

**For discussion
on 27 May 2025**

Legislative Council Panel on Development

Long-term Flood and Shoreline Management Integrated Strategies to Cope with Climate Change

Purpose

This paper briefs Members on the long-term flood and shoreline management integrated strategies for enhancing the Government's capabilities in coping with extreme rainstorms, sea level rise and extreme storm surges¹ under climate change.

Background

2. Hong Kong has an annual average rainfall of about 2 400 millimetres, one of the highest among the cities in the Pacific Rim². The wet season often brings heavy rains, posing potential flood risks to low-lying areas or locations with stormwater drainage systems established long time ago. In addition, coastal low-lying or windy areas are susceptible to storm surges during tropical cyclones, posing risks of seawater backflow and flooding, as well as potential threats to some coastal facilities.

3. Climate change impacts the globe. Similar to other cities, Hong Kong faces challenges from increasingly frequent and severe extreme weather events. Based on the data from recent super typhoons as well as historical rainfalls, sea levels and storm surges, the "Sixth Assessment Report" published by the Intergovernmental Panel on Climate Change (IPCC) and the review of design standards adopted by other international cities, the Government has enhanced the design parameters including rainfalls, sea levels and storm surges in the "Stormwater Drainage Manual" and "Port Works Design Manual". Currently, our design standards are comparable to major cities in the Mainland and overseas such as Shenzhen, Guangzhou, Singapore,

¹ Storm surge is a rise of sea level due to the combined effects of low atmospheric pressure and strong winds brought by tropical cyclone.

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

Tokyo, London and New York³ (**Annex 1**).

4. To combat extreme rainfall, we have reviewed and developed a territory-wide Drainage Master Plan to systematically review the existing drainage systems of various districts. Tailored to the topographical characteristics and constraints of different areas, we have been adopting “Stormwater Interception”, “Flood Storage” and “Drainage Improvement” in implementing our drainage improvement works to reduce flood risks in various districts. Currently, we have 15 drainage improvement projects⁴ (**Annex 2**) underway which are anticipated to complete progressively by the end of 2030.

5. To combat the coastal flood risks due to sea level rise and storm surges, we completed a coastal hazards study in 2021 and identified 26 coastal low-lying or windy residential areas⁵ and formulated improvement works and management measures to safeguard public safety. The improvement works have been progressively taken forward since 2022, with 16 areas completed and the remaining works expected to be completed in an orderly manner by 2027.

6. To further develop the long-term flood and shoreline management integrated strategies, we completed in the end of 2024 the “Strategic Planning Study on Flood Management against Sea Level Rise and Extreme Rainfall” (SPS) and the “Study on Shoreline Management Plan” (SMP). The SPS analysed the flood risks of extreme rainfall and sea level rise in various districts under climate change and the SMP analysed the impacts of storm surges, waves and sea level rise to the coastal areas in Hong Kong under climate change. Both studies holistically analysed major climate change scenarios, including the intermediate⁶ and very high⁷ greenhouse gas emissions scenarios at mid-century (2050) and the end of the century (2100),

³ For example, we consider rainstorms of the 200-year and 50-year return periods for the urban drainage trunk and urban drainage branch systems respectively (including those in the New Development Areas). Our design standards are on par with the major cities in the Mainland and overseas. Also, in response to the extreme rainstorm in September 2023, the Drainage Services Department has updated the “Stormwater Drainage Manual”. The 200-year return period design rainfall at mid-century is increased to 172 millimetres per hour.

⁴ Including the construction of 9 stormwater storage schemes (with a total capacity of 320 000 cubic metres, equivalent to approximately 128 standard swimming pools), construction, improvement, and rehabilitation of over 50 kilometres of stormwater drains, channels and flood walls.

⁵ The 26 coastal low-lying or windy residential areas are shown in Annex 4.

⁶ Intermediate greenhouse gas emissions scenario (SSP2-4.5) represents carbon dioxide emissions remaining around 2015 levels until mid-century and reduced to about a quarter of 2015 levels at the end of the century.

⁷ Very high greenhouse gas emissions scenario (SSP5-8.5) represents carbon dioxide emissions roughly double from 2015 levels by mid-century and rise to three times 2015 levels at the end of the century.

and formulated medium-term and long-term flood and shoreline management strategies.

