

# **Appendix 4**

Study on Drainage, Sewerage and Water Supply Systems

{ Ove Arup & Partners Hong Kong Ltd }



Hong Kong Resort Company Limited

Optimization of Land Use in Discovery Bay

Study on Drainage, Sewerage and Water Supply Systems for Area 4a, 10b and 22

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This report takes into account the particular instructions and requirements of our client. It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number 235928

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Calculations on Proposed Sewerage System

#### **APPENDIX B3**

Capacity Checking Calculations on existing Discovery Bay Reservoir, Fresh Water Service Reservoir and Proposed Water Supply System

## **Executive Summary**

The Hong Kong Resort Company Limited (HKRCL) has been considering the feasibility of implementing additional development areas within the existing boundary of Discovery Bay to provide additional housing supply at Area 10b and Area 4a. A planning statement, titled "Optimisation of Land Use in Discovery Bay" was submitted to Planning Department (PlanD) in July 2013 for Area 10b. A round of comments from various Government departments was received in December 2013 (ref PlanD's letter () L1/L/DBNC/352-17 dated 17 December 2013). Another round of submission was made in August 2014 and the corresponding set of comments was received from various Government departments in December 2014 (ref. PlanD's letter () L1/L/DBNS/352-17(CR) dated 23 December 2014). Subsequently, another round of submission was made in March 2015 and comments were received from various government departments in December 2016 – January 2017. The latest round of submission was made in February 2017.

The latest current scheme refers to Area 4a, 10b and 22. The potential development area is included in the latest approved Discovery Bay Outline Zoning Plan as "Other Specified Uses" and "Government, Institution and Community", despite the fact that some of their development parameters are proposed to be amended.

This report would address the issues relating to drainage, sewerage and water supply for the latest development proposal of Area 4a, 10b and 22, while taking into account the cumulative impact of Area 6f (assessment results indicate that there is no adverse impact for drainage, sewerage and water supply parts under the current proposed scheme). Those relating to noise, air quality, water quality, land contamination and ecology are separately presented in another report.

#### **Drainage**

Discovery Bay has a network of engineering drainage system that originates from the foot of the hills to convey the surface runoff east to the sea. The potential development is located at the catchment with total area of 8.2 ha.

The drainage catchment includes potential Area 4a, 10b and 22, where there is no existing drainage system. The surface runoff directly discharges to the sea under the existing condition.

The potential development will generate increase in surface runoff due to land area partly changed from unpaved to paved condition. A new drainage system is proposed for discharge the runoff at potential Area 4a, 10b and 22 to the sea.

#### Sewerage

Sewage generated from the existing Discovery Bay development is collected by four existing sewage pumping stations at Discovery Bay and then lifted up to Drainage Services Department (DSD) Siu Ho Wan Sewage Treatment Works (SHWSTW) for further treatment and disposal via the internal rising mains between the sewage pumping stations and the existing 450mm diameter twin rising mains laid along Discovery Bay Tunnel to SHWSTW. SHWSTW is a chemically enhanced primary treatment with design treatment capacity of 180,000 m<sup>3</sup>/d and a design peak flow of 3,750 l/s.

Sewage generated from potential development is proposed to discharge to the SHWSTW for further treatment and disposal.

#### Water Supply

Discovery Bay falls within supply zone of Siu Ho Wan Water Treatment Works (SHWWTW) via the Siu Ho Wan Fresh Water Pumping Station (FWPS). SHWWTW and Siu Ho Wan FWPS have a nominal capacity of 150,000 m³/d. Allowance has been made in SHWWTW for expansion to an ultimate capacity of 300,000 m³/d. An existing 1000mm / 1200 mm pumping main delivers fresh water from Siu Ho Wan FWPS to Tung Chung Fresh Water service reservoir. Fresh water is further pumped by Discovery Bay Fresh Water Booster Pumping Station via a 450mm branch-off pipe from the existing 1200 mm fresh water main. A 450 mm diameter outlet pumping main of Discovery Bay FWPS, laid along Discovery Bay Tunnel, delivers fresh water to Discovery Bay Fresh Water Service Reservoirs No. 1 and No. 2 for fresh water supply to Discovery Bay.

The existing capacity of the SHWWTW is insufficient to supply the existing developments, other concurrent and future developments within the supply zone of SHWWTW. Therefore, SHWWTW and Siu Ho Wan FWPS will be upgraded to a capacity of 300,000 m³/d irrespective of the Discovery Bay potential developments. Spare capacity of the upgraded SHWWTW and upgraded Siu Ho Wan FWPS with 300,000 m³/d capacity will then be adequate to supply additional fresh water to Discovery Bay potential development at Area 4a, 10b and 22, which has estimated mean daily fresh water demand of 973.2 m³/d (equivalent to 0.32% of the total upgraded capacity of SHWWTW).

Additional flushing supply to the potential development Area 4a, 10b and 22 will be provided from the existing Discovery Bay Reservoir. It has been checked that the existing reservoir has enough storage even during a drought year to meet this additional flushing water demand.

To facilitate the Discovery Bay potential developments, new water mains including fresh and flushing water mains are required for water supply to potential development Areas 4a, 10b and 22.

#### 1 Introduction

#### 1.1 Background

- 1.1.1 The Hong Kong Resort Company Limited (HKRCL) has been considering the feasibility of implementing additional development areas within the existing boundary of Discovery Bay to provide additional housing supply. A planning statement, titled "Optimization of Land Use in Discovery Bay" was submitted to Planning Department (PlanD) in July 2013. A round of comments from various government departments was received on December 2013 (ref PlanD's letter (L1/L/DBNC/352-17 dated 17 December 2013).
- Another round of submission was made in August 2014 and the corresponding set of comments was received from various government departments in December 2014 (ref. PlanD's letter () L1/L/DBNS/352-17(CR) dated 23 December 2014). A further round of submission was made in March 2015 and only comments from Environmental Protection Department (EPD) were received in May 2015 (ref. PlanD's letter L1/L/DBNS/352-17(CR) dated 19 May 2015). Another round of submission was then made in November 2016 and comments were received from various government departments in December 2016 January 2017. The latest round of submission was made in February 2017 and comments were received from various government departments.
- 1.1.3 Ove Arup & Partners HK Ltd (Arup) has been appointed by HKRCL to conduct assessments to address those comments relating to environmental aspects including noise, air quality, water quality, land contamination, ecology, sewerage and drainage, and water supply.
- 1.1.4 This report addresses the aspects relating to drainage, sewerage and water supply for Area 4a, 10b and 22, taking into account the cumulative impact of the concurrent development at Area 6f. Those relating to noise, air quality, water quality, land contamination and ecology are separately presented in another report.

## 1.2 Overview of Potential Development Proposal

- 1.2.1 After receiving the comments from various government departments in December 2013, December 2014 and May 2015, HKRCL has been optimising the development proposal to address those comments. Under the current planning proposal, an estimated total residential population of 2,145 would be developed in Area 4a and 10b with Area 22 to be developed as sports and recreation club of 5,500 m<sup>2</sup> GFA.
- 1.2.2 Figure 1 illustrates the locations of the potential development Area 4a, 10b and 22 with more relevant description on the details of the potential development area is given in Section 2.
- 1.2.3 It is noted that there is another approved development in Area 6f of Discovery Bay for residential development (site area of 8,300 m<sup>2</sup> and





estimated total residential population of 1,190). For the purpose of the study on drainage, sewerage and water supply, the cumulative impacts from both approved developments at Area 6f and potential development area 4a, 10b and 22 have been considered.

#### 1.3 Key Objectives of this Study

- 1.3.1 The key objectives and scope of this study are given below:
  - Obtain and examine existing drainage, sewerage and water supply record;
  - Carry out site inspection;
  - Estimate the surface runoff based on the proposed development scheme and determine capacity of existing drainage system immediately downstream of the potential development;
  - Assess the effect of the potential development on the existing drainage system and assess any mitigation measures are required;
  - Estimate sewage flow generation from proposed development, describe in board terms the new sewerage infrastructure needed to serve the potential development;
  - Conduct a detailed water demand assessment for the proposed development scheme and examine rainwater collection in existing catchment of the Discovery Bay Reservoir in the drought year as the worst scenario for flushing water supply; and
  - Recommend conceptual water supply to meet the demand of the additional development.

