(iii.) Revised Text of Annex 3 Sewerage and Drainage Impact Assessment

Annex 3

Revised Sewerage and Drainage Impact Assessment

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Sewage and Drainage Impact Assessment

1. Introduction

The Application Site has a site area of about 400 m^2 falls within private land at Lot 1780 in D.D. Cheung Chau, Cheung Chau. The location plan of the Application Site is shown in **Figure 1**. The Application Site falls entirely within an area zoned "Residential (Group C)2" (R(C)2) on the Approved Cheung Chau Outline Zoning Plan No. S/I-CC/9 ("the OZP). The proposed development is an in-situ conversion of the existing building from kindergarten/nursery use to Social Welfare /Facility (Residential Care Home for Persons with Disabilities). The Proposed Development will provide 39 beds with a dining/living/activities area, a kitchen and a lavatory.

This report outlines the existing sewerage and drainage arrangements in the vicinity of the Application Site and examines the available capacity of the existing sewerage and drainage systems including sewage treatment plant and public sewer/drain systems. This report also calculates the sewage and stormwater flows generated from the proposed development and demonstrates that the proposed development is viable in term of the impact on the sewerage and drainage systems.

2. Existing Public Sewerage and Stormwater Facilities

As shown in **Figure 2**, the Application Site is located within the catchment area of Cheung Chau Sewage Treatment Works (CCSTW). The sewage generated from the application site will firstly flow to Tai Shek Hau Sewage Pumping Station (Tai Shek Hau SPS). The sewage will then be conveyed alongside the sea shore to another sewage pumping station namely Pak She Sewage Pumping Station (Pak She SPS) before finally being discharged into CCSTW.

As shown in **Figure 3A**, there is an existing 600mm combined pipe (CWD7000460) constructed from the Application Site to a combined manhole (CMH7000420) at Cheung Kin Road. Out from the combined manhole, the 600mm combined sewer goes eastwards along Cheung Kin Road to another combined manhole (CMH7000421) at the junction between Chung Kin Road and Cheung Shek Road. From the said manhole, the combined pipe enlarges its size to 900mm (CWD7000560) and goes northwards entering at an invert level of 0.73mPD to a combined special manhole (COH7000200) located at the junction between Cheung Shek Road and Cheung Chau Sai Tai Road. Under normal circumstances, the sewer, after leaving the special manhole, will go eastwards along Cheung Chau Sai Tai Road to the Tai Shek Hau SPS via a system of 450mm sewers (FWD7005749, FWD7005750 etc.) and sewer manholes (FMH7004460, FMH7004461 etc.). The sewage pumping station will then pump the sewer to

a system of gravity sewers and sewage manholes to another sewage pumping station, Pak She SPS at Ping Chong Road, before discharging the sewer finally to the CCSTW. In case of heavy rainstorm, the combined sewers, after entering the special manhole, will be discharged to the sea through the 900mm combined sewers (CWD7000561, CWD7000562 and CWD7000563) and combined manholes (CMH7000520 and CMH7000521). As shown in **Figure No. 3B**, another combined manhole CMH7000422 was built by the Government at Cheung Shek Road near the south-east corner of the Application Site. This combined manhole CMH7000422 mainly conveys the sewage from Greenery Crest (33 Cheung Shek Road) and part of the sewage from Hoi Fuk Villa (29 Cheung Shek Road). The flow going out from this combined manhole will be conveyed to the combined manhole CMH7000421 as described above via a combined pipe of size 750mm.

Also shown in **Figure No. 3B** is an existing public stormwater system with stormwater manhole SMH7004713 and 375mm stormwater pipe SWD7005750. The pipe goes westward along Cheung Kin Road to another stormwater manhole SMH7004710 and then turns northward to stormwater manhole SMH7004709. From manhole SMH7004709, the drain enlarges its size to 450mm and goes westward to stormwater manhole SMH7004708 before discharging stormwater to the sea through outfall SNF7000260.

3. Existing Drainage (Storm and Sewage) Arrangement in the Application Site

The existing drainage arrangement in the Application Site is shown in **Figure No.3C.**
The sewage generated from the existing building in the Application Site is presently collected by two sewage manholes located in the vicinity of the northern boundary of the existing building in the Application Site. The two sewer manholes are interconnected by a 100mm sewer pipe which flows eastward and enlarges its size to 150mm before entering another sewage manhole located at the north-east corner of the building. The sewer then turns south and enters the terminal manhole built near the entrance gate of Greenery Crest. As shown in the drainage plan retrieved from the Buildings Department (attached as **Figure 5** in this report), the terminal manhole receives the sewers from the Application Site and Greenery Crest amounting to DWF 523 m^3/day. The sewer will then be discharged from the terminal manhole to the adjacent public combined manhole CMH7000422 via a 300mm sewer.

The stormwater collected from within the Application Site is directed through downpipes from the roof of the existing building and a system of 225mm surface channels on existing ground to an existing catchpit near the north-west corner of the existing building. According to Figure 5, the drainage plan retrieved from BD, part of the rainwater from House 12 will also be discharged through a 300mm downpipe into the said existing catchpit in the Application Site.

Stormwater from the catchpit will then flow to a sand trap before discharging into the existing combined manhole (CMH7000420) via the 600mm combined pipe (CWD7000460) mentioned in the previous paragraphs.

