

**For discussion
on 26 May 2020**

Legislative Council Panel on Development

Management of Typhoon Season Flood Risk

Purpose

This paper aims to brief Members on the flood risk in Hong Kong in the typhoon season¹ and the corresponding management measures being taken by the Government.

Flood Risk in Hong Kong

2. During the typhoon season, Hong Kong is from time to time threatened by inclement weather such as prolonged heavy rains and typhoons. The average annual rainfall is about 2 400 millimetres (mm), making Hong Kong one of the highest rainfall cities in the Pacific Rim². Over the past five years, on yearly-average there are over 20 rainstorms which warrant the issuance of the rainstorm warning signal³, and six tropical cyclones, including the super typhoons Hato (2017) and Mangkhut (2018).

3. For the weather outlook this year, the Hong Kong Observatory (HKO) forecasted in March 2020 that there would be four to seven tropical cyclones coming within 500 kilometres (km) of Hong Kong this year, more or less the same as the figures of previous years. HKO expected that the annual rainfall would be normal to below normal, but the territory may still be affected by heavy rains.

¹ In general, May to November of every year is the typhoon season of Hong Kong.

² The Pacific Rim is a general term for the surrounding countries including islands in the Pacific region.

³ HKO's rainstorm warning system is for alerting the public about the soon occurrence of heavy rain and to ensure a state of readiness for performing emergency duties any moment within the organisations and departments providing emergency services. There are three levels of warning, namely "Amber", "Red" and "Black", which signify that heavy rain of over 30, 50 and 70 mm respectively has fallen or is expected to fall generally over Hong Kong in an hour.

4. Under prolonged heavy rains, there is a risk of flooding in urban and rural areas (especially in low-lying areas). In addition, strong wind and low atmospheric pressure associated with typhoons can cause sea level rising (called "storm surge") and huge waves overtopping seawall (called "overtopping wave"). When the typhoon hits, some coastal low-lying or windy places may face the risk of seawater inundation and backwater effect. Relevant government departments have been taking multi-pronged measures to strengthen flood management with a view to reducing the risk of flooding.

Combating Flood Risk due to Rainstorm

5. To enhance the flood prevention ability of the stormwater drainage facilities in the whole territory under heavy rains, the Drainage Services Department (DSD) adopts the strategy of "stormwater interception at upstream", "flood storage at midstream" and "drainage improvement at downstream" to formulate flood prevention measures. Further, when planning drainage improvement works and new development projects, the DSD also actively promotes the use of design elements bearing the blue-green infrastructure concept in the projects to enhance Hong Kong's flood prevention capability. Blue-green infrastructure is the state-of-the-art stormwater management concept, following the principle of "infiltration, storage, purification, reuse and discharge" in integrating flood management works, so that the city can act like a sponge and can infiltrate, store and purify water when it rains. Besides, when necessary, the stored rainwater can be released and reused, and eventually discharged. The design elements of the blue-green infrastructure concept include flood retention lakes, rain gardens, green roofs and other greening facilities, etc. Taking the Anderson Road Quarry Development project as an example, the Government is currently constructing a flood retention lake there. For most of the time, this flood retention lake will be used for public recreational purpose. During heavy rains, part of the rainwater will be stored at this flood retention lake to alleviate the risk of flooding. In addition, part of the stored rainwater can be reused for irrigation and other non-potable purposes in the area after treatment, serving a threefold purpose.

6. Since 1994, the DSD has been conducting studies in stages to formulate and review the drainage master plan in the major areas of the

territory. In parallel, the DSD progressively delivers a number of works projects in response to the drainage improvement measures proposed by these studies.

7. In the New Territories, the DSD has completed river management projects with a total length of more than 100 km, including Kam Tin River, Shan Pui River, Shenzhen River, Ng Tung River, Sheung Yue River, Ping Yuen River, etc. The DSD has also implemented 27 village flood protection schemes⁴ in low-lying villages. In addition, the Home Affairs Department also responded to the requests of the villagers in the New Territories to carry out minor construction or improvement works to the drainage facilities in the villages through the Rural Minor Works Programme.

8. In the urban area, the major flood prevention works that the DSD has completed include four drainage tunnels in Hong Kong West, Lai Chi Kok, Tsuen Wan and Kai Tak respectively, and four stormwater storage schemes in Tai Hang Tung, Sheung Wan, Happy Valley and On Sau Road respectively.

9. The above completed works have greatly improved the overall stormwater drainage performance in Hong Kong. Since 1995, the DSD has eliminated 126 flooding blackspots. At present, there are only five flooding blackspots in Hong Kong. They are located at San Tin Shek Wu Wai in Yuen Long, Lam Tsuen Valley Basin and Ting Kok Road in Tai Po, Chatham Road South in Tsim Sha Tsui and Pokfulam Village in the Southern District respectively. Among them, the drainage improvement works at Ting Kok Road in Tai Po have been completed. The DSD is monitoring the effectiveness of the improvement works, and this flooding blackspot is expected to be eliminated after this rainy season. A summary of the flooding blackspots over the years is at **Annex 1**.