## 2 Project Description

#### 2.1 Background

- 2.1.1 The Discovery Bay development is a self-contained sub-urban residential development comprising mainly low-density private housing, situated in the eastern part of Lantau Island covering a total land area of about 650 hectares. There are currently around 8,300 nos. of residential flat with total population around 19,300.
- 2.1.2 Discovery Bay falls within the ambit of the Discovery Bay Outline Zoning Plan (Discovery Bay OZP) which was first approved on 21 March 2003. The current approved OZP limits the residential population to 25,000 (i.e. 10,000 nos. of residential flat), which is reflected in the latest Master Plan.

## 2.2 Development Area Description

- 2.2.1 Area 4a, 10b and 22 are located along the existing seafront along Marina Avenue leading to the existing Marina. Site observation reveals that the site is mainly occupied by a number of services facilities including the depot for vehicles, petrol / LPG filling station, ferry pier etc. It is also noted that the entire depot area is paved with concrete.
- 2.2.2 The current permissible land use for Area 4a, 10b and 22 in the OZP is "Government, Institution and Community" and "Other Specified Uses" for staff quarters and a variety of supporting services as shown in OZP S/I-DB/4 Discovery Bay. Within Area 4a, 10b and 22, it is proposed to have residential buildings and sports and recreational club, together with the necessary infrastructure and landscaping elements.

## 2.3 Tentative Implementation Programme

2.3.1 According to the latest design, the tentative time for the occupation of the potential development areas would be beyond 2028 and this actual date would be reviewed throughout the design process.





## 3 Site Inspection

3.1 Several site visits were carried out to inspect existing public and Discovery Bay's private drainage, sewerage and water supply infrastructures. The following tables present the site photos for some major infrastructures components, which will be discussed in this study. Figure 1 illustrates respective location of these infrastructures.

Table 3.1a Existing Government and Private Sewerage Infrastructure

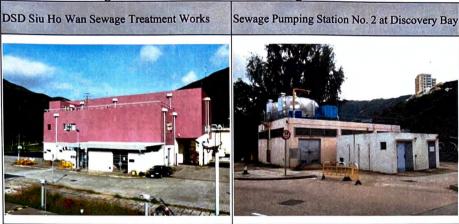


Table 3.1b Existing Government Water Supply Infrastructure

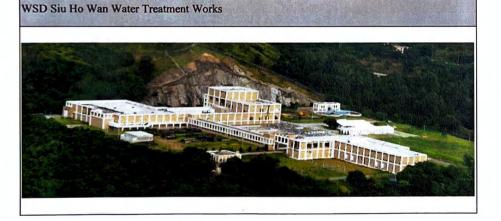
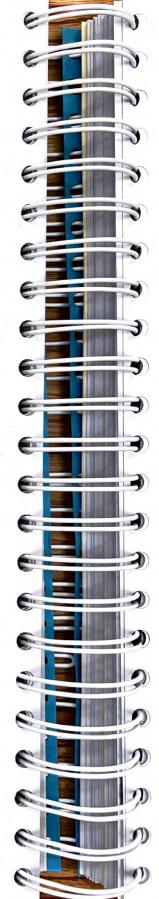


Table 3.1c Existing Private Water Supply Infrastructure

Fresh Water Service Reservoir No. 1 at Discovery Bay	Discovery Bay Reservoir





## 4 Drainage Study

## 4.1 Methodology and Guidelines

4.1.1 The drainage study reviews the existing drainage catchment and systems at the Discovery Bay. It assesses the potential drainage impacts due to the potential development Area 4a, 10b and 22 and identifies the necessary drainage mitigation measures and proposed drainage system for Area 4a, 10b and 22. This section presents the design method, parameters and criteria used for this drainage study.

#### 4.1.2 Design Method

**4.1.2.1** Stormwater drain capacity will be calculated based on the Continuity Equation:

O = AV

Where  $Q = \text{full flow capacity in } m^3/\text{s}$ 

A = cross-sectional area in m<sup>2</sup>

V = velocity at full bore flow in m/s

**4.1.2.2** Velocity at full-bore flow is based on the Colebrook-White equation:

 $V = -(32gRS)^0.5 \log \{(k_s/14800R) +$ 

(1.255v/R(32gRS)^0.5)}

Where  $g = acceleration due to gravity in m/s^2$ 

R = hydraulic radius in m

S = gradient

k<sub>s</sub> = roughness in mm

v = kinematic viscosity of water in m<sup>2</sup>/s

4.1.2.3 Peak stormwater runoff rate will be calculated using Rational Method:

 $Q = 0.278 \, \text{Ci A}$ 

Where Q = peak stormwater runoff in m<sup>3</sup>/s

C = runoff coefficient

i = design mean intensity of rainfall (mm/hr)

A = area of catchment in  $km^2$ 

The design mean intensity of rainfall is based on Gumbel Solution in accordance with DSD Stormwater Design Manual, 5<sup>th</sup> Edition, 2018 (DSD SDM):

$$i = a / (t_c + b)^c$$

Where t<sub>c</sub> = time of concentration in minutes

a, b, c = storm constants

- 4.1.2.4 Climate change effects up to mid 21st century will be adopted. A longer projection year up to the end of 21st century should be adopted if the marginal benefit of the design outweighs the marginal cost.
- 4.1.3 Codes of Practice and Design Manuals
- 4.1.3.1 The assessment has been carried out in accordance with DSD SDM.
- 4.2 Design Parameters
- 4.2.1 Drainage System Capacity
- 4.2.1.1 Capacity of the proposed stormwater drainage system will be designed to cater for return period design peak flow as follows:
  - 1 in 50 years return period design peak flow for urban drainage branch systems
  - 1 in 200 years return period design peak flow for urban drainage trunk systems (equivalent to 1,800 mm diameter pipe or larger)
- 4.2.1.2 To account for the effect of materials deposited in the drainage systems between desilting cycles, the following reduction of flow area is assumed in accordance with DSD SDM:
  - 5% reduction of flow area if the pipe gradient is greater than 1 in 25
  - 10% reduction of flow area in other cases
- 4.2.1.3 Return period storm constants for calculation of rainfall intensities are obtained from DSD SDM and listed as follows:
  - 1 in 50 years return period: a = 451.3; b = 2.46; and c = 0.337
  - 1 in 200 years return period: a = 429.5; b = 2.05; and c = 0.295
- 4.2.2 Runoff Coefficient

Surface Characteristics	Runoff Coefficient, C
Paved Area	1.0
Unpaved Area	0.3



+1



#### 4.2.3 Time of Concentration

Time of concentration (t<sub>c</sub>) is the shortest time in which all parts of the upstream catchment will contribute to the flow at the point of calculation. This is given by the equation:

$$t_c = t_e + t_f$$

Where t<sub>e</sub> = time of entry

 $t_f$  = time of flow

The time of entry, which is equivalent to time of concentration for a natural catchment, is calculated using the Brandsby William's Equation as follows:

$$t_o = \underline{0.14465L}$$

 $H^{0.2} A^{0.1}$ 

Where  $t_0 = \text{time of concentration of a natural catchment (min.)}$ 

 $A = \text{catchment area } (m^2)$ 

H = average slope (m per 100m) of the natural flow

L = distance (m) of the natural flow

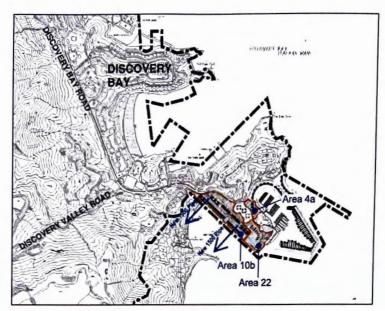
## 4.2.4 Rainfall Increase and Sea Water Rise due to Climate Change

To consider the effects of climate change in the at-grade drainage system, the project of rainfall increase and potential sea level rise adopted and checked for the design is shown as below.

Period to Consider	Rainfall Increase	Sea Level Rise (m)	
Mid 21st Century (2041-2060)	10.4%	0.23	
End of 21st Century (2081-2100)	13.8%	0.49	

## 4.3 Existing Drainage System

- 4.3.1 Discovery Bay has a network of engineering drainage system that originates from the foot of the hills to convey the surface runoff east to the sea. The existing drainage layout plan is illustrated in **Figure 2**. A description of this existing drainage system is provided below.
- 4.3.2 The potential development area is located in the catchment area of size 0.72 ha for Area 4a, 4.2 ha for Area 10b and 3.24 ha for Area 22, shown as the yellow catchment in the following figure.



Drainage Catchment Plan for Site 4a, 10b and 22

4.3.3 The current site area has no existing drainage system. The surface runoff is discharged directly to the sea via overland flow.

