APPENDIX 7.3
Relevant Modelling Parameters and Typical Diurnal Profiles

3.0 MODEL CONSTRUCTION

3.1 Software Selection

3.1.1 A hydraulic model should be built to a degree of details adequate for detailed investigation or scheme appraisals and detailed design of schemes. The software should be able to simulate surcharge and flooding, as well as backwater effects and reverse flows in a network of pipes. It should also be able to simulate flows at ancillary structures such as tanks, overflows, dry weather flow interceptors and pumping stations. Looped system is very common in urban sewerage system and hence the software's ability to model looped networks is a must.

3.1.2 InfoWorks is a worldwide commercial modelling software that fits the criteria for the software selection and is adopted in many Drainage Services Department's projects. InfoWorks CS version 8.0 is adopted for this Project.

3.2 Requirements for Simulation Data

Network Files

3.2.1 The essential physical arrangement of the sewerage system is held within the InfoWorks database as Network files. These files contain information, including level, pipe sizes and inter-connectivity of the system. These files form the "skeleton" of the models.

3.2.2 For nodes, the base area, chamber roof level, chamber plan area and shaft plan area are input into InfoWorks based on survey information, where available. Zero base area and chamber plan area are assigned to dummy nodes. If survey or as-built information is not available, the InfoWorks default values are adopted. The modelling assumptions and parameters of the special features are incorporated in **Appendix F**.

3.2.3 Much of the data for the Network files can be transferred from GIS database, STC25 database or it can be directly input into InfoWorks.

Rainfall Files

3.2.4 Rainfall events are stored as rainfall hyetographs files in the InfoWorks database. InfoWorks contains the historical rainfall data generator for Hong Kong and the rainfall profiles generated by the software are suitable for the design purposes.

Wastewater Profiles

3.2.5 Wastewater profiles are entered into the model to reflect the diurnal variation in wastewater flow throughout the day. 36 nos. of profiles were adopted to represent different flow patterns in different geographic areas or for particular land uses. Flow

monitors were located in the sewerage system to record flows at key positions and provide data for model input. The following profiles are used in this study:

Wastewater Profile No.	Land Use Description
1	Comprehensive Development Area (with residential units above)
2	Cooked Food Stall
3	Commercial Buildings (with offices/residential units inside)
4	Car Park Complex
5	Construction Sites
6	Factories or I/O bldgs in old Industrial Areas
7	Hospitals
8	Hotels
9	Public Lavatories
10	LCSD Facilities – Libraries, Galleries, Museums, Civic Centers
11	Market Complex
12	Office Bldgs (Predominantly offices)
13	Petrol Filling Stations
14	Public Services B – Regular hrs – Post Office, Public Admin, General Government Office
15	Public Services B – Irregular hrs – Fire Station, Police Station
16	Residential Group A
17	Residential Group B
18	Residential Group with more than 1500 population
21	Restaurants in Residential Areas
22	Religious Meeting Places
23	Primary & Secondary Schools/Teaching Institutes
24	Tertiary Education, Universities
25	Shopping Mall & Restaurants (No Office/residential)
26	Sport Grounds, Swimming Pools & Facilities
27	Rail or Traffic Terminus / Public Transport Interchange
29	Utilities
30	Institutions, Hostels, Aged Homes, Prison, Etc
31	Small School/Kindergarten with below 600 students
32	Day Clinics
33	District Community Centre/Office
34	Residential GP A with less than 350 population
35	Public Swimming Pools & Recreation Facilities
36	Temporary Structure

Trade Flow Profiles

3.2.6 The functions of the trade flow profiles are similar to the wastewater profiles except they represent the variation in trade waste flow. The following profiles are used in this study:

Trade Flow Profile No.	Land Use Description
1	Comprehensive Development Area (with residential units above)
2	Cooked Food Stall
3	Commercial Buildings (with offices/residential units inside)
4	Car Park Complex
5	Construction Sites
6	Factories or I/O bldgs in old Industrial Areas
7	Hospitals
8	Hotels
9	Public Lavatories
10	LCSD Facilities – Libraries, Galleries, Museums, Civic Centers
11	Market Complex
12	Office Bldgs (Predominantly offices)
13	Petrol Filling Stations
14	Public Services B – Regular hrs – Post Office, Public Admin, General Government Office
15	Public Services B – Irregular hrs – Fire Station, Police Station
16	Residential Group A
17	Residential Group B
18	Residential Group with more than 1500 population
21	Restaurants in Residential Areas
22	Religious Meeting Places
23	Primary & Secondary Schools/Teaching Institutes
24	Tertiary Education, Universities
25	Shopping Mall & Restaurants (No Office/residential)
26	Sport Grounds, Swimming Pools & Facilities
27	Rail or Traffic Terminus / Public Transport Interchange
28	Cinemas & Theatres
29	Utilities
30	Institutions, Hostels, Aged Homes, Prison, Etc
31	Small School/Kindergarten with below 600 students
32	Day Clinics
33	District Community Centre/Office
34	Residential GP A with less than 350 population
35	Public Swimming Pools & Recreation Facilities
36	Temporary Structure