10. At present, the DSD has two stormwater drainage projects under construction. Further, there are 25 drainage works projects in the planning and design stage, six of which are seeking funding approval by the Legislative Council. A summary of the relevant public works projects is at **Annex 2**.

⁴ These schemes involve the construction of bunds around villages to prevent the inflow of flood water from outside and also involve the pumping of stormwater from within the bunded area to an outside channel during rainstorms to protect the villages in low-lying areas.

Combating Flood Risk due to Storm Surge and Overtopping Wave

11. In 2018, the attack of super typhoon Mangkhut in Hong Kong caused different levels of damage to some seawalls, breakwaters and piers at windy locations. Overall, the damaged piers were mainly located in the North District, Sai Kung and Tai Po. The damaged seawalls were mainly located in Sai Kung, Tseung Kwan O, Cheung Chau, Sha Tin and Tai Po while the damaged breakwaters were mainly located in Aberdeen and Chai Wan. Most of the damages were not significant, and the Civil Engineering and Development Department (CEDD) swiftly completed the relevant repair works.

12. To uplift the ability of the seawalls and breakwaters against wave attacks, the CEDD completed the deployment of precast concrete units at the end portions of the Aberdeen Breakwater and Chai Wan Breakwater in 2019 to strengthen their structure. The surface roughness and interlocking arrangement of the precast concrete units effectively facilitate dissipation of waves on the breakwaters, which would enhance the safety of the vessels inside the typhoon shelters. Additionally, we also completed the construction of a wave wall along the Tseung Kwan O Waterfront Park to alleviate the threat of overtopping waves to coastal facilities during typhoon attacks. Furthermore, the CEDD and DSD have provided support to the Leisure and Cultural Services Department and the Architectural Services Department on construction of planter walls and flood gates in the Heng Fa Chuen Playground to prevent the influx of overtopping wave water in the Playground. The construction works of the planter walls have been completed in September 2019.

13. The CEDD also carries out regular inspections of coastal infrastructures⁵ under its maintenance. The CEDD strives to introduce equipment with new surveying technologies to enhance the efficiency of the regular inspection of coastal infrastructures, including the imaging sonar for the inspection of underwater marine piles, the integrated multibeam echo sounder and the laser scanner system for the inspection of breakwaters and seawalls, and the unmanned aerial vehicle for the inspection of pier deck structures and pier roofs.

⁵ The CEDD maintains various coastal infrastructures including 127 km of breakwaters and seawalls, 323 piers and landings, fairways, anchorage areas and major tidal river channels.

14. After lowering of the tropical cyclone warning signal No. 8, the CEDD will follow the established procedures to swiftly carry out above-water inspections on essential coastal infrastructures so as to ascertain whether there are damages after typhoon attacks. We will deploy the aforesaid new surveying technologies to enhance the efficiency of our inspections and arrange the necessary repair works in a timely manner.

Study on Coastal Hazards under Climate Change and Extreme Weather

15. To enhance the capability of coastal areas against huge waves in the long-term, the CEDD engaged consultants in April 2019 to commission the related Coastal Hazard Study to comprehensively review the condition of the low-lying coastal or windy locations, and to carry out the relevant investigations of storm surges and waves in order to assess the impacts of extreme weather on these locations. Based on the outcomes of the Study, the Government will formulate appropriate protection measures, including improvement works and management measures etc, to mitigate the impact of extreme weather and climate change on the low-lying coastal or windy areas.

16. At present, the consultants have largely identified the low-lying coastal or windy locations in Hong Kong including the Eastern District and the Southern District of the Hong Kong Island, Tseung Kwan O, Sai Kung and Lei Yue Mun, and have collected the geographical information of their coastal areas, including coastline, coastal topography, bathymetry, seawall structure and drainage system, etc. The consultants have also considered the weather information, such as the information of the past tropical cyclones (including super typhoon Mangkhut) that have seriously affected Hong Kong, sea water levels, storm surges, and wind and wave conditions, etc. Currently they are conducting computer modelling analysis and studying the impact of extreme weather on the low-lying coastal or windy locations. Upon completion of the data analysis, the consultants will explore and evaluate different short, medium and long-term defence and response measures for protecting the low-lying coastal or windy locations with due consideration of cost-effectiveness, and the impact on navigation channels, environment and regional areas etc. The initial findings of the study are expected to be available by end 2020.

Preparation and Contingency Measures for Typhoon Season

17. With the continuous efforts of the relevant government departments, the flood risk has already been greatly reduced. Nevertheless, under inclement weather, such as super typhoons or prolonged localised heavy rains, flooding may still occur at the affected areas. Therefore, the Government has also strengthened preparations before the typhoon season and formulated a set of contingency measures to cope with the challenges posed by the inclement weather.