#### 4.4 Potential Drainage Impacts

- 4.4.1 The potential development scheme will generate increase in surface runoff due to land area partly changed from unpaved to paved surface. To be conservatively, it is assumed that the whole 8.2 ha site area at Area 4a, 10b and 22 is unpaved before development and will be changed to paved condition after development to estimate the worse drainage impact. The expected impact on the existing drainage system and the requirement for any measures to accommodate the increase in surface runoff are discussed below.
- **Table 4.1** summarizes the change in catchment area from existing to proposed conditions.

Table 4.1: Summary of Catchment Area Changes

Downstream	Existing /	Total	Paved Area (ha)		
Drainage System	Potential Development Area	Catchment Area (ha)	Existing	Proposed	Increase
N.A.	Area 4a, 10b and 22	8.2	N.A.	8.2	8.2

## 4.5 Evaluation of Drainage Impacts, Mitigation Measures and Proposed Drainage

4.5.1 Potential development Area 4a, 10b and 22 will be developed on existing area without drainage system. The surface runoff is currently



discharged directly to the sea via overland flow. New drainage system for these areas are proposed to collect the surface runoff and discharge directly to the sea. The peak surface runoff from Area 4a, 10b and 22 has been estimated and two new 1500 mm diameter outfall pipes are proposed.

- **4.5.2** Figure 2 shows the proposed drainage scheme and calculations are attached in APPENDIX B1.
- 4.5.3 Area 6f is located at a different catchment, and no cumulative drainage impact is anticipated.

## 5 Sewerage Study

#### 5.1 Methodology and Guidelines

5.1.1 The sewerage study estimates the sewage flows to be generated from the approved development Area 4f, the potential development Area 4a, 10b and 22, and existing OZP approved 25,000 population at Discovery Bay. It reviews the existing sewerage system within the Discovery Bay and its discharge to the public sewerage and sewage treatment facilities at Siu Ho Wan. It recommends the sewerage collection, treatment and disposal scheme for the potential development Area 4a, 10b and 22, with consideration of the accumulative effects of the concurrent development at Area 6f. This section presents the design method, parameters and criteria used for this sewerage study.

#### 5.1.2 Design Method

5.1.2.1 Sewer capacity will be calculated based on the Continuity Equation:

Q = AV

Where Q = full flow capacity in m<sup>3</sup>/s

A = cross-sectional area in m<sup>2</sup>

V = velocity at full bore flow in m/s

5.1.2.2 Velocity at full-bore flow is based on the Colebrook-White equation:

 $V = -(32gRS)^0.5 \log \{(ks/14800R) + (1.255 (R/22 - R))^0.5 \}$ 

(1.255v/R(32gRS)^0.5)}

Where  $g = acceleration due to gravity in m/s^2$ 

R = hydraulic radius in m

S = gradient

k<sub>s</sub> = roughness in mm

v = kinematic viscosity of water in m<sup>2</sup>/s

## 5.1.3 Codes of Practice and Design Manuals

5.1.3.1 The assessment has been carried out in accordance with the guidelines set out in EPD Report No. EPD/TP1/05 Guidelines for Estimating Sewage Flows (GESF) for Sewage Infrastructure Planning Version 1.0 and in accordance with DSD Sewerage Manual (2013) [(Part 1: Key Planning Issues and Gravity Collection System (3<sup>rd</sup> Edition) and Part 2: Pumping Station and Rising Main (2<sup>nd</sup> Edition)]

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#### 5.2 Design Parameters

#### 5.2.1 Unit Flow Factors

5.2.1.1 Unit flow factor is the average sewerage flow (average dry weather flow or ADWF) contributed by one unit of sewage source (person, employee or unit area) per day. According to Guidelines for Estimating Sewage Flows for Sewage Infrastructure Planning (GESF) published by EPD, the recommended unit flow factors are summarized in following Table 5.1:

Table 5.1: Unit Flow Factors

Type	Unit Flow Factor		
	(m³/person/day)		
Domestic			
Public Rental Housing	0.19		
Private R1	0.19		
Private R2	0.27		
Private R3	0.37		
Private R4	0.37		
Traditional Village	0.15		
Permanent Housing	0.23 (1)		
Commercial			
Commercial Employee	0.08		
Commercial activities:			
S1 (J7)	-		
S2 (J1)	0.45		
S3 (J2)	0.25		
S4 (J9)	0.15		
S5 (J5)	-		
S6 (J4)	-		
S7 (J4)	-		
S8 (J3)	0.10		
S9 (J10)	1.50		
S10 (J10)	1.50		
S11 (J3)	0.10		
S12 (J6)	-		
S13 (J6)	-		
S14 (J6)	-		
S15 (J12)	-		
S16 (J11)	0.20		
S17 (J11)	0.20		
S18 (J11)	0.20		
S19 (J11)	0.20		
Industrial			
Industrial Employee	0.08		
Industrial Activities	0.20		
Institutional			
School Student	0.04		

Note: (1) Permanent housing for North Lantau catchment wide planning

#### 5.2.2 Peaking Factors

5.2.2.1 Peaking factors cater for seasonal/diurnal fluctuation and normal amount of infiltration and inflow. The peaking factors shall be in accordance with GESF and are shown in **Table 5.2**.

Table 5.2: Peaking Factors for Various Population Ranges

Population Range	Peaking Factor (including stormwater allowance) for facility with existing upstream sewerage	Peaking Factor (excluding stormwater allowance) for facility with new upstream sewerage
Sewers		
< 1,000	8	6
1,000 - 5,000	6	5
5,000 - 10,000	5	4
10,000 - 50,000	4	3
> 50,000	Max (7.3/N <sup>0.15</sup> , 2.4)	Max (6/N <sup>0.175</sup> , 1.6)
Sewage Treatment Worl Stations	s, Preliminary Treatment V	Works and Pumping
< 10,000	4	3
10,000 - 25,000	3.5	2.5
25,000 - 50,000	3	2
> 50,000	Max (3.9/N <sup>0.065</sup> , 2.4)	Max (2.6/N <sup>0.065</sup> , 1.6)

Note:

N = Contributing population in thousands.

Contributing population = Calculated total average flow (m<sup>3</sup>/d) / 0.27 (m<sup>3</sup>/d)

## 5.3 Sewage Flow Estimation

5.3.1 The potential development at Area 4a, 10b and 22 will generate 844.47 m<sup>3</sup>/d as shown in **Table 5.3** below.

Table 5.3: Sewage Flow Estimation Summary

Areas	Proposed Uses	Population	Unit Flow Factor (UFF) (m³/person/d) <sup>(1)</sup>	ADWF (m³/d)
Existing School with GFA Increase	School	62	0.04	2.48
Area 6f	Residential	1,190	0.37	440.30
Area 4a	Residential	180	0.37	66.60
Area 10b	Residential	1,965	0.37	727.05
Area 22	Sports and Recreational	182	0.28	50.82

Total Additional ADWF (m³/d) 1,287.25

Note: (1) R3 residential type is adopted for potential development



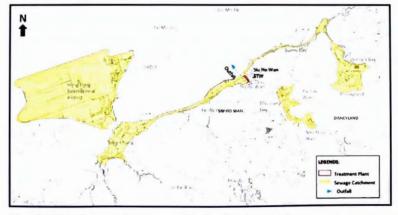
5.3.2 For the purpose of assessing the potential impact on the existing sewerage and sewage treatment facilities, sewage flow generated from another approved development at Area 6f and minor increase in student number due to existing school with GFA increase will also be considered. The total additional sewage flow generation is 1,287.25 m<sup>3</sup>/d.

## 5.4 Existing Sewerage System

5.4.1 Sewage generated from existing Discovery Bay development is collected by four existing sewage pumping stations (i.e. Sewage Pumping Station No. 1, No. 2, No. 3 and No. 4) at Discovery Bay and then transferred to DSD Siu Ho Wan Sewage Treatment Works (SHWSTW) for further treatment and disposal via internal rising mains between the sewage pumping stations and existing 450mm diameter twin rising mains laid along Discovery Bay Tunnel. Existing sewerage system is illustrated in Figure 3.