Ancillary Hydraulic Structures

3.2.7 Data for ancillary structures, including pumping stations and DWFIs are entered into the hydraulic model. There are 3 nos. of DWFIs in the Tuen Mun catchement. Locations of the DWFI's and pumping stations are provided in **Figure 3.1.**

3.2.8 DWFIs were constructed to intercept and divert DWF from the stormwater drainage system to the sewerage system. These interceptors are modelled as either weirs or sluice gate. The methodology of assessing inflow and infiltration and hydraulic theory for modelling dry weather flow interceptor with examples are shown in **Appendices D and E** respectively.

Network Assets Parameters

3.2.9 (a) Headloss Coefficients

Headloss Coefficients shall be calculated based on the angle of approach of the incoming and outgoing pipes to each node. InfoWorks software package gives typical values for the headloss coefficient at certain angle of approach, and the software will calculate appropriate values as defaults throughout the network. The headloss coefficients would be modified only at some extreme cases such as at location where a side branch joined the trunk sewer at an acute angle.

3.2.10 (b) Sediment Depth and Pipe Roughness

The presence of sediment deposits in a pipe reduces the hydraulic capacity of the affected length of sewer, due to the loss of cross-sectional area and increase in roughness, and subsequently affects the upstream hydraulics.

For planning and design purpose, 10% of the pipe diameter is adopted as silt depth to simulate sewers aging in future. Flow surveys were conducted to obtain actual value for some critical cases, e.g. flat sewers, which had been incorporated into the hydraulic model. The Colebrook-White coefficient (Ks) of 3mm is used for both top and bottom roughness of a conduit.

The existing sediment depths should be verified and adjusted if necessary, when results from manhole and flow monitoring surveys are available according to the Sewerage Rehabilitation Manual published by WRc.

3.2.11 (c) Flood Types

Three types of flooding conditions at a node can be modelled by InfoWorks CS, as detailed below:

Flood Type	**Description**	**Description**
0	Sealed	The water level can rise indefinitely without any flooding occurring.
1	Stored	The flood water on the catchment surface is retained in the storage volume defined by the flood levels and areas specified below. The flood

Flood Type	Description	Description
		water returns to the drainage system as the levels drop.
2	Lost	Flood water is lost from the system.
3	Gully	In a storage volume defined in the Level / Plan Area Grid on the *Storage Parameters Page*. The discharge between surface storage and manhole is defined by a Head Discharge Table.

3.2.12 Flood type 2 is applied to all foul nodes except where sealed manholes, dummy nodes or flooded water are discharged to a separate system. The locations of these manholes are identified and confirmed on site. The double conical flood storage setting is amended as follows.

Depth 1 = 0.1m
Area 1 = 10%
Depth 2 = 1m
Area 2 = 50%

3.2.13 Gully type is suitable for controlling the flooded water flow out and returning to the system through the gully in the stormwater drainage system. It is not suitable for modelling sewerage system and will not be used in this study.

Contributing Areas

3.2.14 Contributing areas are the surface areas that contribute surface runoff to the model network. The urban drainage and sewerage system in Hong Kong are separate systems. The surface runoff should distribute to the storm drainage network and hence the contributing areas to the foul sewer network should be zero. In actual conditions, a small proportion of the surface runoff is connected to the foul sewer network by means of overflows or expedient connections. In general, a percentage contribution of 5% had been applied to the model initially and would be reviewed based on the short term flow monitoring survey results.

Runoff Area 1

3.2.15 There are surface areas that contributing surface runoff to the model network. Because the urban drainage and sewerage system in Hong Kong are separate systems, the surface runoff generally distributes to the storm drainage network and hence the Runoff Area 1 shall be zero.