18. The DSD analysed the records of flooding cases in recent years and found that more than 60% of the cases involved the blockage of water intakes such as catchpits by litter, fallen trees, leaves or other debris washed down by surface runoff. Such blockage hampered the performance of the drainage system. In view of this, the DSD is adopting the following measures: -

- (a) Before the typhoon season, the DSD will strengthen the inspection, cleansing and repair of the public stormwater drainage system, and work with the relevant departments to check the road gullies, rainwater inlets, drainage channels and waterways to ensure smooth drainage discharge.
- (b) During heavy rain, obstructions such as tree leaves and branches may fall and block the drainage system. In this connection, the DSD implements the "just-in-time clearance" arrangement, by deploying manpower to timely inspect the around 200 locations in the territory that are vulnerable to blockages by washouts or other obstructions. If any flooding is reported or drainage inlets are found obstructed during the inspection, the DSD will immediately arrange clearances. This is to ensure that the drainage system is inspected and cleared in a timely and effective manner. At the same time, the DSD also provides emergency support to the public. Whether private or public drainage system is involved, the DSD will spare no efforts in clearing the blocked channels and draining stormwater.

- (c) After each heavy rainstorm, the DSD also inspects all public stormwater drainage inlets, major river channels and locations prone to flooding, clean up any blocked drains and river channels to ensure that the drainage system is functioning properly for coping with the rains of the next rainstorm.

19. With technological advancement, the DSD has been continuously strengthening the application of technology in the management of the drainage system. At present, staff of the DSD can make use of their mobile phones to monitor the real time hydrometric data such as water level of major rivers, rainfall and tide level. Utilising the real time information from a total of about 100 hydrological gauging stations, the DSD can swiftly and timely analyse the risk of flooding so that appropriate contingency measures can be taken promptly. Apart from that, as a pilot the DSD is introducing robots for carrying out regular inspections and silt clearing works at drainage box culverts, with a view to improving work safety and efficiency, and ensuring proper drainage function. The DSD will continue to develop and expand the smart drainage network and monitoring system, install monitoring and sensing facilities in the drainage network, transmit and automatically analyse the flow data of underdrains in real time, so as to carry out the clearance and maintenance work timely and further improve the overall performance of the drainage system.

20. When the HKO issues a red or black rainstorm warning, or a tropical cyclone signal of number 8 or above, the DSD will activate its Emergency Control Centre to monitor and arrange emergency teams to handle emergency incidents.

21. To cope with the coastal inundation flood risk, the Government has set up an early alert system for locations affected by storm surges and overtopping waves, such as Tai O, Lei Yue Mun, etc. When the HKO predicts that the sea level at these locations will exceed the corresponding alert level, it will send a storm surge alert message to the relevant departments via short message service (SMS). Upon receipt of the SMS, the DSD will deploy the emergency response teams of its contractor to assist the locals in flood relieve, including placing sandbags and water pumps, as well as installing demountable flood barriers at specific locations, etc. In addition, the relevant District Offices will contact the relevant residents, estate management offices, etc. in order to make the necessary preparations

against floods as early as possible. In addition, the DSD has installed tide poles at the appropriate locations which show the highest water level scale during the passage of past strong typhoons, thereby raising public awareness of flood prevention.

22. To increase the knowledge about flood risk among departments, relevant organisations and residents, and to enhance their emergency preparedness and understanding about the related contingency measures in the event of serious flooding, the DSD conducts inter-departmental rescue and evacuation drills jointly with other relevant departments. An example is the annual drill held in Tai O, which aims to properly prepare for the typhoon season through mock evacuation, rescue and emergency support operations.

23. The DSD strives to raise public awareness, preparedness and vigilance towards flood risk through TV Announcement in the Public Interest (API) and pamphlets. In April this year the DSD launched a brand new TV and radio API reminding the public not to block or improperly alter watercourses. It also appeals the public to regularly inspect and clear private drainage facilities, so as to reduce flood risk by concerted effort.