Guiding Principle and Strategic Approach for Combating Climate Change

7. According to the climate change projections in various time horizons and greenhouse gas emissions scenarios for Hong Kong based on the “Sixth Assessment Report” published by the IPCC and other related studies, the difference in the climate change impacts for Hong Kong between the intermediate and very high greenhouse gas emissions scenarios at mid-century is insignificant⁸. Depending on the effectiveness of decarbonisation efforts by various nations, there are considerable uncertainties in the climate change impacts at the end of the century. The difference between intermediate and very high greenhouse gas emissions scenarios is more prominent⁹. To this end, we adopt the “**Progressive Adaptive Approach**” with integrated strategies of **Adaptation, Resilience and Management** to cope with the potentially increasing flood risks under the impacts of climate change. Many international cities, including New York, London and Singapore, also adopt such approach to implement their adaptation measures.

Progressive Adaptive Approach

8. In view of the commitments towards carbon neutrality by various nations and their efforts on decarbonisation, we adopt the Progressive Adaptive Approach and take the intermediate greenhouse gas emissions scenario at mid-century as the design standard (this standard is also sufficient to address the very high greenhouse gas emissions scenario at the mid-century). Where practically feasible, design provisions shall be included to enable timely and cost-effective upgrade of our infrastructure in the future as needed, so as to combat the effects under the very high greenhouse gas emissions scenarios at the end of the century.

9. As there exist considerable uncertainties in the impacts of climate change near the end of the century, the Progressive Adaptive Approach provides sufficient flexibility and adaptability so that we can have sufficient time to develop effective and cost-efficient measures according to the actual situation.

⁸ Taking sea level rise as an example, the median projections for sea level rise by 2050 under the intermediate and very high greenhouse gas emissions scenarios are 0.20 metres and 0.23 metres respectively, with a difference of only 0.03 metres.

⁹ Taking sea level rise as an example, the median projections for sea level rise by 2100 under the intermediate and very high greenhouse gas emissions scenarios are 0.56 metres and 0.78 metres respectively, with a difference of 0.22 metres.

This can avoid premature development or implementation of large-scale projects leading to unnecessary construction, operation and maintenance expenses. For example, we can build a larger foundation for new wave wall so that we can increase the height of wave wall based on the actual need when necessary, or we can reserve lands in new development areas so that the drainage system can be expanded as required in the long term. The design requirements for the Progressive Adaptive Approach, including the design allowance for potential additional increase in rainfall and sea level rise, have been incorporated into the “Stormwater Drainage Manual” and “Port Works Design Manual”. We will continue to review and update the design manuals according to the reports published by the IPCC and related research studies.

Adaptation, Resilience and Management Integrated Strategy

10. In view of various unpredictable situations brought by extreme weather, the international community generally agrees that investment in infrastructure for avoiding flooding completely is not the most effective nor cost-efficient approach. In this regard, we adopt a comprehensive and multi-pronged integrated strategy to address flood risks caused by extreme weather and to further enhance Hong Kong’s capabilities in adaptation and resilience. Our integrated strategy focuses on three aspects including:

- Adaptation: Implementing drainage and coastal improvement works in an orderly manner by adopting the Progressive Adaptive Approach to reduce flooding impact;
- Resilience: Adopting temporary or non-structural measures to control flood risks or reduce flooding impact for speedy society recovery; and
- Management: Strengthening emergency preparedness, leveraging innovative technologies, enhancing information dissemination, conducting drills, reviewing and timely updating guidelines/standards, with a view to raising public awareness of flood prevention.

11. We have also consulted numerous experienced local, Mainland, as well as international scholars and experts on the above guiding principle and strategic approach for addressing climate change. Additionally, we have engaged and closely communicated with relevant Mainland authorities, and shared our experience in major international conferences. These ensure that our guiding principle and strategic approach for addressing climate change are broadly aligned with the standards of the Mainland and other international cities.

Combating Flood Risks at Mid-Century (2050)

Integrated Flood Management Strategy and Measures

12. Under the strategic framework of advance emergency preparedness, enhanced early warning, decisive emergency response and speedy recovery, we have formulated a territorial forward-looking Integrated Flood Management Strategy to combat the impacts brought by climate change. This strategy aims to integrate adaptation, resilience and management measures, with a focus on advancing the concept of “flood resilience” to enhance urban resilience and strengthen Hong Kong's overall flood preparedness in face of climate change.

13. For adaptation, in addition to the on-going projects, we are proactively planning drainage improvement works across various districts. These projects will take into account the existing topography, flood risks and impacts on surrounding areas, drainage capacity of existing drainage system, technical feasibility and cost-effectiveness, etc. The drainage improvement works will be implemented by batches in an orderly manner to mitigate the flood risks at mid-century.