4. Estimated Sewage and Stormwater Flows from the Application Site

Toilet flushing and kitchen waste are the major sewage arising from the proposed development. The quantity of wastewater generated by the proposed development is calculated based on the Environmental Protection Department (EPD) Guidelines for Estimating Sewage Flows for Sewage Infrastructure Planning (GESF) and DSD Sewage Manual Part 1. The following global unit flow factors (UFF) are adopted in the estimation. A UFF of 0.28 m^3/person/d is assumed for overnight employees. The peaking factor is adopted according to GESF with category of population < 1,000. In consideration of the sewage from the proposed development would be discharged to an existing combined sewer, peaking factor of 8, including storm water allowance, is adopted.

Population description	Global Unit Flow Factors (m^3/person/d)
Domestic, Special class	0.19
Commercial J11 activities	0.28
Overnight employee	0.28

In consideration that there may be misconnections and infiltrations due to pipe defects to the sewerage system, the Catchment Inflow Factor of 1.5 (Table T-4 of GESF) is included in estimating the average sewage flow from the development.

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The sewage generated from the proposed development with 6 staff with 2 staff staying overnight is estimated below:

Population Description	Estimated Population	Category	UFF (m^3/day)	Daily average sewage discharge (m^3/day)	Total ADWF (m^3/day)	Peaking factor (<1000)	Peak Flow (m^3/day)
Residents	39	Institutional and special class	0.19	7.41	9.65 x 1.5 = 14.48	8	115.8 (0.00134m^3/s)
Commercial Employee	6	J11 Community, social & personal	0.28	1.68			
Overnight Employee	2	Community, social & personal	0.28	0.56			

The stormwater collected from the application site is estimated below:

Catchment area of Application Site with landscape area = 512m^2

Catchment area from House 12 discharging to the catchpit in Application Site = 464m^2

Total catchment area = 512 + 464 = 976 m^2
Runoff coefficient = 1.0
Assuming time of concentration = 2.5 minutes and
Rainstorm return period of 1 in 50 years, rainfall intensity, i = 275mm/hr
Q = kAi/3600 = 1.0 x 976 x 275 / 3600 = 74.55 litre / s = 0.0746 m^3/s

In summary, sewage generated from the Application Site will be 15.32 m^3/day (ADWF). The peak sewage discharge from the Application Site will be 0.00134^3/s while the peak stormwater discharge will be 0.0746 m^3/s. If sewage and stormwater are combined, the total peak flow will be 0.00134m^3/s + 0.0746 m3/s = 0.0759m^3/s

5. Sewage and Drainage Disposal Scheme

The sewage generated from the existing building in the Application Site is presently collected, conveyed and discharged to an existing terminal manhole near the entrance gate of Greenery Crest. Sewage from the terminal manhole will then be discharged into the public combined manhole CMH7000422 via a 300mm sewer. As described above, the proposed development is an in-situ conversion of the existing building from kindergarten/nursery use to Social Welfare /Facility (Residential Care Home for Persons with Disabilities). The existing sewerage system in the application Site is well established and maintained by the owners. The design calculation enclosed in Appendix A showed that the existing sewerage system has sufficient capability to deal with the sewage generated from the proposed development and the associated Greenery Crest to the public combined manhole CMH7000422. It is proposed to keep this sewerage arrangement unchanged.

As described above, the stormwater collected within the Application Site is presently being discharged into the combined manhole CMH7000420 which will then combine with the sewage from the Application Site in the combined manhole CMH7000421 at the junction between Cheung Kin Road and Cheung Shek Road. In consideration that there is a public stormwater system constructed near the Application Site and to support the objectives of EPD and DSD not to impair the coastal water quality in Cheung Chau, it is proposed to divert the stormwater from the Application Site to the existing public stormwater manhole SMH7004713 in Cheung Kin Road as shown in **Figure 4**. By adopting the proposed separate systems, the quantity of peak sewage discharge to the existing combined manhole CMH7000422 will be substantially reduced from 0.0759 m^3/s to 0.00134 m^3/s.

6. Sewage Impact Assessment

(i) Existing Combined Discharge

The Application Site is currently used and operated as a kindergarten/nursery. The existing building is a one-storey building. In terms of classroom provision, the by KMVN Anglo-Chinese Kindergarten.Nursery has a total of 5 classrooms providing kindergarten/nursery education to about 87 students with about 8 numbers of teachers/workers. With reference to GESF, the sewage generated from the existing kindergarten/ nursery education can be estimated as follows:

Population Description	Estimated Population	Category	UFF (m^3/day)	Daily average sewage discharge (m^3/day)	Total ADWF (m^3/day)	Peaking factor (<1000)	Peak Flow (m^3/day)
Residents	87	School students	0.04	3.48	5.72 x 1.5 = 8.58	8	68.64 (0.00079m^3/s)
Commercial Employee	8	J11 Community, social & personal	0.28	2.24			

The stormwater collected from the application site is estimated below:
Catchment area of Application Site with landscape area = 512m^2
Catchment area from House 12 discharging to the catchpit in Application Site = 464m^2
Total catchment area = 512 + 464 = 976 m^2
Runoff coefficient = 1.0
Assuming time of concentration = 2.5 minutes and
Rainstorm return period of 1 in 50 years, rainfall intensity, i = 275mm/hr
Q = kAi/3600 = 1.0 x 976 x 275 / 3600 = 74.55 litre / s = 0.0746 m^3/s

