

10. SEWERAGE AND SEWAGE TREATMENT

Introduction

10.1 This section comprises the following:

- Introduction – Describes the background of the Assessment and the structure of this report.
- Sewerage Catchment Area – Introduces the study area in Aberdeen Sewerage Catchment.
- Design Assumption and Criteria – States the assumption made in estimating the sewage flow.
- Development and Flow Projections – Presents the planning year studied and provides the corresponding projected population and sewage flow figures for both the existing and redevelopment proposals.
- Existing and Committed Sewerage Infrastructure – Describes the sewerage infrastructure studied under this report.
- Sewerage Impact Assessment – Identifies any adverse impacts on the existing sewerage infrastructure due to the proposed redevelopments; and presents the proposed sewerage improvement works for the study area.
- Summary and Conclusions.

Background

- 10.2 The purpose of this Sewerage Impact Assessment (SIA) is to assess the impacts due to Ocean Park redevelopment on the existing public sewerage networks.
- 10.3 The Ocean Park is located in the southern part of the Hong Kong Island near Ap Lei Chau and within the Aberdeen Sewerage Catchment. It can be divided into three zones, namely Tai Shue Wan, Headland and Lowland. It is to be redeveloped with new attractions and expanded guest area. After the completion of Ocean Park redevelopment, the design peak in-grounds attendance is estimated to be 38,000 visitors per day by the year 2021/22.
- 10.4 Under the Ocean Park redevelopment scheme, the existing Lowland area will be expanded with the construction of a new entry plaza and additional attractions, whereas the Headland area will be enlarged by the creation of a new Summit area and the inclusion of new attractions at the existing Headland area. The existing Tai Shue Wan will not be used for park facilities but will be reserved for possible future hotel development.
- 10.5 The proposed hotel developments, at the new entry plaza and at Tai Shue Wan area, are not considered as part of the current Ocean Park redevelopment scheme and are to be separately implemented. Therefore, the hotel development is not considered in this SIA.
- 10.6 The Ocean Park redevelopment scheme is tentatively to be implemented in three phases. Phase 1 is to be completed towards end 2008, whereas Phase 2 and Phase 3 by mid 2010 and mid 2011 respectively.

Sewerage Catchment Area

Overall Description

- 10.7 The Aberdeen Sewerage Catchment embodies South Bay, Repulse Bay, Deep Water Bay, Shouson Hill, the eastern part of the Peak area, Wong Chuk Hang, Aberdeen, Tin Wan and Chi Fu Fa Yuen. Part of the sewage generated within catchment is conveyed to the Aberdeen Preliminary Treatment Works (PTW) for the treatment.

Study Area

- 10.8 Sewage generated from the Ocean Park will discharge to three public sewers (Shum Wan Road, Nam Long Shan Road and Wong Chuk Hang Road) and finally flow to Aberdeen PTW. Thus the sewerage impact from the redevelopment of Ocean Park will shrink to the sewerage system from Nam Long Shan Road, Shum Wan Road and Wong Chuk Hang Road to the Aberdeen PTW.

Design assumptions and criteria

General Criteria

- 10.9 This SIA has been carried out following the guidelines set out in the Sewerage Manual Part 1 (DSD, 1995) (SM), based on the design peak in-grounds attendance of 38,000 visitors per day by the year 2021/22.
- 10.10 As not all the population type (such as visitors) are covered in Table 2 of the SM, assumptions are then made for the unit flow factors of the populations type adopted in this SIA based on the global unit flow factors in Table 2 of SM. **Table 10.1** below provides a summary of the flow factors used for different population types.

Table 10.1 Assumptions on Unit Flow Factors

Population Type	Unit Flow Factor (m³/h/day)
Restaurant Customers	0.2125
Restaurant / General staff	0.35*
Visitors	0.06

*Note: According to the SM Table 2, combining sanitary and commercial activities

- 10.11 The global peaking factors, including stormwater allowance, given in Table 3 in the SM, are adopted in the SIA.
- 10.12 A roughness coefficient, k_s , of 3.0mm is used for the pipes of the proposed sewers.

Development and Flow Projections

Development Projections

Planning Year Considered

- 10.13 In accordance with the schedule of the proposed redevelopment, it will be completed by mid 2011. Projections for population and sewage flow estimates are therefore considered for the planning year of 2016 for conservatism to assess the sewerage impacts arising from the proposed redevelopment.