14. For resilience, it mainly includes blue-green drainage infrastructure and flood barriers. Floodable area, as an element in blue-green drainage infrastructure, primarily utilizes public spaces and recreational facilities for temporary stormwater storage during extreme rainfall events, achieving benefit of “single site, multiple use”. Other blue-green elements such as green roof, rainwater harvesting system and rain garden can reduce surface runoff during rainfall events and relieve pressure on the drainage system. Regarding flood barriers, we will promote the adoption of the new generation of various types of flood barriers including electrical auto flip-up barrier, water filled tube barrier, doorway barrier, etc., to enable rapid and efficient deployment of temporary flood barriers in diverse settings, hence minimizing flood risks due to water ingress. We have promoted various flood barriers to relevant government departments and stakeholders, including MTR Corporation Limited, Link Real Estate Investment Trust, The Hong Kong and China Gas Company Limited, CLP Power Hong Kong Limited, The Hongkong Electric Company Limited, Property Management Services Authority, Institute of Shopping Centre Management, The Hong Kong Federation of Insurers and other related stakeholders, to safeguard their facilities and enhance Hong Kong's overall resilience against flood risks.

15. For management, we are continuously enhancing multi-faceted measures by strengthening the “just-in-time” clearance, leveraging innovative technologies and reinforcing information dissemination. These measures include increasing number of emergency response teams and emergency support stations, introducing powerful pumping robots¹⁰, piloting artificial intelligence-based flood monitoring systems and new types of flood monitoring sensors such as Flood Monitoring Device, disseminating real-time water level information and publishing list of flood prone areas, etc. We will also strengthen our collaboration with the Hong Kong Observatory to monitor and collect extreme weather data, using them as a basis to continuously review, update and formulate standards and guidelines. In addition, we have developed the “Guidelines on Flood Resilience” for reference by relevant industries such as property management, public utilities, etc.

Integrated Shoreline Management Strategies and Measures

16. With reference to Mainland and overseas experience, we consider various factors such as the existing topography, land use, flood risk and impacts on the surroundings, defence capability of existing facilities, technical feasibility and cost-effectiveness, etc., and adopt adaptation, resilience and management measures. The shoreline management strategies can be divided into 4 categories (**Annex 3**):

- (i) “No Active Intervention”: Retain the existing shoreline;
- (ii) “Hold The Line”: Maintain or enhance coastal defence along the existing shoreline;
- (iii) “Managed Realignment”: Relocate the coastal defence line further inland; and
- (iv) “Advance The Line”: Establish a new coastal defence line seaward to protect inland areas.

17. According to the current estimate, the flood risk brought by climate change to the coastal areas in Hong Kong at mid-century is considered manageable. The “No Active Intervention” and “Hold The Line” strategies can not only effectively manage the risks in response to the coastal conditions of Hong Kong, but also reduce the impacts on valuable lands and marine resources. Therefore, these two strategies are currently the most suitable for use in the natural and artificial shorelines in Hong Kong respectively.

¹⁰ Compared to traditional pumping devices, pumping robots offer higher efficiency in pumping floodwater. These robots can be deployed across diverse environments, including roads, villages, underground facilities, and low-lying regions, enhancing drainage efficiency and reducing time for emergency pumping in inundated areas.

18. For all coastal areas in Hong Kong¹¹, we continue to adopt a risk management approach to assess the likelihood and consequences¹² of seawater inundation, and identified 11 coastal areas planned for advance preparation to cope with the coastal risks near the mid-century (**Annex 4**). In collaboration with relevant departments and stakeholders, we will plan improvement measures involving public spaces and private properties through the “Hold The Line” strategy. The improvement measures will continue to adopt a multi-layered protection design to mitigate coastal flood risks and reduce the impacts of flooding. The multi-layered protection design includes:

- (i) Adopting adaptation measures along the coastline as the first line of defence to reduce the coastal hazards, for example, constructing or raising wave walls;
- (ii) Adopting resilience measures in suitable locations behind the coastline to form the second line of defence, for example, demountable flood barriers to form a buffer zone to further reduce the seawater flowing towards inland areas;
- (iii) Adopting contingency measures in front of important buildings as the third line of defence, for example, demountable flood boards and/or sandbags; and
- (iv) Finally, in conjunction with management measures, such as early warning systems and action plans on emergency arrangement, installation of water gauges, pumps and warning signs, etc. to raise public alertness and strengthen preparedness.