3.2.16 Based on results from the short term flow monitoring survey, the percentage of the surface runoff connected to the sewerage network by means of overflows or expedient connections is shown as follows:

Flow Monitor Ref no.	Percentage of Runoff Connected to Sewerage Network in Upstream Sub-catchment
TM01	30%
TM04	10%
TM14	25%
TM17	5%
TM19	5%
TM20	1%
TM22	2%
TM23	2%
TM24	5%
TM25	5%
TM26	5%
TM34	3%
TM37	5%
TM38A	5%

Connectivity

3.2.17 The connectivity value of a catchment is a percentage of population within the catchment that the sewage generated from which is connected to the sewerage network. It is noted that some of the sewage flows from properties are connected to storm drainage network and therefore do not enter the sewerage network (unless intercepted by special constructed chambers in the drainage network). This leads to pollution of the storm drains and subsequently the Harbour. This particular variable was calibrated based upon the short term flow monitoring survey and manhole survey of the sewerage network under this Agreement and summarized below:

Flow Monitor Ref no.	Connectivity in Upstream Sub-catchment
TM01	100%
TM04	100%
TM14	100%
TM17	100%
TM19	75%
TM20	100%
TM22	100%
TM23	100%
TM24	100%
TM25	100%
TM26	100%
TM34	27%
TM37	100%
TM38A	100%

Infiltration

3.2.18 Infiltration can be assigned to individual pipe lengths or catchment areas in InfoWorks. Where infiltration is identified during dry weather condition of the model calibration, it is assigned to the catchment areas. Infiltration strictly occurs along pipe lengths, but it is significantly more useful, from an engineering perspective, to assign the infiltration flows to the catchment areas. The catchment areas can then be 'thematically mapped' to illustrate the distribution of infiltration across the catchment and highlight areas requiring further investigation.

3.2.19 The inflow values for the Study Area are provided in **Figure 3.2** and as follows:

Catchment by Flow monitor Ref no.	**Base Flow in Each upstream sub-catchment**
TM04	0.00014 m^3/s
TM14	0.00013 m^3/s
TM20	0.00004 m^3/s

Land Use ID	WW Profile No	Land Use Description	Unit Flow Factor
CDA	1	Comprehensive Development Area (with residential units above)	0.19
CFS	2	Cooked Food Stall	1.58
COM	3	Commercial Buildings (with offices/ residential units inside)	0.37
CPK	4	Car Park Complex	0.18
CSITE	5	Construction Sites	0.23
FTY	6	Factories or I/O bldgs in old Industrial Areas	0.63
HOS	7	Hospitals	0.37
HTL	8	Hotels	0.24/1.58
LAV	9	Public Lavatories	0.28
LCSF	10	LCSD Facilities - Libraries, Galleries, Museums, Civic Centres	0.28
MKT	11	Market Complex	0.28
OFF	12	Office Bldgs (Predominantly offices)	0.08
PFS	13	Petrol Filling Stations	0.28
PSA	14	Public Services B - Regular hrs - Post Office, Public Admin, GeneraGovt Ofice,	0.28
PSB	15	Public Services B - Irregular hrs - Fire Stn, Police Stn,	0.28
RA	16	Residential Group A	0.19
RB	17	Residential Group B	0.37
RAL	18	Residential Group with more than 1500 population	0.19
RESTC	19	Restaurants in Commercial Areas	1.58
RESTI	20	Restaurants in Industrial Areas	1.58
RESTR	21	Restaturants in Residential Areas	1.58
RMP	22	Religious Meeting Places	0.04
SCH	23	Primary & Secondary Schools/ Teaching Institutes	0.04
SCH3	24	Tertiary Education, Univetisties	0.04
SHM	25	Shopping Mall & Restaurants (No Office/ residential)	0.37
SPF	26	Sport Grounds, Swimming Pools & Facilities	0.28
STN	27	Rail or Traffic Terminus/ Public Transport Interchange	0.0005/ 0.28
THT	28	Cinemas & Theatres	0.03/ 0.28
UTI	29	Utilities	0.28
INST	30	Institutions, Hostels, Aged Homes, Prison , Etc	0.19
SCH2	31	Small School/ Kindegarten with below 600 students	0.04
CLN	32	Day Clinics	0.28
DCC	33	District Community Centre / Office	0.28
RAS	34	Residential Gp A with less than 350 population	0.19
SWP	35	Public Swiming Pools & Recreation Facilites	0.04/0.28