The existing combined peak discharge to the public combined manhole is 0.0746 + 0.00079 = 0.0754 m^3/s

(ii) Sewage Discharge After Development

The Proposed Development is an in-situ conversion of the existing building to Social Welfare /Facility (Residential Care Home for Persons with Disabilities), whereby the existing building height, site coverage and plot ratio shall be kept the same as the last approved General Building Plan ("**GBP**"). The Proposed Development will provide 39 beds. By referring to the estimation in Section 4, the sewage generated is as follows:

Population Description	Estimated Population	Category	UFF (m^3/day)	Daily average sewage discharge (m^3/day)	Total ADWF (m^3/day)	Peaking factor (<1000)	Peak Flow (m^3/day)
Residents	39	Institutional and special class	0.19	7.41	9.65 x 1.5 =14.48	8	115.8 (0.00134m^3/s)
Commercial Employee	6	J11	0.28	1.68			

		Community, social & personal					
Overnight Employee	2	Community, social & personal	0.28	0.56			

The peak sewage generated will be 0.00134 m^3/s which is slightly higher than the existing sewage discharge of 0.00079 m^3/s. However, with the proposed alteration of the existing combined system to a new separate system, the quantity of flow discharging into the public sewerage system will be substantially reduced from 0.0754 m^3/s to 0.00134 m^3/s.

(iii) Sewage Impact

The Application Site is located within the catchment area of Cheung Chau Sewage Treatment Works (Cheung Chau STW). Both public combined system and stormwater system have been constructed to the vicinity of the Application Site by the Government and ready for the connection of the foul and storm waters from the Application Site. The proposed connection of the sewage flow from the development through the public sewers to Cheung Chau STW is not conflicting to the planning of Hong Kong Government.

Based on DSD Contract No. DC/2019/07 titled "Outlying Islands Sewerage Stage 2 – Upgrading of Cheung Chau Sewage Treatment and Disposal Facilities", it is known that the upgrading of existing Cheung Chau STW to increase its treatment capacity from 4000m^3/day to 9800 m^3/day with sewage treatment level from preliminary treatment to secondary level and increasing the capacity of the existing Pak She Sewage Pumping Station from 29000m^3/day to 42000 m^3/day had been commenced in 2020 for completion in 2026. The purpose of the project is to upgrade the treatment capacity to cater for the projected ultimate population from existing population of 22000 to 38200. The project also aims to cope with planned developments in Cheung Chau to meet the increased demand and gradual expansion of village sewerage network to other unsewered areas of Cheung Chau in the future.

Comparing with the existing sewage generation, the additional sewage generation due to the revised use of the application site is only about 14.48 – 8.58 = 5.90 m^3/day (ADWF) while the capacity of the future Cheung Chau STW will be 9,800 m^3/day (ADWF). The increase in flow would only be about 0.06% of the capacity of Cheung Chau STW. The Cheung Chau STW should have sufficient capability to cater for this negligible increase in sewage quantity. Coupling with the fact that, with the proposed change of the existing combined system to future separate system, the peak flow to the Cheung Chau STW will be reduced substantially from 0.0754 m^3/s to 0.00134 m^3/s, the impact of the flow from the application site on Cheung Chau STW is considered insignificant and acceptable.

The minimum size of the existing public sewer (CWD7000461) along Cheung Shek Road downstream of the development site is 750mm. The design checking in **Appendix A** indicated that the minimum capacity of the public sewer is 0.773 m^3/s. The peak flow from the development (peaking factor of 8) calculated above is only 0.00134 m^3/s. Combining with the sewages from Greenery Crest (peaking factor of 6) and Hoi Fuk Villa (peaking factor of 8) amounting to peak flows of 0.0324 m^3/s and 0.0034 m^3/s respectively, the total peak flow is only 0.0371 m^3/s which is substantially lower than the capacity of the smallest downstream public sewer of 0.773 m^3/s. The design calculation showing the capacity of the existing downstream public sewer is shown in **Appendix A**.

In view of the above considerations, the impacts on the Cheung Chau STW and the existing public sewer downstream of the development are insignificant.

7. Drainage Impact Assessment

As mentioned in Section 5 above, all stormwater collected from within the Application Site is proposed to be diverted to the adjacent public stormwater manhole SMH7004713 in Cheung Kin Road. The stormwater will then be discharged to the sea through the existing stormwater drainage system consisting of public manholes, from upstream to downstream, SMH7004713, SMH7004710, SMH7004709, SMH7004708 and public drains SWD7005750 (375mm), SWD7005746 (375mm), SWD7005815 (450mm) and SWD7005745 (600mm). The catchment areas for the flows to the manholes are shown in the Catchment Areas Plan (Figure 6). The design calculation in **Appendix A** showed that the existing public stormwater drainage system has sufficient capacity to drain the flows from the Application Site and the catchments downstream of the Application Site. The proposed diversion of the stormwater from the Application Site to the public stormwater system has no adverse impact to the existing public stormwater system.