#### 5.4.2 Siu Ho Wan Sewage Treatment Works

- 5.4.2.1 Siu Ho Wan Sewage Treatment Works (SHWSTW) was a preliminary sewage treatment works when it was commissioned in 1996. It was subsequently upgraded under the Project PWP Item 4224DS "Outlying Islands Sewerage Stage 1 Phase 1C Upgrading of Siu Ho Wan Sewage Treatment Plant" to chemically enhanced primary treatment (CEPT). The scope of the project included increasing the treatment capacity of SHWSTW to 180,000 m³/d and a peak flow of 3,750 l/s so as to cater for the increase in sewage flow. Space was previously reserved for further extension to around 5,000 l/s.
- 5.4.2.2 Currently SHWSTW receives sewage from Hong Kong International Airport, Tung Chung, Disneyland, Penny's Bay, Sunny Bay, Discovery Bay and Siu Ho Wan. Catchment area of SHWSTW is shown as follows:



Siu Ho Wan Sewage Treatment Works Catchment Area

### 5.5 Sewerage Impacts

- 5.5.1 Additional sewage generated from the approved and the potential development is proposed to discharge to the SHWSTW for further treatment and disposal. In order to assess the potential impact on the sewerage network, the future sewage flows in the sewage catchment of the SHWSTW have been extracted from the Tung Chung New Town Extension Environmental Impact Assessment (TCNTE EIA), which is available EPD website.
- As refer to the TCNTE EIA, the projected sewage flows (ADWF) at SHWSTW forecast to Year 2031 is 144,585 m³/day. The future sewage flows in the catchment of SHWSTW as extracted from the TCNTE EIA have been estimated based on the population forecast in the Tung Chung New Town Extension as well as the 2009-based Territorial Population and Employment Data Matrix (TPEDM) within the catchment with sewage projections from the interfacing 3RS project at HKIA considered. Table 5.5 summarized the estimated sewage flow at SHWSTW in year 2031 as extracted from the TCNTE EIA.

**Table 5.5:** Summary of Estimated Sewage Flow at Existing STW in Year 2031 (Extracted from TCNTE EIA)

Catchment [1]		ADWF (m³/day)	Design Capacity (Existing Capacity) (m³/day, ADWF)
SHW STW	Existing catchment (PDZs 239,241,245,247,262,266,2 82,327,395,396,398) + TCW Development + TCE Development Ultimate Stage + 3RS project	144,585	180,000 (90,000)

#### Notes:

- Refer to 2009-based TPEDM for Planning Data Zone (PDZ) boundaries
- 5.5.3 With the total additional sewage flow from the approved and potential development at Area 6f, 4a, 10b and 22 of 1,287.25 m³/day, the total future ADWF at SHWSTW in year 2031 will be 145,872 m³/day which is within the design capacity of SHWSTW of 180,000 m³/d.

### 5.6 Proposed Sewerage System

5.6.1 Gravity sewer is proposed to convey the sewage from Area 4a, 10b and 22 to the existing Sewage Pumping Station No. 2. The sewer is proposed to have size of 350mm diameter.

## 6 Water Supply Study

## 6.1 Methodology and Guidelines

6.1.1 The water supply study reviews the existing water supply system for Discovery Bay. It estimates the fresh and flushing water demands from the approved development Area 6f, the potential development Area 4a, 10b and 22, and the existing OZP approved 25,000 population at Discovery Bay. It also recommends water supply option to supply the new development area. This section presents the design method, parameters and criteria used for this water supply study.

## 6.1.2 Design Method

6.1.2.1 Water main capacity will be calculated based on the Continuity Equation:

Q = AV

Where  $Q = \text{full flow capacity in } m^3/s$ 

A = cross-sectional area in m<sup>2</sup>

V = velocity at full bore flow in m/s

## 6.1.3 Codes of Practice and Design Manuals

6.1.3.1 In accordance with WSD's Departmental Instruction (DI) No. 1309 "Design Criteria", the following design parameters and peak demand factors are adopted for the design of proposed fresh and flushing water supply systems.

## 6.2 Design Parameters

#### 6.2.1 Unit Demand

6.2.1.1 The unit water demands for the residential water demand estimate listed in WSD's DI 1309 are shown in **Table 6.1** below. Since no detailed breakdown of zone types is available at this stage of Study, water unit demand for R3 has been adopted to suits the potential developments.

Table 6.1: Fresh and Flushing Water Unit Demand for Demand Estimate

	Fresh Water		Flushing	
Zone Type	Residential	Service Trade	Flushing Water	Unit
		Resident	ial	

	Fresh Water		Washing.	
Zone Type	Residential	Service Trade	Flushing Water	Unit
Public Rental Housing	140	40	70	Litre/head/day
RI	230	40	70	Litre/head/day
R2	300	40	70	Litre/head/day
R3	390	40	70	Litre/head/day
R4	390	40	70	Litre/head/day
Village	230	40	70	Litre/head/day
		Commerc	ial	
General	40		20	Litre/m <sup>2</sup> GFA/day
Hotel	1200	'	140	Litre/room/day
Hospital	455		295	Litre/bed/day
School Student	25		25	Litre/head/day

#### 6.2.2 Water Treatment Works Capacity:

Fresh water system – 1.2 times mean daily demand

#### 6.2.3 Service Reservoir Capacity:

 Fresh water system (Secondary) – 85% of mean daily demand for isolated supply zones.

#### 6.2.4 Peak Flow Rates in Pumping Main:

- Fresh water system 1.5 times mean daily demand
- Salt water system 1.5 times mean daily demand

#### 6.2.5 Peak Flow Rates in Distribution Main:

- Fresh water system 3 times mean daily demand
- Salt water system 2 times mean daily demand

#### 6.2.6 Residual Head Requirement:

- Fresh water system 20m
- Salt water system 15m

#### 6.2.7 Maximum Flow Velocity for Pumping Main:

· 3 m/s under peak flow conditions

#### 6.2.8 Maximum Flow Velocity for Distribution Main:

- > DN700 ≤ 3 m/s
- DN700 to DN525  $\leq$  2.5 m/s
- DN450 to DN375 ≤ 2 m/s



DN300 to DN200 ≤ 1.5 m/s

#### 6.3 Water Demand Estimation

6.3.1 The potential development at Area 4a, 10b and 22 will generate 973.2 m<sup>3</sup>/d (887.4+85.8) fresh water demand and 162.9 m<sup>3</sup>/d flushing water demand based on 2,327 population, as shown in **Table 6.2** below.

Table 6.2: Water Demand Estimation Summary

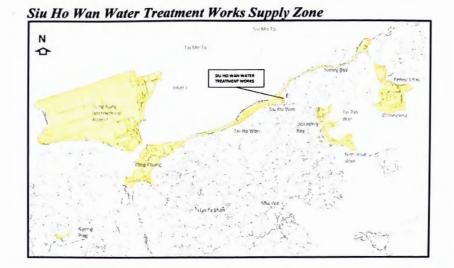
Areas	Proposed Uses	Population		ter Demand (d) <sup>(1)</sup>	Flushing Water
Areas	Proposed Oses		Fresh Water	Service Trades	Demand (m³/d)
Existing School with GFA Increase	School	62	1.6	-	1.6
Area 6f	Residential (Approved)	1,190	464.1	47.6	83.3
Area 4a, 10b and 22	Residential + Sports and Recreational (Potential)	2,327	887.4	85.8	162.9
	Total Resident =	3,579	1,4	186.4	247.7

Note: (1) R3 residential type is adopted for potential development, i.e. fresh water unit demand = 0.390 m³/head/day; service trades unit demand = 0.040 m³/head/day; and flushing water unit demand = 0.070 m³/head/day.

6.3.2 For the purpose of assessing the potential impact on the existing water supply infrastructure, water demand from another approved development at Area 6f and the existing school with GFA increase will also be considered. With a residential population of 1,190 at Area 6f and the minor increase in staff no. of 62, the estimated fresh and flushing water demands are 513.3 m<sup>3</sup>/d (464.1+47.6+1.6) and 84.9 m<sup>3</sup>/d (83.3+1.6) respectively.

## 6.4 Existing Fresh Water Supply System

6.4.1 Discovery Bay falls within supply zone of Siu Ho Wan Water Treatment Works (SHWWTW) and the Siu Ho Wan FWPS. Supply zone of SHWWTW is shown below and the existing fresh water supply system is illustrated in **Figure 4**.



#### 6.4.2 Siu Ho Wan Water Treatment Works

6.4.2.1 SHWWTW was commissioned in November 1996 and has a nominal capacity of 150,000 m<sup>3</sup>/d. Allowance has been made for expansion to an ultimate capacity of 300,000 m<sup>3</sup>/d.

#### 6.4.3 Siu Ho Wan Fresh Water Pumping Station

6.4.3.1 Treated water from SHWWTW with capacity of 150,000 m³/d is delivered by Siu Ho Wan FWPS to Tung Chung Fresh Water Service Reservoir via existing 1000mm / 1200mm fresh water pumping main.