We will proactively share the potential improvement options with relevant stakeholders and plan improvement measures in a timely manner to mitigate coastal flood risks at mid-century and strengthen the defence capability of the shoreline.

19. In addition, we will increase the number of monitoring locations to strengthen monitoring of water level changes at different coastal locations. We will also proactively engage relevant Mainland and international organizations regarding the review, updating and formulation of standards and guidelines.

¹¹ SMP has covered and considered the previously identified 26 coastal low-lying or windy residential areas, as well as the ongoing coastal improvement measures. After implementing the relevant measures, it is concluded that the coastal flood risks in these 26 areas are at a manageable level.

¹² This includes the extent of coastal flooding and structural damage caused by overtopping wave during extreme weather events, low-lying area flooding due to storm surges, and public safety and community resilience that are endangered.

Combating Flood Risks at the End of the Century (2100)

20. The nations around the world are working together to curb the trend of global warming, and Hong Kong is committed to achieving carbon neutrality by 2050¹³. Nevertheless, we still need to make advance preparation for the long-term uncertainties posed by climate change. Therefore, in addition to the mid-century scenarios mentioned above, the two studies have also analysed the flood risks under intermediate to very high greenhouse gas emissions scenarios by the end of the century. Given that the scenarios at the end of the century are relatively far-future and subject to uncertainties in long-term climate change, coupled with the evolving land development in Hong Kong over time, we will continue to collaborate and exchange insights with international organizations and the Hong Kong Observatory to monitor the latest climate change trends, review flood risks across districts and formulate appropriate measures in a timely manner so as to mitigate the risks.

21. We have identified preliminary options¹⁴ for the developed areas with potential flood risks. For new development areas, such as the Northern Metropolis, the stormwater drainage systems will be designed to address mid-century climate change impacts, while implementation plans will be developed and land will be reserved for scenarios at the end of the century, enabling future expansion following the Progress Adaptive Approach.

22. As for shoreline management, according to current estimate, the “No Active Intervention” and “Hold The Line” strategies can generally still manage the coastal flood risks at the end of the century. The two low-lying areas, i.e. Tai O and Lei Yue Mun, may face greater impacts when approaching the end of the century under the very high greenhouse gas emissions scenario. For these two areas, we have currently implemented resilience and management measures to mitigate coastal flood risks. We can prudently observe the long-term development of climate change after mid-century to decide long-term measures in the future, such as whether “Advance The Line” strategy¹⁵ should be adopted to address climate change risks at these two locations.

¹³ Our country targets to achieve carbon neutrality by 2060.

¹⁴ Examples include implementing stormwater storage schemes, barrages, stormwater pumping stations and drainage tunnels, as well as installing smart penstocks at drainage outlets in low-lying areas.

¹⁵ Both “Managed Realignment” and “Advance The Line” strategies can mitigate coastal risks. However, given the scarcity of land resources in Hong Kong, SMP preliminarily recommends considering “Advance The Line” for these two locations to address long-term coastal risks under climate change.

23. Considering the climate change risks for new development projects, we have taken a long-term planning approach by incorporating the “Guidelines on Flood Resilience” and draft guidelines for managing coastal flood risks into the relevant design manuals for implementation. These guidelines will also be appropriately included in the “Hong Kong Planning Standards and Guidelines” as reference, which includes introducing the Progressive Adaptive Approach, the concept of “flood resilience”, risk-based planning and design principles, as well as options and examples of measures (**Annex 5**). Stakeholders in the community can also refer to these guidelines to formulate appropriate defence measures according to actual needs and circumstances, thereby enhancing capabilities of the relevant facilities against climate change.

Public Education

24. In addition, to enhance Hong Kong's capability to cope with extreme weather, we must obtain the participation of relevant stakeholders and the public. We will continue to publicize and educate relevant stakeholders and the public on climate change risks, related improvement measures, emergency preparedness and safety awareness, etc. through TV announcements in the public interests, publications and other engagement activities, such as international conferences, open days of government departments, seminars for relevant government departments and stakeholders (including utility providers, professional bodies, etc.), and other outreach education programs, etc., thereby strengthening their vigilance in face of extreme weather and climate change.