8. Conclusion

The proposed development is an in-situ conversion of the existing building from kindergarten/nursery use to Social Welfare /Facility (Residential Care Home for Persons with Disabilities). The existing drainage system is a combined system with both sewage and stormwater from within the site discharging into public combined manholes. The peak sewage generated from the existing site, as a kindergarten, is very small and is only 0.00079 m^3/s. With an estimated peak stormwater discharge of 0.0746 m^3/s from the Application Site and its associated areas, the peak combined flow to the existing public combined system is 0.0746 +

0.00079 = 0.0754 m^3/s. After the development, the peak sewage discharge will be slightly increased from 0.00079 to 0.00134 m^3/s. In term of combined discharge, this increase is negligible.

In consideration that there is a public stormwater system constructed near the Application Site and to support the objectives of EPD and DSD not to impair the coastal water quality in Cheung Chau, it is proposed to divert the stormwater from the Application Site to the public stormwater system in the vicinity of the site. After the diversion, the existing combined system in the Application Site will become separate systems and the peak sewage flow to the public combined system will then be substantially reduced from 0.0754 m^3/s to 0.00134 m^3/s.

It is known that the upgrading of existing Cheung Chau STW to increase its treatment capacity from 4000m^3/day to 9800 m^3/day and increase the capacity of the existing Pak She Sewage Pumping Station from 29000m^3/day to 42000 m3/day had been commenced in 2020 for completion in 2026. Comparing with the existing sewage generation, the additional sewage generation due to the revised use of the Application Site is only about 14.48 – 8.58 = 5.90m^3/day (ADWF). The increase in flow would only be about 0.06% of the capacity of Cheung Chau STW. The increase is negligible to the capacity of Cheung Chau STW. Coupling with the fact that, with the proposed change of the existing combined system to future separate systems, the peak flow from the Application Site to the Cheung Chau STW will be reduced substantially from 0.0754 m^3/s to 0.00134 m^3/s, the impact of the flow from the Application Site on Cheung Chau STW is considered insignificant. No adverse impact due to the sewerage generated from the project on the existing sewerage system in Cheung Chau is anticipated. The proposed works will be beneficial to the existing public sewerage system by reducing the burden of the downstream sewerage pipes during peak flow scenarios.

The design calculation enclosed in Appendix A showed that the proposed diversion of the stormwater from the Application Site to the public stormwater system has no adverse impact to the existing public stormwater system.

The project proponent will be responsible for the implementation of the proposed stormwater and sewerage works. The details of the proposed stormwater and sewage disposal schemes will be further confirmed at the detailed design stage and close liaison will be carried out with relevant departments to approve the schemes.

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APPENDIX A

Design Calculation of Proposed Sewage and Stormwater Systems
and
Checking of Existing Downstream Combined Pipes and Stormwater pipes.

Design Calculation of Proposed Sewage and Stormwater Systems

Discharge of sewer to CCSTW

Sewer generated from Application Site

The estimated population will include 39 residents, 6 commercial employees and 2 overnight employees with global unit flow factors (UFF) of 0.19 m^3/person/day, 0.28 m^3/person/day and 0.28 m^3/person/day respectively.

The sewage (ADWF) from the Application Site with CIF of 1.5

= (39 x 0.19 + 6 x 0.28 + 2 x 0.28) x 1.5 = 14.48 m^3/day = 0.000168 m^3/s

Sewer from Greenery Crest (referring to Table T-1 of GESF for Modern Village)

As shown in the drainage plan retrieved from the BD, the total nos. of occupant of Greenery Crest were 1152, with flow of 0.27 m^3/day/person (Modern village).

The sewage (ADWF) from Greenery Crest with CIF of 1.5

= 1152 x 0.27 x 1.5 = 466.56 m^3/day = 0.0054 m^3/s

Sewage and Combined flow from Hoi Fuk Villa (referring to Table T-1 of GESF for Modern Village)

No submission record from Hoi Fuk Villa to the Buildings Department was found. The flow can be estimated with reference to Table T-1 of GESF.

Total no. of units in Hoi Fuk Villa was 18. With 5 no. of occupant per unit, the total nos. of occupant of Hoi Fuk Villa were 90, with flow of 0.27 m^3/day/person (Modern village),

The sewage (ADWF) from Hui Fuk Villa with CIF of 1.5

= 90 x 0.27 x 1.5 = 36.45 m^3/day = 0.000422 m^3/s

Stormwater catchment = 1686m^2,

Stormwater flow = 1.0 x 1686 x 250 / 3600 = 117 litre/s = 0.117 m^3/s,

Peak combined flow with peaking factor of 8 = 0.000422 x 8 + 0.117 = **0.12** m^3/s

Cumulated Sewer (ADWF) from the Application Site, Greenery Crest and Hoi Fuk Villa

The cumulated sewer (ADWF) from the Application Site, Greenery Crest and Hoi Fuk Villa

= 0.000168 + 0.0054 + 0.000422 = **0.006** m^3/s.