Population Estimates

Baseline Condition

- 10.14 In the estimation of population and sewage arising from Aberdeen Sewerage Catchment in 2016, reference is made to the Review of Hong Kong Island Sewerage Master Plans (HKISMP) Final Report (Dec. 2003). The planning data of the population of each Planning Vision and Strategy (PVS) zone in baseline estimation is based on the 2003 version Territory Population and Employment Data Matrices (TPEDM) Scenario II (Compiled in November 2004). **Figure 10.1** shows the PVS zone in the Aberdeen Sewerage Catchment. The detail breakdown of the population in the Catchment is listed in **Appendix 10.1**.

Flow Projections

Average Dry Weather Flows

- 10.15 Average dry weather flows (ADWF) were estimated by applying appropriate unit sewage flow factors to the population data. Reference was made to the unit flow factors as recommended in the SM.
- 10.16 With the exception of industrial developments, the adopted unit flow factors are consistent with the recommendations of the SM and shown in **Table 10.2** below.

Table 10.2 Recommended Unit Flow Factors

Development Type	Unit	Unit Flow Factor (l/h/d)
Residential		
Low Cost Rental	Person	175
R1	Person	240
R2	Person	300
R3	Person	370
Village	Person	240
Government/Institution/Community	Person	240
Commercial		
Job Types J2 to J5	Employee	280*
Industrial		
Job Type J1	Employee	443*
Schools		
School	School place	25

Notes:

Based on Sewerage Manual Part 1 (DSD, 1995).

* denotes in line with Review of HKISMP Final Report (Dec. 2003).

Baseline Condition

- 10.17 The evaluated ultimate ADWF for the Aberdeen Sewerage Catchment by development type are presented in **Table 10.3** and the details of planning and flow data are included in **Appendix 10.1**:

Table 10.3 ADWF in Year 2016 for the Aberdeen Catchment

Development Type	ADWF (m ³ /d)
Residential	31,272
Commercial (J2 to J12)	16,794
Industrial (J1)	570
School	630
TOTAL	49,266

Peaking Factors

- 10.18 Peak wet weather flows (PWWF) are used in the assessment of hydraulic adequacy of the sewerage systems. Peaking factors including stormwater allowance in accordance with the SM were applied to the ADWF to establish the peak flows. The recommended peaking factors are presented in **Table 10.4** below:

Table 10.4 Recommended Peaking Factors for Sewers

Population	Peaking Factor for Sewers*
< 1,000	8
1,000 – 5,000	6
5,000 – 10,000	5
10,000 – 50,000	4
> 50,000	$7.3/N^{0.165}$

Notes:

- * denotes peaking factors including stormwater allowance based on Sewerage Manual Part 1 (DSD, 1995).
- N denotes equivalent population / 1,000.
- Equivalent population = ADWF (m³/d) / 0.27.

Sewage Impact Assessment Condition

- 10.19 With the proposed redevelopment of Ocean Park, the total projected flow from Ocean Park to public sewers are evaluated and presented in **Table 10.5**. The sewage flows from Ocean Park is estimated based on the projected number of visitors and staffs in Ocean Park after the redevelopment and the unit flow factor of each staff and visitor as shown in Sewerage Manual Part 1, Table 1.

The detailed breakdown is shown in **Appendix 10.2**.

Table 10.5 Estimated sewage flow from Ocean Park after redevelopment

Discharge Location	ADWF (L/s)
Nam Long Shan Road Sewer	47.53
Shum Wan Road Sewer	9.26
Wong Chuk Hang Road Sewer	27.75

Existing & Committed Sewerage Infrastructure

- 10.20 Sewage flows generated by redevelopments within the study area in Aberdeen Sewerage Catchment are collected by the existing sewerage systems en route to the Aberdeen PTW for preliminary treatment. The treated effluent from Aberdeen PTW is discharged into the sea.

Sewerage System

Existing Sewerage Systems

- 10.21 The redevelopment site is located within the Aberdeen Sewerage Catchment and is served by the Aberdeen PTW. A layout of the existing sewerage system in Aberdeen Sewerage Catchment is shown on **Figure 10.2**. The sewerage system in the study area is shown in **Figure 10.3**.
- 10.22 Under the existing scenario, the existing sewerage of Ocean Park is connected to the public sewerage at three locations: Tai Shue Wan, Nam Long Shan Road and Wong Chuk Hang Road. It

is proposed that upon the redevelopment of the Ocean Park, all these three existing connections will be maintained.