Advice Sought

25. Members are invited to offer views on the document.

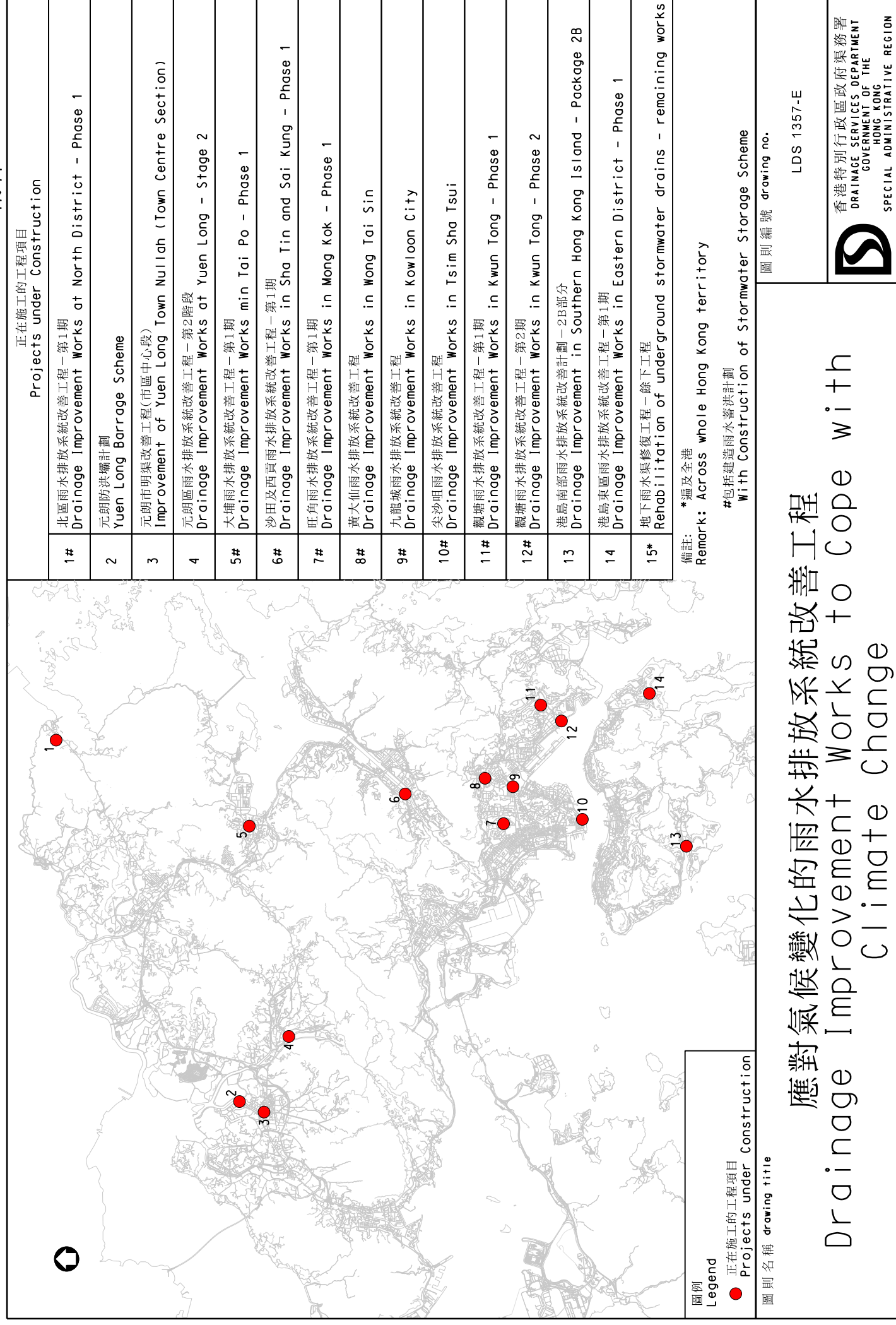