(i) Checking capacity of sewage pipe within the Application Site

Peak flow from Application Site with peaking factor of 8 = 8 x 0.000168

= 0.00134 m^3/s

From sewerage design manual,

Colebrook-White Equation, $V = -(8gDs)^{1/2}\log(ks/(3.7D)+2.51v/(D(2gDs)^{1/2})$

where V = mean velocity (m/s)

g = gravitational acceleration (m/s^2) = 9.81 m/s^2

D = internal pipe diameter (m) = 0.10m

ks = hydraulic pipeline roughness (m) = 3.0 mm = 0.003m

v = kinematic viscosity of fluid (m^2/s) = $1.14x10^{-6}$ m^2/s

s = hydraulic gradient (energy loss per unit length due to friction)

The minimum size of the existing sewer within the Application Site is 100mm

Area of pipe, A = 3.14 x $(0.1/2)^2$ = 0.00785 m^3

Invert level at upstream end = 4.17 mPD (from Figure 3C)

Invert level at downstream end = 3.66 mPD (From Figure 3C)

Length of sewer = 20m (measured from Geomap)

Gradient s = (4.17-3.66)/20 = 0.0255

$V= -(8x9.81x0.1x0.0255)^{1/2}\log(0.003/(3.7x0.1) + 2.51x1.14x10^{-6}$
$/(0.1(2x9.81x0.1x0.0255)^{1/2})$
$= 0.932$ m/s

Minimum capacity of existing sewer within Application Site = A x V

= 0.00785 x 0.932 = 0.0073 m^3/s > 0.00134 m^3/s. O.K.

(ii) Checking capacity of existing public combined pipe (min. 750mm pipe) from Application Site to special manhole COH7000200, and then to outfall:

The existing combined pipes along Cheung Shek Road receiving sewers from the Application Site and Greenery Crest, and combined flow from Hoi Fuk Villa are as follows:

From	To	Population	Peaking Factor	Total Flow (m^3/s) from Hoi Fuk, Greenery Crest and Application Site
Hoi Fuk Villa	CMH7000423	<1000	8	0.12
CMH7000423	CMH7000422	<1000	8	0.12
CMH7000422	CMH7000421	>1000	6	0.12+(0.0054+0.000168) x 6 = 0.153
CMH7000421	COH7000200	>1000	6	0.153

The minimum size of the existing public sewer (CWD7000461) along Cheung Shek Road downstream of the development site from manhole CMH7000422 to CMH7000421 is 750mm

Area of pipe, A = 3.14 x $(0.75/2)^2$ = 0.442 m^2

Invert level at upstream end = 1.23 mPD (from Geomap)

Invert level at downstream end = 1.04 mPD (From Geomap)

Length of sewer = 32m (measured from Geomap)

Gradient s = (1.23-1.04)/32 = 0.0059

V= -(8x9.81x0.75x0.0059)$^{1/2}$log(0.003/(3.7x0.75) + 2.51x1.14x10^{-6}
/(0.75(2x9.81x0.75x0.0059)$^{1/2}$)
= 1.745 m/s

Minimum capacity of public combined sewer = A x V
= 0.442 x 1.745 = 0.773 m^3/s >> 0.153 m^3/s. O.K. (only 19.8%)

The checking of the entire public combined system from Hoi Fuk Villa through Greenery Crest and Application Site along Cheung Shek Road to the outfall is presented in the following table using Excel manipulation:

Cheung Chau - Public Combined System Along Cheung Shek Road to Outfall
Hydraulic Analysis for Sewerage System (underground gravity pipe)

Peak flow from Hoi Fuk Villa = 0.12 m^3/s (combined flow)
Peak flow from Application Site = 0.001m^3/s (sewage with peaking factor of 6)
Peak flow from Greenery Crest = 0.0324m^3/s (sewage with peaking factor of 6)
Total flow = 0.12 + 0.001 + 0.0324 = 0.153 m^3/s (combined flow)

Colebrook-White Equation

$$V = -2(2gDS)^{0.5}\log\left(\frac{k}{3.7D} + \frac{2.5\nu}{D(2gDS)^{0.5}}\right)$$

where K_s (m) = 0.003; ν (m^2/s) = 1.14E-06; g (m/s^2) = 9.81

Upstream Manhole	Downstream Manhole	USGL (mPD)	DSGL (mPD)	USIL (mPD)	DSIL (mPD)	USGL-USIL (m)	DSGL-DSIL (m)	Dh (m)	Pipe Size (mm)	Pipe Length (m)	Pipe Gradient (1 in)	Hydraulic Area A (m^2)	Velocity (m/s)	Capacity =AV (m^3/s)	Peak Flow (m^3/s)	Result
Hoi Fuk	CMH7000423	4.30	4.30	1.66	1.61	2.64	4.30	0.05	750	5.0	100.00	0.44179	2.27	1.004	0.120	OK
CMH7000423	CMH7000422	4.30	4.78	1.61	1.49	2.69	3.29	0.12	750	20.0	166.67	0.44179	1.76	0.777	0.153	OK
CMH7000422	CMH7000421	4.78	4.40	1.23	1.04	3.55	3.36	0.19	750	32.0	168.42	0.44179	1.75	0.773	0.153	OK
CMH7000421	COH7000200	4.40	4.17	0.87	0.73	3.53	3.44	0.14	900	30.0	214.29	0.63617	1.75	1.110	0.153	OK
COH7000200	CMH7000520	4.17	4.10	0.63	0.61	3.54	3.49	0.02	900	5.0	250.00	0.63617	1.62	1.028	0.153	OK
CMH7000520	CMH7000521	4.10	4.14	0.50	0.45	3.60	3.69	0.05	900	10.0	200.00	0.63617	1.81	1.149	0.153	OK
CMH7000521	Outfall	4.14	4.14	0.32	0.17	3.82	3.97	0.15	900	35.0	233.33	0.63617	1.67	1.064	0.153	OK