## 6.4.4 Discovery Bay Fresh Water Booster Pumping Station

6.4.4.1 Discovery Bay Fresh Water Booster Pumping Station delivers fresh water to Discovery Bay via a 450mm branch-off pipe of the existing 1200 mm fresh water pumping main near SHWWTW. A 450 mm outlet pumping main of Discovery Bay Fresh Water Booster Pumping station, laid along Discovery Bay Tunnel, delivers fresh water to the Discovery Bay Fresh Water Service Reservoirs No. 1 and No. 2 for distribution to the Discovery Bay.

#### 6.4.5 Discovery Bay Fresh Water Service Reservoir

6.4.5.1 There are two fresh water service reservoirs in Discovery Bay, namely Discovery Bay Fresh Water Service Reservoirs No. 1 and No. 2. They are interconnected and located at the same level of around +95 mPD with top water level of +101 mPD. Discovery Bay Fresh Water Service Reservoirs No. 1 and No. 2 have capacities of 7,250 m<sup>3</sup> and 2,992 m<sup>3</sup>

respectively. Total capacity of these two service reservoirs is 10,242 m<sup>3</sup>.

## 6.5 Existing Flushing Water Supply System

- 6.5.1.1 Discovery Bay has its own flushing water supply system by intercepting existing hillside runoff by catchwater to the Discovery Bay Reservoir for flushing purpose. Existing flushing water supply system is illustrated in Figure 4.
- 6.5.1.2 The existing Discovery Bay Reservoir also provides both fresh and flushing water supply to the adjacent Nim Shue Wan Village.
- 6.5.1.3 Discovery Bay Reservoir collects and stores rainwater to supply flushing water to existing Discovery Bay developments and fresh and flushing water to Nim Shue Wan Village. It has a rainwater catchment area of around 138 ha, including 18 ha of the reservoir itself (at top water level). Summary details of the Discovery Bay Reservoir are provided in **Table 6.3**.

Table 6.3: Description of Discovery Bay Reservoir

Name of Reservoir	Supply Zone	Capacity (m³)	Invert Level (mPD)	Top Water Level (mPD)
Discovery Bay Reservoir	Discovery Bay and Nim Shue Wan Village	3,400,000	+125	+175

- 6.6 Fresh Water Supply Impacts and Provisions
- 6.6.1 Fresh Water Supply Supply from Siu Ho Wan Water Treatment Works
- 6.6.1.1 Siu Ho Wan Water Treatment Works and Siu Ho Wan Fresh Water Pumping Station
- 6.6.1.2 Fresh water to the approved development Area 6f and the potential development Area 4a, 10b and 22 is proposed to be supplied by the SHWWTW.
- 6.6.1.3 The existing capacity of the SHWWTW is insufficient to supply the existing developments, other concurrent and future developments within the supply zone of SHWWTW. However, the future expansion works of SHWWTW and Siu Ho Wan FWPS to a capacity of 300,000 m³/d should be adequate to supply both its catchment and additional fresh water (1,486 m³/d) to Discovery Bay approved and potential developments at both Area 6f and 4a, 10b & 22 (i.e. 0.5% of 300,000 m³/d upgraded treatment capacity of SHWWTW).
- 6.6.1.4 Existing capacity of Siu Ho Wan FWPS is same as SHWWTW (150,000 m<sup>3</sup>/d). Upgrading of Siu Ho Wan FWPS to 300,000 m<sup>3</sup>/d would be necessary.

#### 6.6.1.5 Discovery Bay Fresh Water Booster Pumping Station

Existing Discovery Bay Fresh Water Booster Pumping Station has four pump bays and house three pump sets (2 duty and 1 standby) with a reliable output of about 15,120 m³/d (87.5 L/s each with 100.5m head) to deliver fresh water to Discovery Bay. It will be capable of delivering the total fresh water demand of Discovery Bay including the Discovery Bay potential developments at both Area 6f and 4a, 10b & 22 and existing school with GFA increase (12,339 m³/d) as shown in **Table 6.6**.

Table 6.6: Total Fresh Water Demand of Discovery Bay

Population	Population Type	Unit Flow Factor (m³/person/d)	Fresh Water Demand (m³/d)
25,000	Residential	0.390 + 0.04	10,750
4,100	School	0.025	102.5
62	School	0.025	1.55
1,190	Residential	0.390 + 0.04	512
2,145	Residential	0.390 + 0.04	922.4
182	Sports and Recreation Club	0.28	50.8
	25,000 4,100 62 1,190 2,145	Population         Type           25,000         Residential           4,100         School           62         School           1,190         Residential           2,145         Residential           Sports and Recreation	Population Type         Population Factor (m³/person/d)           25,000         Residential         0.390 + 0.04           4,100         School         0.025           62         School         0.025           1,190         Residential         0.390 + 0.04           2,145         Residential         0.390 + 0.04           Sports and Recreation         0.28

Total MDD = 12,339

6.6.1.7 The existing 450 mm pumping main from Discovery Bay Fresh Water Booster Pumping Station to Discovery Bay has been checked to be capable of meeting total fresh water demand of Discovery Bay and the approved and the potential development. No upgrading of this trunk main would be envisaged. Detailed calculations are provided in APPENDIX B3.

#### 6.6.1.8 Fresh Water Service Reservoirs at Discovery Bay

- 6.6.1.9 According to WSD's DI 1309, fresh water service reservoir requires total storage capacity of 0.85MDD (for isolated water supply zones), i.e. 12,339 m³/d x 0.85 = 10,488 m³/d (to supply the existing development, the approved development Area 6f and the potential development Area 4a, 10b and 22 with minor increase in GFA in the existing school). Detailed calculations are provided in APPENDIX B3 and summary of total fresh water demand of Discovery Bay is provided in above Table 6.6.
- 6.6.1.10 Total capacity of existing Discovery Bay Fresh Water Service Reservoirs No. 1 and No. 2 is 10,242 m<sup>3</sup>/d (7,250m<sup>3</sup> + 2,992m<sup>3</sup>). The storage volume of the existing reservoirs is marginally below 0.85MDD

of the ultimate fresh water demand from the existing Discovery Bay, the approved development and the potential development (total 10,488 m³/d). The storage of the Service Reservoirs No. 1 and No. 2 are recommended to be expanded: additional fresh water storage of 246m³ will be required (to support both Area 6f, 4a, 10b and 22 and minor increase in GFA in the existing school). Detailed calculations are provided in APPENDIX B3.

## 6.7 Flushing Water Supply Impacts and Provisions

## 6.7.1 Discovery Bay Reservoir

6.7.1.1 Discovery Bay Reservoir provides flushing water to existing Discovery Bay and both fresh and flushing water to Nim Shue Wan Village. Following the current flushing water supply arrangement, flushing water for the approved and the potential development Areas 6f and 10b & 4a is proposed to be supplied by the Discovery Bay Reservoir. Detailed calculations are provided in APPENDIX B3 and a summary of total water supply from Discovery Bay Reservoir is provided in Table 6.8.

Table 6.8: Total Water Demand from Discovery Bay Reservoir

Supply Zone	Population	Population Type	Unit Flow Factor (m³/person/d)	Flushing Water Demand (m³/d)
Flushing Demand from	25,000	Residential	0.07	1,750
Existing Discovery Bay Development	4,100	School	0.025	102.5
Existing School with GFA Increase	62	School	0.025	1.55
Fresh and Flushing Water Demand from Existing Nim Shue Wan Village	150	Residential + Service Trades	0.23+0.04+0.07	51.0
Discovery Bay approved development Areas 6f	1,190	Residential	0.07	83.3
Discovery Bay potential development Areas 4a and 10b	2,145	Residential	0.07	150.2
Discovery Bay potential development Area 22	182	Sports and Recreation Club	0.07	12.7
			Total =	2,152.8

6.7.1.2 A similar analysis has been carried out to check the adequacy of water supply for the Discovery Bay Reservoir during a drought year. The assessment considered all inflows and outflows into and out of the reservoir during the drought year in 2011. It estimated that after the drought year, the Discovery Bay Reservoir will still have around 1.1

million  $m^3$  storage volume, which is still more than total water demand for a whole year  $(2,153 \text{ m}^3/\text{d} \times 365 = 0.79 \text{ million m}^3)$ . It shows that it is feasible to provide flushing water supply for the approved and the potential developments from the Discovery Bay Reservoir. Capacity checking calculations for Discovery Bay Reservoir in the drought year are provided in **APPENDIX B3**.

6.7.1.3 The Discovery Bay Reservoir is feasible to provide flushing water supply for developments at both Area 6f and Area 4a, 10b & 22 and the minor increase in GFA in the existing school.

#### 6.7.2 Existing Flushing Water Main

Reservoir has been checked to be capable to supply flushing water to Discovery Bay as well as both fresh and flushing water to Nim Shue Wan Village. No upgrading of flushing water main would be envisaged. Checking calculations are attached in APPENDIX B3.