Sewerage Connection at Tai Shue Wan

- 10.23 For the sewage discharge from the Ocean Park at Tai Shue Wan, sewage will be discharged to an existing 300mm gravity sewer along Shum Wan Road and pumped by the existing Shum Wan Road Sewerage Pumping Station via a sewage rising main, then combines with the sewage flow from Lowland (which is discharged to the public sewerage system at Wong Chuk Hang Road) and finally flow to the Aberdeen PTW. This PTW provides preliminary treatment to the collected sewage prior to disposal into sea.

Sewerage Connection at Nam Long Shan Area

- 10.24 The sewage from the existing Headland area is currently discharged by gravity to an existing 225mm gravity sewer along the section of the public Nam Long Shan Road. The connection point is located in Nam Long Shan Road closed to the current Ocean Park boundary. It is proposed that all additional sewage generated from the proposed Summit area and the expanded Headland area is connected to the public sewerage in Nam Long Shan Road and finally goes to Aberdeen PTW through the sewer along Wong Chuk Hang Road.

Sewerage Connection at Wong Chuk Hang Road

- 10.25 The sewage from the existing Lowland area is currently discharged to the 300mm public sewer across the Wong Chuk Hang Road towards the Aberdeen PTW.

Sewage Treatment Facilities

- 10.26 Sewage collected from the Ocean Park is conveyed by the existing sewerage systems to the Aberdeen PTW for treatment. The treated effluent is ultimately discharge to sea for disposal.
- 10.27 Aberdeen PTW is located at Tin Wan Praya Road. It has a design capacity of 2.08 m³/s. Capacities of the individual treatment units are shown in **Table 10.6**.

Table 10.6 Existing Facilities of the Aberdeen PTW*

Treatment Unit	No. of Units	Capacity of Each Unit (m ³ /s)
Coarse Screens	1 Duty + 1 Standby	2.45
Medium Screens	1 Duty + 1 Standby	2.45
Inlet Pumps	3 Duty + 1 Standby	2.45
Fine Screens	2 Duty + 1 Standby	2.08
Grit Trap	2 Duty	2.48

*Extracted from Review of HKISMP Final Report (Dec. 2003)

Sewerage Impact Assessment

- 10.28 Section 10.17 revealed that the contributing population for Aberdeen Sewerage Catchment are 182,467 and 209,519, whilst the sewage flows are 49,266m³/d (ADWF) and 56,570m³/d (ADWF), for the Baseline and SIA conditions respectively.
- 10.29 It is noted that there are local increases of flows at 3 connections of sewers at Nam Long Shan Road, Shum Wan Road and Wong Chuk Hang Road. These local effects on the existing sewerage

system were assessed. The existing sewerage network is depicted in **Figures 10.4a, 10.4b and 10.4c**.

- 10.30 Improvement works are also proposed to improve the sewerage infrastructure identified with hydraulic inadequacies in the performance assessment.

Performance Assessment for Sewerage System

- 10.31 The performance of the existing sewerage infrastructure was assessed for planning year (2016) incorporating TPEDM data. Hydraulic analysis has been carried out on the basis of sewerage record plans collected from DSD. The flows of 190.12L/s, 37.05L/s and 110.98L/s from Ocean Park are discharged into nodes no. 322_6, 330_4 and 252_3 respectively. Peak flows are used in the assessment of hydraulic adequacy of the sewerage system within Aberdeen Sewerage Catchment.
- 10.32 Planning information at Street Block level was adopted for the evaluation of sewage flows. The flows were assigned to appropriate manholes of the hydraulic model as inflows from the respective developments. The cumulative peak flows conveyed by the sewerage system were used in the assessment for hydraulic adequacy.
- 10.33 Information on the existing sewerage network is sourced from the Drainage Record Plans obtained from DSD.

Baseline Condition

- 10.34 The performance assessment results showed that there were some existing sewers identified as hydraulic inadequate in the model under the flows in year 2016.
- 10.35 In accordance with the SM, the long-term goal is to implement sewerage improvement works to eliminate all surcharged conditions. Surcharged sewers are therefore identified for both the Baseline and Sewerage Impact Assessment conditions. Upgrading works are recommended for the surcharged sewers.
- 10.36 224m of 225mm diameter sewers were identified to be surcharged under peak flow condition and the details are listed in **Appendix 10.3**.
- 10.37 The surcharged sewers under Baseline Condition are shown in **Fig 10.5a, 10.5b and 10.5c**.