(iii) Checking hydraulic capacity from proposed site to manhole FMH7004461 to ensure the downstream pipe capacity can support the sewage flow from the new development

Sewage manhole FMH7004461 receives the sewage from special manhole COH7000200 which in turn collects the cumulated flow from the Application Site, Greenery Crest and the Hoi Fuk Villa via CWD7000560, and the upstream sewage along Cheung Chau Sai Tai Road, Cheung Chau Family Walk, Tsan Tuen Road and Cheung Chau Peak Road West via FWD7005747.

From previous calculation, the cumulative ADWF flow from the Application Site, Greenery Crest is 0.006 m^3/s. Combining with the upstream sewage flow from FMH7004590 with a total population of more than 5000, the peaking factor shall be 5 with reference to GESF.
The peak flow from the Application Site, Greenery Crest and Hoi Fuk Villa
= 5 x 0.006 = 0.03 m^3/s

The flow from FWD7005747, which collects the sewage from quite a number of public facilities such as Tai Shek Hau Refuse Barging Point, Cheung Chau South Substation, Tsan

Tuen Road Public toilet and private developments such as Round Table 1st, 2nd and 3rd Villages, New Villa Cecil, Treasure Villa, Ying Sin Lung Care Village, Sai Wan Care Village and Lui Kwan Pok Care Village Centre, is beyond the knowledge of private developer.

It is noted that the upstream sewage along Cheung Chau Sai Tai Road etc will flow to FWD7005747 of size 375mm before entering special manhole COH7000200. We may then conservatively assume the capacity of the 375mm to be the cumulative flow of the upstream sewage (i.e. 100% usage of the pipe). The sewage pipe FWD7005747 changes its size from 375mm to 450mm after combining the flows from Greenery Crest and Hoi Fuk Villa,

The checking of the sewerage system from sewage manhole FMH7004590 through special manhole COH7000200 to sewage manhole FMH7004461 can then be assessed in the following table using Excel manipulation:

Cheung Chau - Public Sewerage System Along Cheung Chau Sai Tai Road
Hydraulic Analysis for Sewerage System from FMH7004590 to FMH7004461

ADWF from Hoi Fuk Villa = 0.000422m^3/s (sewage)
ADWF from Application Site = 0.000168m^3/s (sewage)
ADWF from Greenery Crest = 0.0054m^3/s (sewage)
Total ADWF to COH7000200 = 0.000422 + 0.000168 + 0.0054 = 0.006 m^3/s
Flow from COH7000200 to FMH7004461 = 0.006 x 5 + **0.115** = 0.145 m^3/s

Colebrook-White Equation

$$V = -2(2gDS)^{0.5}\log\left(\frac{k}{3.7D} + \frac{2.5\nu}{D(2gDS)^{0.5}}\right)$$

where K_s (m) = 0.003
ν (m^2/s) = 1.14E-06
g (m/s^2) = 9.81

Upstream Manhole	Downstream Manhole	USGL (mPD)	DSGL (mPD)	USIL (mPD)	DSIL (mPD)	USGL-USIL (m)	DSGL-DSIL (m)	Dh (m)	Pipe Size (mm)	Pipe Length (m)	Pipe Gradient (1 in)	Hydraulic Area A (m^2)	Velocity (m/s)	Capacity =AV (m^3/s)	Peak Flow (m^3/s)	Result
FMH7004590	COH7000200	4.33	4.17	-1.85	-2.01	6.18	6.18	0.15	375	28.7	190.07	0.110	1.05	**0.115**	**0.115**	OK
COH7000200	FMH7004460	4.17	4.20	-2.09	-2.15	6.26	6.35	0.06	450	18.7	287.69	0.159	0.96	0.152	0.145	OK
FMH7004460	FMH7004461	4.20	4.30	-2.15	-2.26	6.35	6.56	0.11	450	33.3	297.32	0.159	0.94	0.150	0.145	OK

From the above hydraulic analysis, with the size of the public sewer enlarged from 375mm to 450mm after receiving the flow from the Application Site, Greenery Crest and Hoi Hok Villa, the public sewerage system is able to convey the sewage from the proposed development even though the capacity of the 375mm sewer, FWD7005747, is fully utilized (a very conservative assumption).

Discharge of Stormwater to Sea

Upon diversion of the stormwater from the Application Site to the public stormwater system, the water will ultimately flow to the sea through a number of manholes and outfall structure namely, from upstream to downstream, SMH7004713, SMH7004710, SMH7004709, SMH7004708, outfall SNF4000260. The catchment areas are shown in the **Catchment Areas**

Plan (Figure 6) enclosed. The following table summarizes the sub-catchment areas of the manholes:

Manhole	Out Going Pipe and Size	Catchment Area
SMH7004713	SWD7005750, 375mm	1424 m^2
SMH7004710	SWD7005746, 375mm	1424 + 965 = 2389 m^2
SMH7004709	SWD7005815, 450mm	2389 + 2728 = 5117 m^2
SMH7004708	SWD7005745, 600mm	5117 + 4061 = 9178 m^2

Checking capacity of existing public stormwater system from Application Site to outfall SNF7000290

From the record plan retrieved from the Buildings Department, upon the completion of the proposed stormwater diversion, the catchment area of the stormwater from the Application Site (once called the commercial centre) and House 12 of Greenery Crest as shown on the enclosed catchment areas plan to the public stormwater manhole SMH7004713 in Cheung Kin Road will be about 512 + 464 = 976m^2. Assuming half of the stormwater from the existing Cheung Chau South Substation located north of the Application Site will drain also to the manhole SMH7004713, total catchment area for the manhole will be 976 + 448= 1424 m^2.