**Development Bureau
Drainage Services Department
Civil Engineering and Development Department**

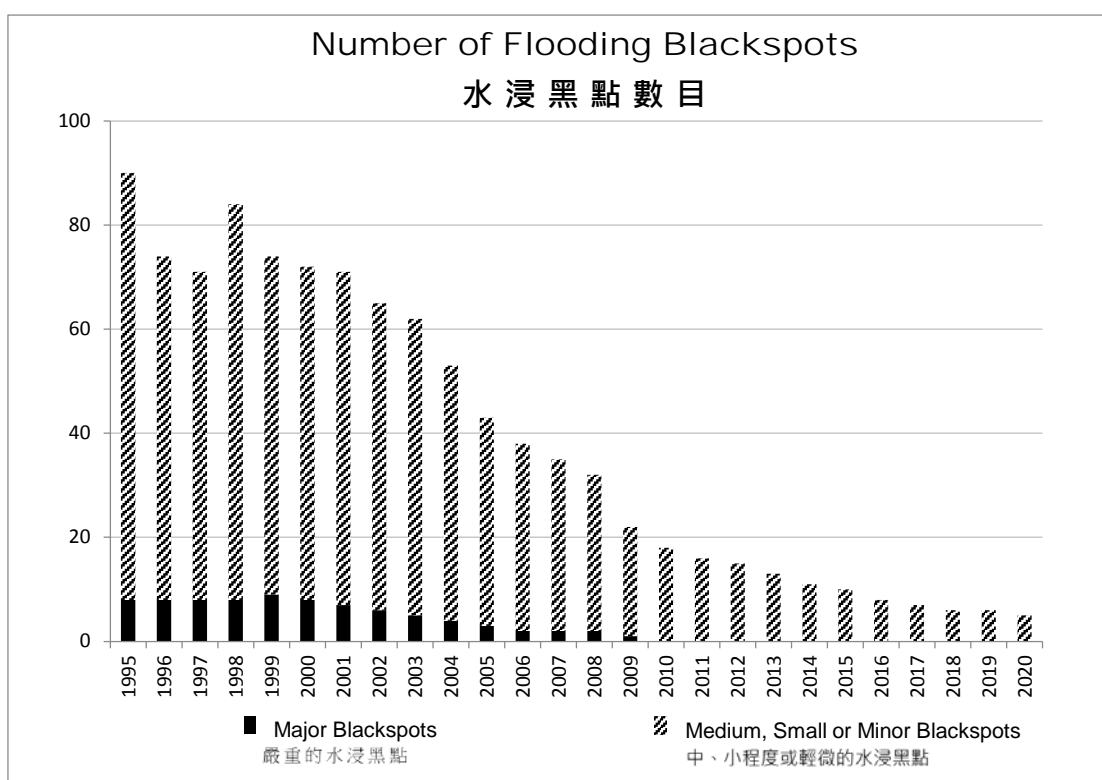
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Flooding Blackspots

Existing flooding blackspots

District	Number	Location
Yuen Long	1	Shek Wu Wai, San Tin
Tai Po	2	Lam Tsuen Valley Basin
	3	Ting Kok Road – Shuen Wan Chim Uk to Wong Yue Tan section
Yau Tsim Mong	4	A section of Chatham Road South between Granville Road and Austin Avenue
Southern	5	Pok Fu Lam Village

Number of flooding blackspots over the years



Drainage Works Projects by Drainage Services Department

Drainage works projects at construction stage

1. 4108CD West Kowloon Drainage Improvement – Inter-reservoirs Transfer Scheme
2. 4180CD Rehabilitation of underground stormwater drains stage 1

Drainage works projects at planning and design stage

Projects seeking funding approval:

1. 4118CD Drainage improvement in Northern New Territories–package B (remaining works)
2. 4144CD-1 Drainage improvement in Southern Hong Kong Island–package 2A
3. 4163CD Drainage improvement works at Ngong Ping
4. 4166CD-1 Drainage improvement works at Yuen Long – Phase 1
5. 4171CD Energizing Kowloon East–revitalisation of Tsui Ping River
6. 4172CD-1 Rehabilitation of underground stormwater drains– Stage 2

Other projects:

7. 4112CD Drainage improvement in Northern New Territories (remaining works)
8. 4144CD-2 Drainage improvement in Southern Hong Kong Island–Package 2 (remaining works)
9. 4161CD Improvement of Yuen Long Town Nullah (Town Centre Section)
10. 4165CD-1 Drainage improvement works at North District– Phase 1
11. 4165CD-2 Drainage improvement works at North District– Phase 2
12. 4166CD-2 Drainage improvement works at Yuen Long (remaining works)
13. 4172CD-2 Rehabilitation of underground stormwater drains (remaining works)
14. 4173CD Drainage improvement works in Ta Kwu Ling
15. 4174CD Drainage improvement works in Mong Kok
16. 4175CD Drainage improvement works in Tsim Sha Tsui
17. 4176CD Drainage improvement works in Wong Tai Sin
18. 4177CD Drainage improvement works in Kwun Tong
19. 4178CD Yuen Long Barrage Scheme
20. 4179CD Drainage improvement works in Kowloon City
21. 4181CD Drainage improvement works in Eastern District
22. 4182CD Drainage improvement works in Sha Tin and Sai Kung
23. 4183CD Drainage improvement works in Tai Po
24. 4187CD Revitalisation of Tai Wai Nullah
25. 4188CD Revitalisation of Fo Tan Nullah