Sewerage Impact Assessment Condition

- 10.38 Surcharged sewers measuring a total length of 1520m ranging from 225mm to 375mm diameter were identified under peak flow condition and the details are listed in **Appendix 10.3. Table 10.7** present summaries of the surcharged sewers under SIA condition.

Table 10.7 Summary of Surcharged Sewers at Peak Flow under SIA Condition

Pipe Dia. (mm)	Length (m)
225	1,211
300	37
375	272
Total	1,520

- 10.39 The surcharged sewers under SIA Condition are shown in **Fig 10.6a, 10.6b and 10.6c**.
- 10.40 It shows that with the redevelopment of Ocean Park, there is a sewerage impact to the existing sewers, in particular at the 2 connections at Nam Long Shan Road and Wong Chuk Hang Road. The upgrading of the sewers is necessary for the redevelopment project.

Aberdeen Preliminary Treatment Works

- 10.41 The existing capacity of the Aberdeen PTW is 2.08 m³/s according to the Review of HKISMP Final Report (Dec. 2003). The total catchment flow under the Baseline Condition is estimated to be 1.88m³/s. With the proposed redevelopment of the Ocean Park, the total flow is estimated to be increased to 2.04 m³/s. It is concluded that the Aberdeen PTW has adequate capacity to cater for the total flow generated by the Aberdeen Sewerage Catchment in year 2016 even with the Ocean Park redevelopment.
- 10.42 The detailed calculation of the sewage flow to Aberdeen PTW is shown in **Appendix 10.4**.

Recommended Works

- 10.43 There are upgrading sewerage systems proposed for the redevelopment of Ocean Park.
- 10.44 The SIA has identified sewers of a total length of 1520m in the existing sewerage systems would be subjected to surcharge.
- 10.45 In accordance with the findings from the hydraulic analysis, three sections (links ref. 322_3 to 322_55, 322_78 to 322_147 and 252_3 to 200_171) of the sewers are surcharged and are recommended to be upgraded.
- 10.46 Based on the findings, there should be no major hydraulic problem in the sewerage network. Urgent rectification work or interim measure is not required. However, it is recommended to upgrade relevant sections of the sewers to relieve the projected hydraulic bottlenecks and those pipes with surcharged conditions in the sewerage systems in future. The recommended sewerage improvement works has a total length of 1,543m which is summarised in **Table 10.8** below. They are also shown in **Fig 10.7a, 10.7b and 10.7c** and listed in **Appendix 10.3**.

Table 10.8 Summary of Recommended Sewerage Upgrading Works

Location	Existing Pipe Size (mm)	Upgrading Pipe Size (mm)	Pipe Length (m)
Nam Long Shan Road	225	450	1,211
Wong Chuk Hang Road	300	500	37
Wong Chuk Hang Road	375	500	295
Total			1,543

- 10.47 It is understood that CEDD is the proponent of the proposed sewerage improvement works. The construction works is therefore not part of the Ocean Park redevelopment project.

Summary and Conclusion

Summary

- 10.48 The performance of the existing sewerage infrastructure under TPEDM projected population condition was assessed and formed the Baseline Condition
- 10.49 The SIA Condition takes into account of the redevelopment of Ocean Park and the impacts to the Aberdeen Sewerage Catchment. Hotel development within the Ocean Park is outside the scope of the EIA study and is not considered in the SIA.

- 10.50 The adopted unit flow factors are generally based on the recommendations of the SM.
- 10.51 The recommended peaking factors are based on the SM. The estimated peak flow is $1.88\text{m}^3/\text{s}$ for Baseline Condition whilst peak flow of $2.04\text{m}^3/\text{s}$ is estimated under SIA Condition. These peak flows are used in the hydraulic assessment of the existing Aberdeen PTW.

Conclusion

- 10.52 The performance assessment results have identified surcharged sewers measuring a total length of 1543m with diameters ranging from 225mm to 375mm under the SIA peak flow condition. Works to improve these surcharged sewers are needed in accordance with the SM.
- 10.53 The Aberdeen PTW was assessed to be adequate to convey the total catchment flows under both Baseline and SIA Conditions under this Study.
- 10.54 Sewerage improvement works to the existing sewers were recommended. It is proposed to upgrade the existing sewers with pipes of diameters ranging from 225mm to 375mm in order to relieve the identified hydraulic inadequacies and surcharged condition.