The stormwater discharged to manhole **SMH7004713** is estimated below:
Catchment area = 1424m^2
Runoff coefficient, k = 1.0
Assuming time of concentration = 4.0 minutes
For rainstorm return period of 1 in 50 years, rainfall intensity, i = 250mm/hr
By Rational Formula, Q = kAi/3600 = 1.0 x 1424 x 250 / 3600 = 98.9 litre / s
= 0.099 m^3/s
The size of the existing public stormwater pipe (**SWD7005750**) along Cheung Kin Road downstream of the development site is 375mm
Invert level at upstream end = 3.68 mPD (from Geomap)
Invert level at downstream end = 3.53 mPD (From Geomap)
Length of pipe = 30m (measured from Geomap)
Gradient s = (3.68-3.53)/30 = 0.005
Roughness factor , n = 0.012
Area of 375mm pipe = 3.14 x 0.375 x 0.375 / 4 = 0.11 m^2
Wetted perimeter = 3.14 x 0.375 = 1.18m
R = A/P = 0.11/ 1.18 = 0.093 m
$Q = (1/n)AR^{0.67} S^{0.5}$ $= (1/0.012) \times 0.11 \times (0.093)^{0.67} \times (0.005)^{0.5}$
= 0.132 m^3/s > 0.099 m^3/s (75% usage) O.K.

Stormwater from the 375mm pipe will be discharged to manhole **SMH7004710** which will then convey the water to manhole **SMH7004709** through another 375mm storm drain **SWD7005746**. The capacity of this storm drain is checked as below:

The stormwater discharged to manhole **SMH7004710** is estimated below:
Catchment area = 1424m^2 + 965 m^2 = 2389 m^2
Time of concentration = 4.5 minutes
For rainstorm return period of 1 in 50 years, rainfall intensity, i = 245mm/hr
Q = kAi/3600 = 1.0 x 2389 x 245 / 3600 = 166 litre / s
= 0.163 m^3/s
The size of the existing public stormwater pipe (**SWD7005746**) is 375mm
Invert level at upstream end = 3.46 mPD (from Geomap)
Invert level at downstream end = 3.11 mPD (From Geomap)
Length of pipe = 26m (measured from Geomap)
Gradient s = (3.46-3.11)/26 = 0.0135
Area of 375mm pipe = 3.14 x 0.375 x 0.375 / 4 = 0.11 m^2
Wetted perimeter = 3.14 x 0.375 = 1.18m
R = A/P = 0.11/ 1.18 = 0.093 m
Q = $(1/n)AR^{0.67} S^{0.5}$ = (1/0.012) x 0.11 x $(0.093)^{0.67}$ x $(0.0135)^{0.5}$
= 0.217 m^3/s > 0.163 m^3/s (75% usage) O.K.

The stormwater discharged to manhole **SMH7004709** is estimated below:
Catchment area = 2389m^2 + 2728 m^2 = 5117 m^2
Time of concentration = 5 minutes
For rainstorm return period of 1 in 50 years, rainfall intensity, i = 237mm/hr
Q = kAi/3600 = 1.0 x 5117 x 237 / 3600 = 337 litre / s
= 0.337 m^3/s
The size of the existing public stormwater pipe (**SWD7005815**) along Cheung Chau Sai Tai Road is 450mm
Invert level at upstream end = 2.87 mPD (from Geomap)
Invert level at downstream end = 2.46 mPD (From Geomap)
Length of pipe = 30m (measured from Geomap)
Gradient s = (2.87-2.46)/30 = 0.0135
Area of 450mm pipe = 3.14 x 0.45 x 0.45 / 4 = 0.159 m^2
Wetted perimeter = 3.14 x 0.45 = 1.413m
R = A/P = 0.159/ 1.413 = 0.1125 m
Q = $(1/n)AR^{0.67} S^{0.5}$ = (1/0.012) x 0.159 x $(0.1125)^{0.67}$ x $(0.0135)^{0.5}$

$= 0.356\ m^3/s \quad > \quad 0.337\ m^3/s$ (94.7% usage) O.K.