## 6.8 Proposed Fresh and Flushing Water Supply Systems

6.8.1 New 200 mm fresh water main and new 80 mm flushing water main are proposed for water supply to potential development Area 10b. New 50mm fresh water main and 25mm flushing water main are proposed for water supply to potential development Area 4a and 22 respectively. Figure 4 shows the proposed water supply layout plan and water main sizing calculations are attached in APPENDIX B3.



## 7 Conclusions

7.1.1 Sections 4 to 6 have provided a baseline review and preliminary impact assessments on drainage, sewerage and water supply systems. Mitigation measures to existing facilities and recommendation on new facilities to cater for the potential developments have also been proposed.

## 7.2 Drainage System

7.2.1 Preliminary drainage scheme has been proposed to discharge the surface runoff generated from potential development Area 4a, 10b and 22 to the sea nearby.

## 7.3 Sewerage System

7.3.1 Sewage generated from potential development is proposed to discharge to the SHWSTW for further treatment and disposal. Gravity sewer is proposed to convey the sewage from Area 4a, 10b and 22 to the existing Sewage Pumping Station No. 2. The sewer is proposed to have size of 350mm diameter.

## 7.4 Water Supply System

## 7.4.1 Fresh Water Supply System

- 7.4.1.1 The existing capacity of the SHWWTW is already insufficient to supply the existing developments and other concurrent developments within the supply zone of SHWWTW irrespective of the Discovery Bay potential developments. However, the future expansion of SHWWTW and Siu Ho Wan FWPS to the capacity of 300,000 m³/d is expected to take into account the 0.5% fresh water demand of Discovery Bay the approved and the potential developments at both Area 6f and 4a, 10b & 22 and the minor increase in GFA in the existing school. Upgrading SHWWTW and Siu Ho Wan FWPS to the capacity of 300,000 m³/d would be adequate.
- 7.4.1.2 Existing Discovery Bay Fresh Water Booster Pumping station has four pump bays and house three pump sets (2 duty and 1 standby) with a reliable output of about 15,120 m<sup>3</sup>/d (87.5 L/s each with 100.5m head) to deliver fresh water to Discovery Bay including the potential developments. It will be capable to deliver total fresh water demand of Discovery Bay.

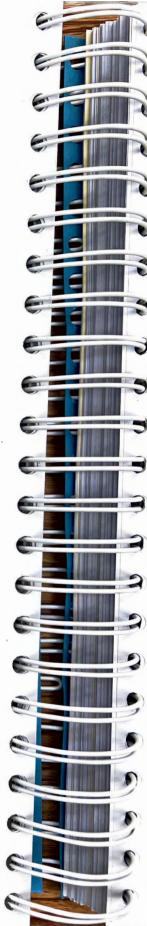
## 7.4.2 Flushing Water Supply System

7.4.2.1 Discovery Bay Reservoir, has been checked to be capable of flushing water supply to both the existing and potential developments including

the existing water supply to Nim Shue Wan Village. No upgrading of Discovery Bay Reservoir would be envisaged.

#### 7.4.3 Proposed Fresh and Flushing Water Supply Systems

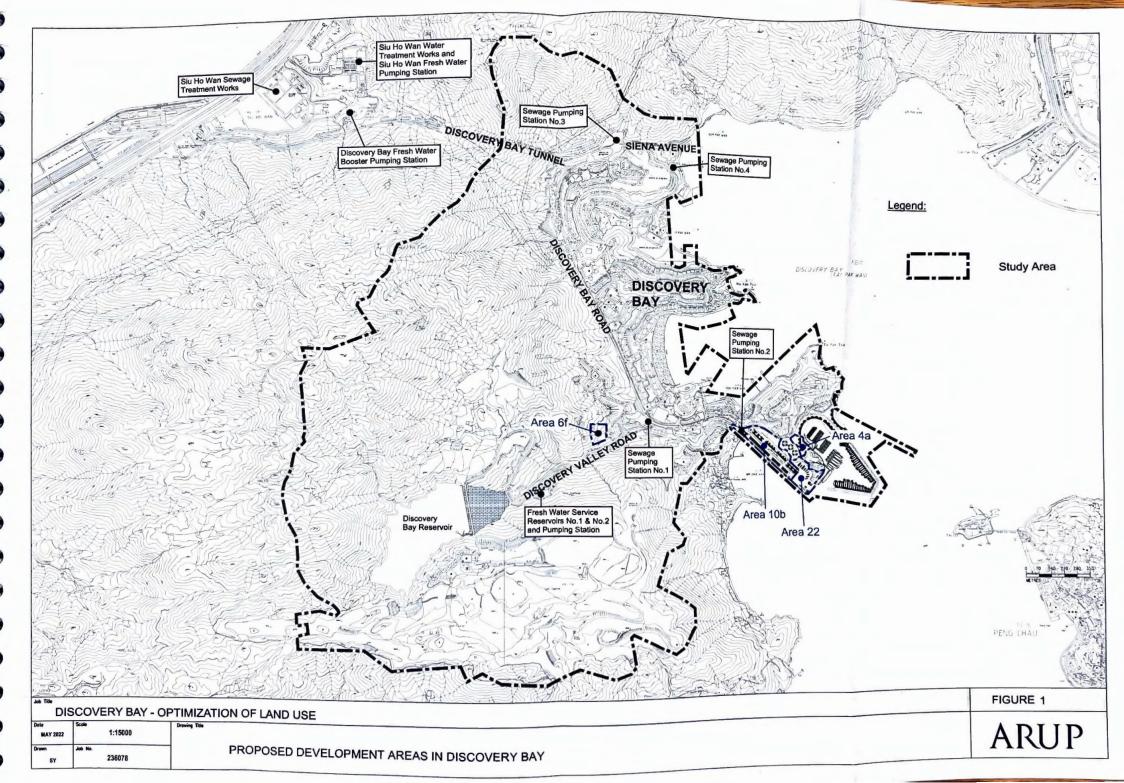
7.4.3.1 New 200 mm fresh water main and new 80 mm flushing water main are proposed for water supply to potential development Area 10b. New 50mm fresh water main and 25mm flushing water main are proposed for water supply to potential development Area 4a and 22 respectively.

