets due to uncertainty of development types because of the limited of available data, the peak flow generated from each development is also presented.

Table 8.3 Flow Estimate for New Developments

Site Reference	Proposed Use	Population	ADWF (l/s)	Peak Flow (l/s)
WDII/3	HKAPA Extension	255	1.03	9.09
WDII/4	HK Visual Arts Education Centre	51	0.21	1.82
WDII/5	Central Ventilation Building	2	0.01	0.06
WDII/7	Helipad	5	0.02	0.16
WDII/8	Railway Ventilation Building	2	0.01	0.06
WDII/11	Ferry Pier	30	0.12	0.97
WDII/12	Waterfront Related Commercial and Leisure Uses	31	0.13	1.11
WDII/13	Waterfront Related Commercial and Leisure Uses	34	0.14	1.21
WDII/14	Waterfront Related Commercial and Leisure Uses	53	0.21	1.89
WDII/15	Indoor Games Hall and Leisure Uses	35	0.14	1.25
WDII/16	Wan Chai North PTI	20	0.08	0.71
WDII/18	Salt Water Pumping Station	5	0.02	0.16
WDII/19	Public Promenade and Water Recreation Centre	20	0.08	0.71
WDII/23	Tin Hau Temple	5	0.02	0.16
WDII/26	East Ventilation Building	2	0.01	0.06
WDII/29	Administration Building	30	0.12	0.97
			Total	**20.41**

Impacts to Existing Sewerage System

Local Sewerage Network

8.4.9 The sewer from WDII/16 will be connected directly to the deep trunk sewer. Other sewers are intended to be connected to the local sewerage network, through which most flows will eventually be conveyed to the Wan Chai East Sewage Screening Plant.

8.4.10 For the development in WDII/3, WDII/4 and WDII/5, the proposed connection point is made at manhole no. HK35154801 which will be upgraded under CW3 sewerage project and finally collected by Manhole W13 of the trunk sewer. It is found that the capacity of the sewerage network between manhole no. HK35154801 and the trunk sewer manhole is sufficient to cater for the additional flow.

8.4.11 For the other developments, since the estimated peak flows are relatively small, no adverse impact will be introduced to the existing local sewerage system.

Deep Trunk Sewer under CW3

8.4.12 The sewage flows resulting from the WDII developments to be discharged to the deep trunk sewer manholes are summarised in the following table.

Table 8.4 WDII Flows to Deep Trunk Sewer

Site Reference	Population	ADWF (l/s)	Peak Flow (l/s)	CW3 trunk sewer manholes
WDII/3	255	1.03	9.09	W13
WDII/4	51	0.21	1.82	
WDII/5	2	0.01	0.06	
WDII/7	5	0.02	0.16	W21*
WDII/8	2	0.01	0.06	
WDII/11	30	0.12	0.97	
WDII/12	31	0.13	1.11	
WDII/13	34	0.14	1.21	
WDII/14	53	0.21	1.89	
WDII/15	35	0.14	1.25	
WDII/16	20	0.08	0.71	W18
WDII/18	5	0.02	0.16	W21*

* W21 represents the upgraded WCE PTW

8.4.13 The assessment of additional sewage flows arising from the WDII developments shows that the additional flows will not have any adverse impact on the trunk sewer system. In fact, sufficient allowance has been made in the detailed design of trunk sewer to accommodate the sewage inflow from WDII in manholes W13 and W18.

8.4.14 Manhole W18 of the trunk sewer system has been constructed with plug ends reserved for the connections from WDII. Thus, no modification to the existing manhole is required.

Wan Chai East Sewage Screening Plant

8.4.15 As noted above, the Wan Chai East Sewage Screening Plant has been designed to handle sewage flows of 4,613 l/s. This capacity is sufficient to accommodate flows to the plant at present.

8.4.16 As reviewed under the HATS Stage 2A project, the total flow going into the Plant under the ultimate development scenario may exceed the plant capacity in the long term. The total flow going into the plant is subject to further review and hence it is not at this stage to draw the conclusion that WCE SSP is required to be upgraded. Nevertheless, provision for expansion of the plant has been allowed and subject to further review at a later stage.

Wan Chai East Sewage Outfall

8.4.17 The capacity of the existing submarine sewage outfall had been assessed during the detailed design of CW3 Sewerage as 2,280 l/s.

8.4.18 It is therefore apparent that the existing twin 1,200mm diameter submarine outfall at Wan Chai East will not have adequate capacity to cope with the design flow of 4,613 l/s and will require upgrading.

8.5 Proposed Upgrading Works

Proposed New Sewers and Connections

8.5.1 To accommodate the WDII development, new sewers will be required to connect the development areas to the existing sewerage system**. Figures 8.1, 8.2** and **8.3** indicate the proposed sewerage system and sewer connections for the WDII development.

8.5.2 For the connections to the trunk sewer, as there have been special features such as vortex drops and temporary plug ends allowed for the future connections from WDII, no modification work is required to these existing manholes.

New Sewage Outfall

8.5.3 Reprovisioning of the existing Wan Chai East Sewage Outfall will be required as a result of the WDII reclamation. A section of the existing outfall, approximately 40m long, will lie underneath the new reclamation and a new diversion will be needed to replace this section before reclamation works are undertaken in the vicinity.

8.5.4 Moreover, whilst the existing submarine outfall has sufficient capacity to cope with the present operating conditions, based on operating flow predictions up to 2008, the outfall will need to be upgraded to handle the projected design flows in 2011 and beyond. Consequently, it has been agreed that a new sewage outfall should be provided to meet the future demand. The provision of this new outfall under the WDII project will avoid unnecessarily abortive reprovisioning works and minimise project interfacing problems. In addition, the new outfalls shall be completed and operated prior to the decommissioning of Wan Chai West sewage screening plant, that should be taken into account in the detailed design and construction stages.

8.5.5 The configuration of the new sewage outfall will comprise a landfall section of 2,250mm diameter pipe with approximate length of 180m, and a marine section of twin 1,600mm diameter submarine pipelines of some 500m length. Based on preliminary assessment, this configuration will have capacity to cater for a design peak flow of 4,613 l/s.

8.5.6 The preliminary analysis has been based on the new outfall having similar configuration to the existing, with similar diffuser arrangements. The hydraulic performance of the new outfall, and the efficiency of the diffusers, will be assessed more thoroughly in the detailed design stage.