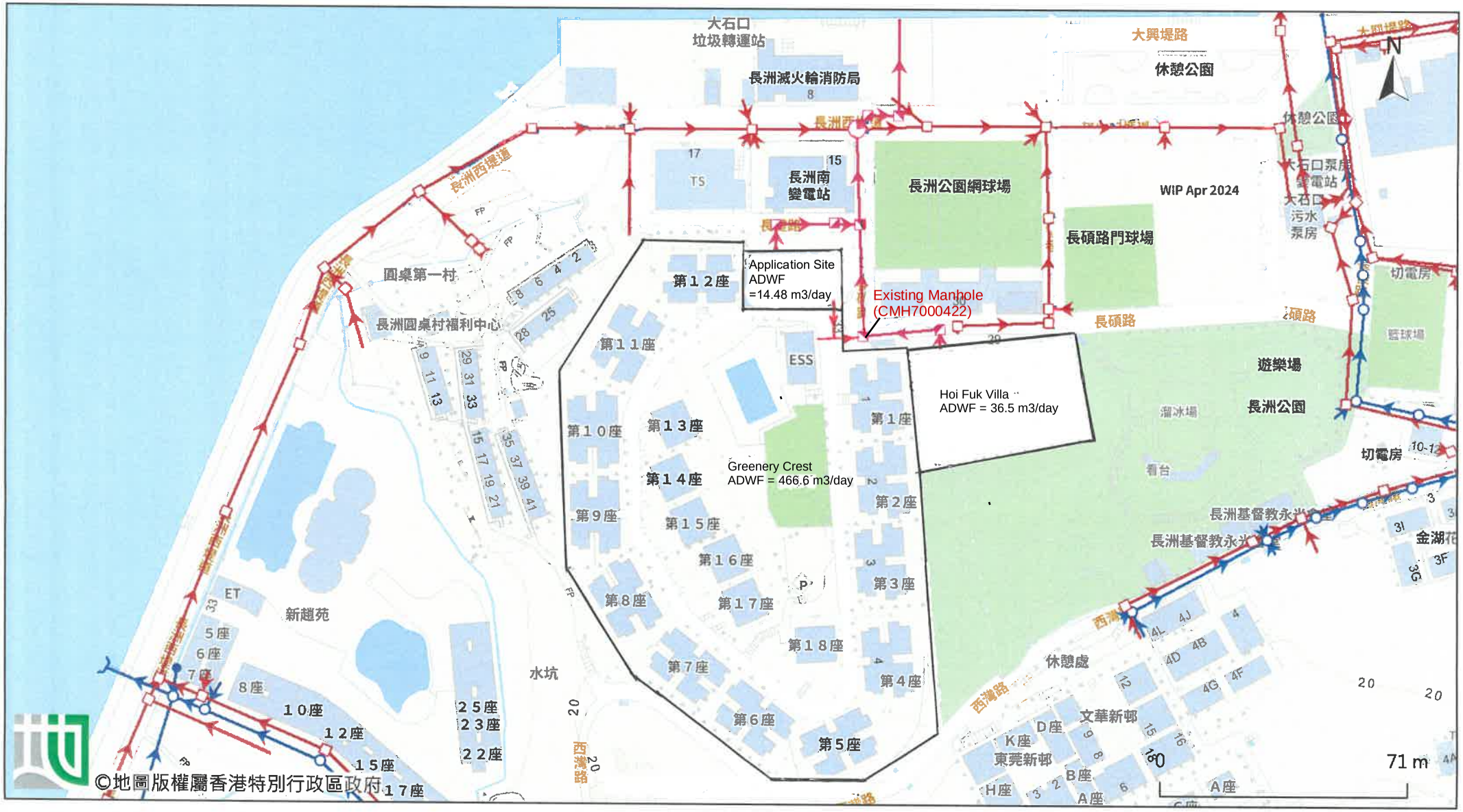
The stormwater discharged to manhole **SMH7004708** is estimated below:
Catchment area = $5117m^2 + 4061\ m^2 = 9178\ m^2$
Time of concentration = 5.5 minutes
For rainstorm return period of 1 in 50 years, rainfall intensity, i = 235mm/hr
Q = kAi/3600 = 1 x 9178 x 235 / 3600 = 599 litre / s
$= 0.599\ m^3/s$
The size of the existing public stormwater pipe (**SWD7005745**) discharging water to the sea via the outfall is 600mm
Invert level at upstream end = 0.51 mPD (from Geomap)
Invert level at downstream end = 0.18 mPD (From Geomap)
Length of pipe = 12m (measured from Geomap)
Gradient s = (0.51-0.18)/12 = 0.0275
Area of 450mm pipe = 3.14 x 0.60 x 0.60 / 4 = $0.283\ m^2$
Wetted perimeter = 3.14 x 0.60 = 1.884m
R = A/P = 0.283/ 1.884 = 0.15 m
$Q = (1/n)AR^{0.67} S^{0.5} = (1/0.012) \times 0.283 \times (0.15)^{0.67} \times (0.0275)^{0.5}$
$= 1.097\ m^3/s \quad > \quad 0.599\ m^3/s$ (54.6% usage) O.K.

The existing public stormwater drainage system has therefore sufficient capacity to drain the flows from the Application Site and the catchments downstream of the Application Site. The proposed diversion of the stormwater from the Application Site to the public stormwater system has no adverse impact to the existing public stormwater system.

(iv.) Revised Sewerage Catchment Plan

GEOINFO MAP
地理資訊地圖

前往地圖: https://www.map.gov.hk/gm/geo:22.2043,114.0234?z=1128



由「地理資訊地圖」網站提供: https://www.map.gov.hk

SEWERAGE CATCHMENT PLAN FOR SEWERS AT CHEUNG SHEK ROAD