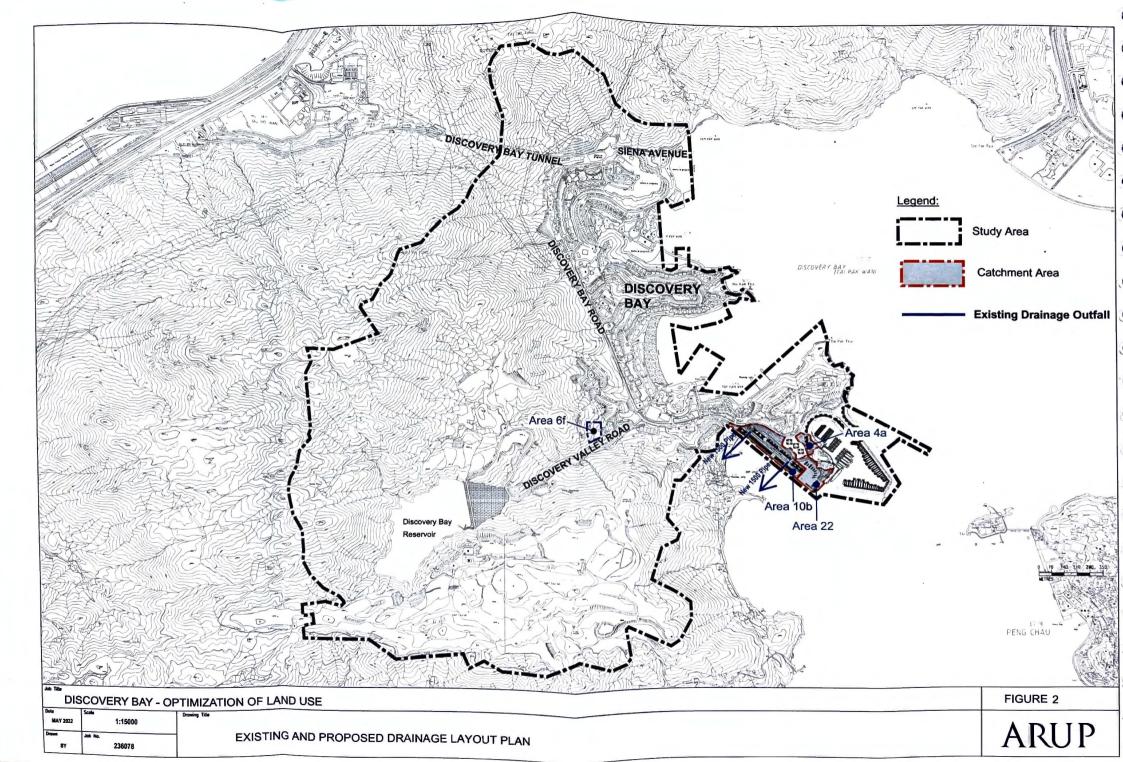


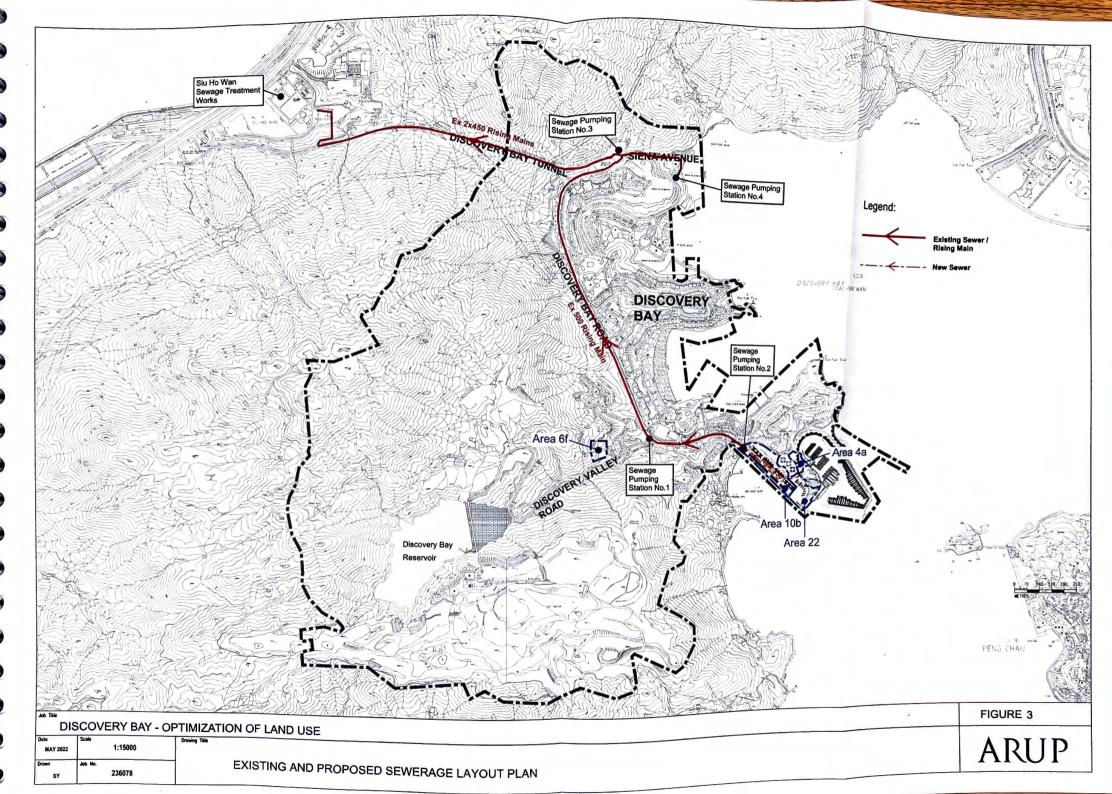


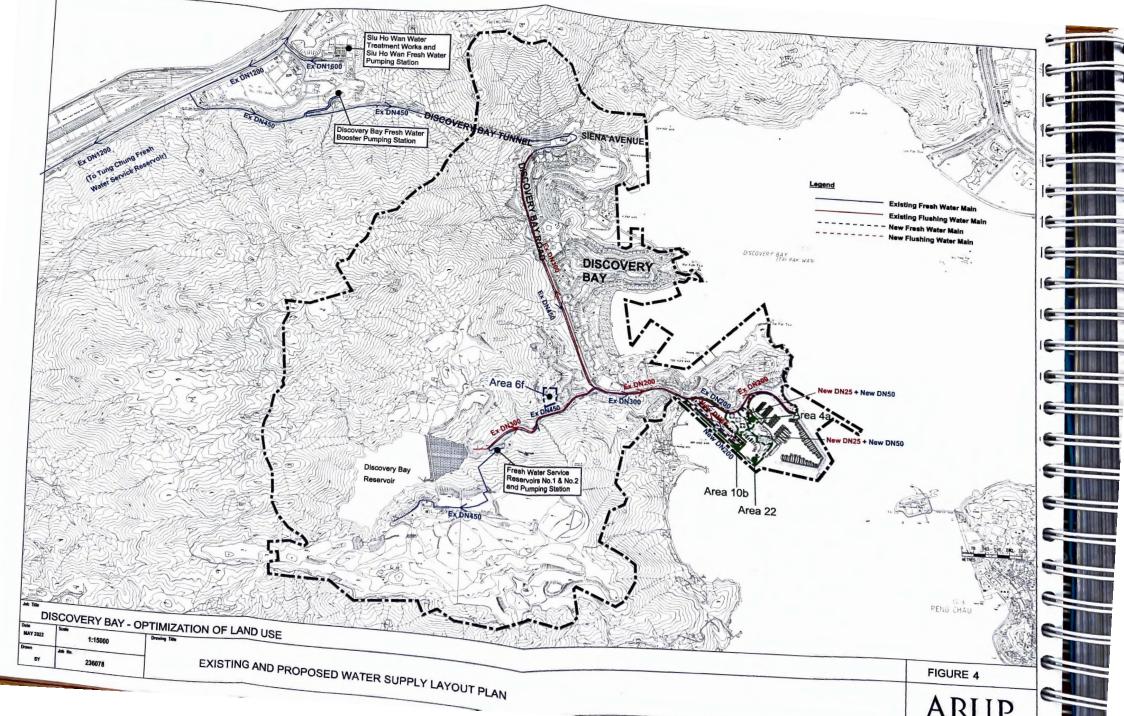
## APPENDIX A

Figures











## APPENDIX B1

Calculations on Proposed Drainage System

ARUP .

Design Assumption:

Job Title:

Discovery Bay Optimization of Land Use

Rational method to estimate runoff and determination proposed drainage pipe

Use

1 in 200 year design event for sizing trunk system

2.05

to = time of concentration of a natural catchment (min.)

= 0.14465L

H0.2 A0.1

where A = catchment area ( $m^2$ ) = 32.8x10<sup>4</sup>  $m^2$ H = average slope (m per 100m) of the natural flow = 72m L = distance (m) of the natural flow = 473m

u = 1.0E-6 ks = 0.6 C (Paved) = 1.00 C (unpaved) = 0.30

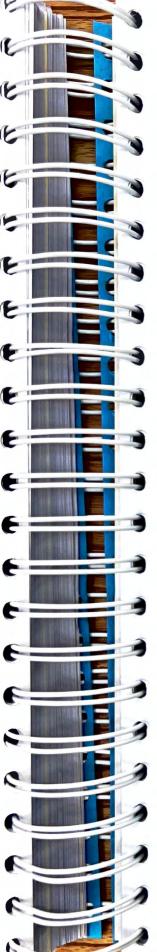
(200 year) a = 429.5

Rainfall Increase = 13.8%

(End of 21st Century)

Potential Development Area	Pipe Size	Length (m)	No. of Pipe	Pipe Width (m)	Pipe Height (m)	Gradient (%)	Gradient (1 in X)		Perimeter (m)	R =A/P (m)	32gRS	Velocity (m/s)	Tf (min)	Tc (min)	Intensity (mm/hr)	Total Catchment Area (paved & unpaved) (m²)	Catchment Area (paved) (m²)	Cumulative Catchment Area (paved) (m²)	Catchment Area (unpaved) (m²)	Cumulative Catchment Area (unpaved) (m <sup>2</sup> )	Cumulative Runoff From Catchment (m³/s)	Pipe Capacity (m³/s)	% Full
Site 4a, 10b and 22	1500 Dia.	10	2	1.50	1.50	0.3%	300	1.766	4.710	0.375	0.626	2.471	0.067	5.067	274	81,600	81,600	81,600	0	0	6.214	8.730	71%
•					•							14.1											

Checked By:



## **APPENDIX B2**

Calculations on Proposed Sewerage System

#### **ARUP**

Job Title:

Discovery Bay Optimization of Land Use

Development	No. of Residential Unit	Non-Domestic GFA (m²)	Population / Employee	Population Type	Unit Flow Factor (m³/person/day)	C 4500-	ks= 3 Peaking Factor for		Ta	Checked By Rev.	NN.	
Existing Discovery	10000 (Existing)		25,000 (Existing)	Existing Residential	0.37	0	Sewer	Peak Flow (L/s)	Proposed Sewer Size		Capacity of Proposed	
Bay Development			4,100 (Existing)	Existing School	0.04	0	100		(mm)	Gradient (1:x)	Sewer (L/s)	
bay bevelopment	-		62 (Proposed)	Existing School with GFA Increase	0.04	-	- Carlo				Sewer (L/S)	Proposed Sewer
Area 6f	476 (Approved)	-	1,190 (Approved)	Approved Residential	0.37		4.482					
Area 4a	72 (Proposed)		180 (Proposed)	Proposed Residential	0.37		14 8 37 2			Dr		
Area 10b	786 (Proposed)		1965 (Proposed)	Proposed Residential	0.37		476					
Area 22		5500 (Proposed)	182 (Proposed)	Proposed Sports and Recreational	0.28	844.47						

Total Existing ADWF (m3/d) 9,414.00 Total Existing & Additional ADWF (m3/d) 10,701.25

Notes:

Employment density shall refer to Commercial and Industrial Floor Space Utilization Survey published by PlanD. Community, Social & Personal Services = 3.3 employee per 100m<sup>2</sup> of GFA.



## **APPENDIX B3**

Capacity Checking Calculations on existing Discovery Bay Reservoir, Fresh Water Service Reservoir and Proposed Water Supply System

ARUP

Discovery Bay Optimization of Land Use Job Title:

Calculation on Water Main and Service Reservoir

180   Trade   0.43   180   1965   Residential + Service   0.43   845   1965   182	Development	Population	Population Type	Unit Flow Factor (m <sup>3</sup> /person/day)	Water Demand (m³/d)
10b 1965 Trade 0.43	44	180		0.43	77.4
	106	1965		0.43	845.0
	22	182	Sports + Recreational Club	0.28	50.8

Development	Population	Population Type	(m³/person/day)	Water Demand (m³/d)
40	180	Residential	0.07	12.6
10b	1965	Residential	0.07	137.6
22	182	Sports + Recreational Club	0.07	12.7
		1 000	T-1-1 D	162.9

Development	Population	Population Type	Unit Flow Factor (m³/person/day)	Water Demand (m <sup>1</sup> /d)
Existing School with GFA Increase	62	School	0.025	1.6
61	1190	Residential + Service Trade	0.43	511.7
40	190	Residential + Service Trade	0.43	77.4
106	1965	Residential + Service Trade	0.43	845.0
22	182	Sports + Recreational Club	0.28	50.8

Development	Population	Population Type	Unit Flow Factor (m <sup>3</sup> /person/day)	Water Demand (m³/d)
Existing School with GFA Increase	62	School	0.025	1.6
6f	1190	Residential	0.07	83.3
43	180	Residential	0.07	12.6
106	1965	Residential	0.07	137.6
22	182	Sports and Recreational Club	0.07	12.7
			Total Demand (m3/d)	242.7

Existing Fresh Water Demand	10853	(m <sup>3</sup> /d)	
New Fresh Water Demand	1486	(m³/d)	
Total Fresh Water Demand	12339	(m³/d)	( 142.8
Service Reservoir Capacity Required for Fresh Water System (85% of MDD)	10488	(m <sup>2</sup> )	
Capacity of Existing Service Reservoirs No. 1 (7,250m²) & No. 2 (2,992m²)	10242	(m³)	

Development	Population	Population Type	Unit Flow Factor (m³/person/day)	Water Demand (m <sup>1</sup> /d)
Existing Discovery Bay	25000	Residential	0.07	1750.0
Developments + the OZP (DB)	4100	School	0.025	102.5
Existing School with GFA Increase	62	School	0.025	1.6
Existing Nim Shue Wan	150	Residential + Service Trade	0.23+0.04+0.07	51.0
New Discovery Bay Development (6f, 4a, 10b and 22)	See Table 4	See Table 4	See Table 4	. 247.7
			Total Demand (m <sup>3</sup> /d)	2152.8

Total Water Demand (L/s)	Factor of Distribution Main	Total Peak Flow (U/s)	Proposed Distribution Main (mm)	Cross Section Area (mm²)	Proposed Main Velocity (m/s)
0.90	0.90 3		50	1963	1.37
9.78	3	29.34	200	31400	0.93
0.59	3	1.76	50	1963	0.90

tal Water Demand (L/s)	Factor of Distribution Main	Total Peak Flow (L/s)	Proposed Distribution Main (mm)	Cross Section Area (mm³)	Proposed Main Velocity (m/s)	
0.15	0.15 2		25	491	0.59	
1.59	2	3.18	80	5024	0.63	
0.15	2	0.29	25	491	0.60	

Total Water Demand (L/s)	Factor of Pump Main	Total Peak Flow (L/s)	Existing Pump Main (mm)	Cross Section Area (mm³)	Proposed Main Velocity (m/s) 1.3	
142.8	1.5	214.2	450	158963		

Total Water Demand (L/s)	Factor of Distribution Main	Total Peak Flow (L/s)	Existing Distribution Main (mm)	Cross Section Area (mm²)	Proposed Main Velocity (m/s)	
24.9	2	49.8	300	70650	0.7	

ARUP Job Title:

Discovery Bay Optimization of Land Use

Prepared By: Checked By:

Summary of Historic Monthly Rainfall Data Collected from Hong Kong Observatory

	Rainfall Data	(in mm) for	r Discovery	Bay (from Ho	ong Kong Ol	servatory, H	KO)	2014	2013	2012	2011*	2010 (Delease)
Year	2021	2020	2019	2018	2017	2016	2013	2638.3	2847.3	1924.7	1487.2	2371.7 (Driest Year *)
Total	2307.1	2395.0	2396.2	2162.9	2572.1	3026.8	1874.5	2638.3	2017.0	- 32	1	
Rainfall						BAR T			-			

<sup>\*</sup> The driest year with minimum rainfall during a 12-month period is considered.

Summary of Discovery Bay Reservoir Volume and Water Levels

Top water level of the Reservoir = Invert level of the Reservoir = Total Capacity of the Reservoir = Average surface area of the Reservoir =

Lowest water level of the Reservoir = (from record data during March 2008 to March 2014)

mPD 175 i.e. 50m water depth mPD 125 3,400,000

> i.e. 43.6m water depth mPD

> > 2152.8

(Assumed to be min. water level during the driest year in 2010/2011)

By pro-rata, storage volume of the Reservoir at lowest water level of +168.6 mPD =

2,964,800 m<sup>3</sup>

68,000

To be very conservative, assume only 50% of the Reservoir volume is available for water supply =

1,482,400 m<sup>3</sup>

Total Water Demand Required =

Checking of Adequacy of Existing Discovery Bay Reservoir to Meet Existing and New Water Demand during Driest Year

Water Demand: Flushing Water of New DB Development (Areas 6f, 10b and 4a) to be Supplied by Discovery Bay Reservoir

Development	Population	Population	Fresh Water /	Unit Flow Factor	Water Demand
Existing Discovery Bay 25000		Residential	Flushing Water	0.07	1750.0
Developments	4100	School	Flushing Water	0.025	102.5
Existing School with GFA Increase	62	School	Flushing Water	0.025	1.6
Existing Nim Shue Wan	150	Residential + Service	Fresh & Flush	0.23+0.04+0.07	51.0
New Discovery Bay	See Table 5	See Table 5	Flushing Water	See Table 5	247.7

(a) Inflow to Discovery Bay Reservoir

Runoff collected by catchwater from catchment

Total rainfall depth 1,487.2 mm Catchment Area 120 ha (assume runoff coefficient 0.3) Annual rainfall volume 535,392

Direct Rainfall on Reservoir Area

Total rainfall depth 1,487.2 mm Average surface area of Reservoir 68,000 Annual rainfall volume 101,130

(b) Outflow from Discovery Bay Reservoir

**Evaporation from Reservoir Surface** 

Annual evaporation rate in 2010 / 2011 1376.3 mm Reservoir top surface 18 Annual evaporation volume 247,734 Water demand from Existing and Proposed New Development

Daily total water demand 2,152.8 Annual water demand 785,756

Remaining Volume of Discovery Bay Reservoir

Reservoir Volume Inflow volume 1,482,400 m3 636,522 m3

Outflow volume 1,033,490 m<sup>3</sup>

1,085,432 m³

(Therefore Reservoir has adequate volume to meet water demand)

m3/d

(very conservative assumption)