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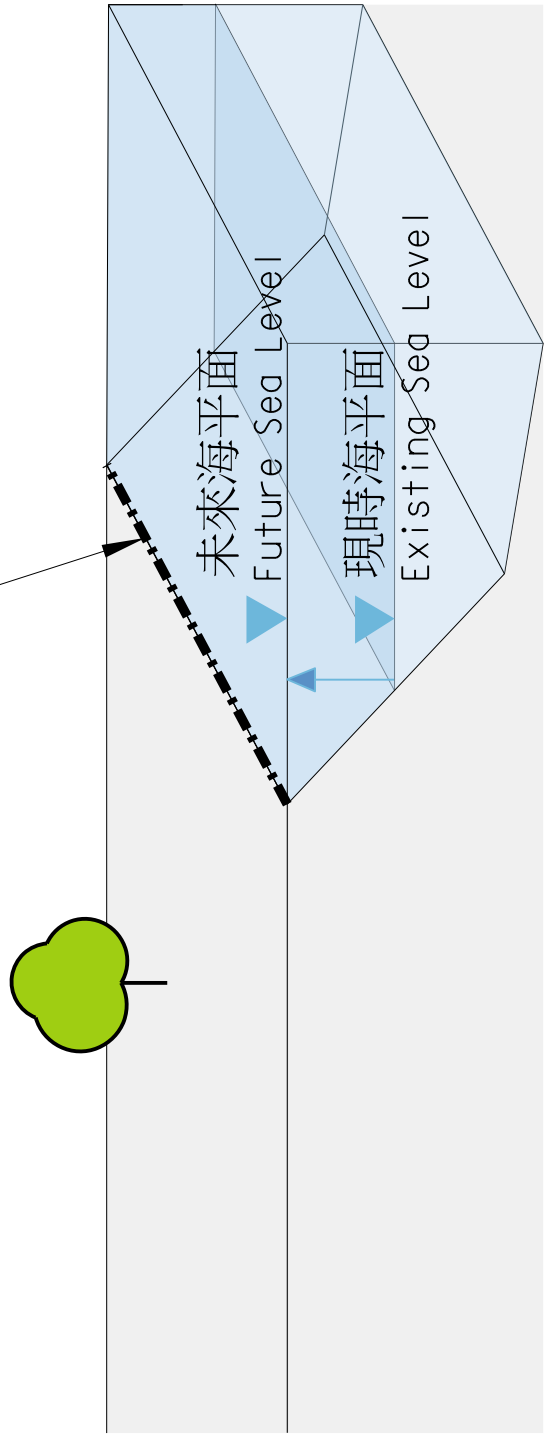
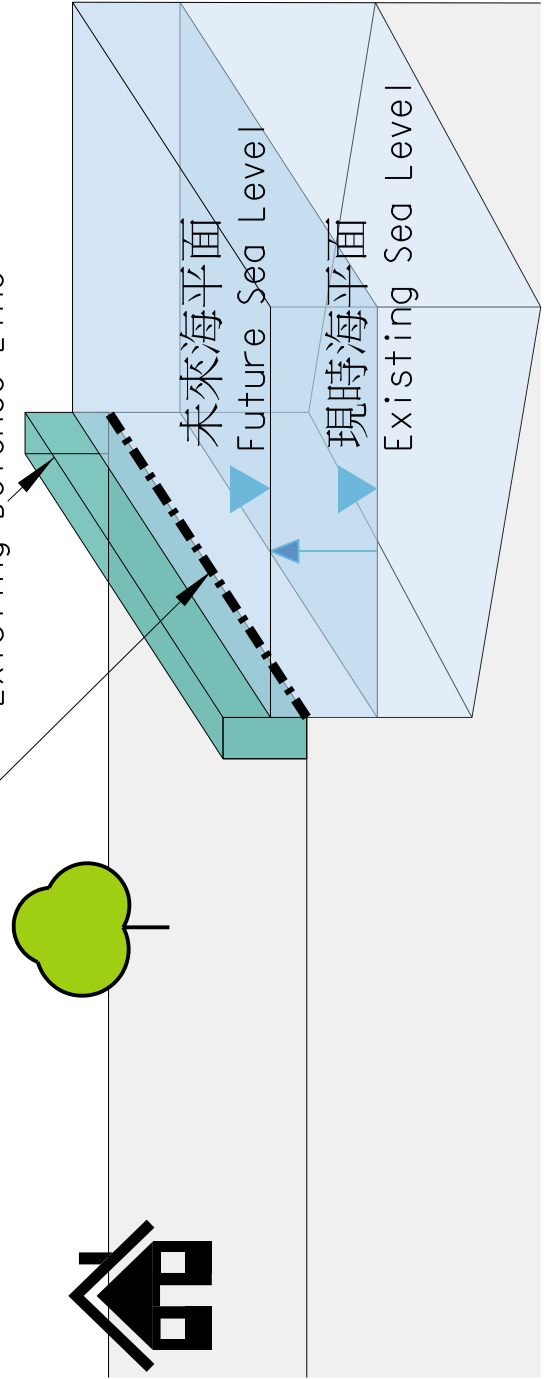
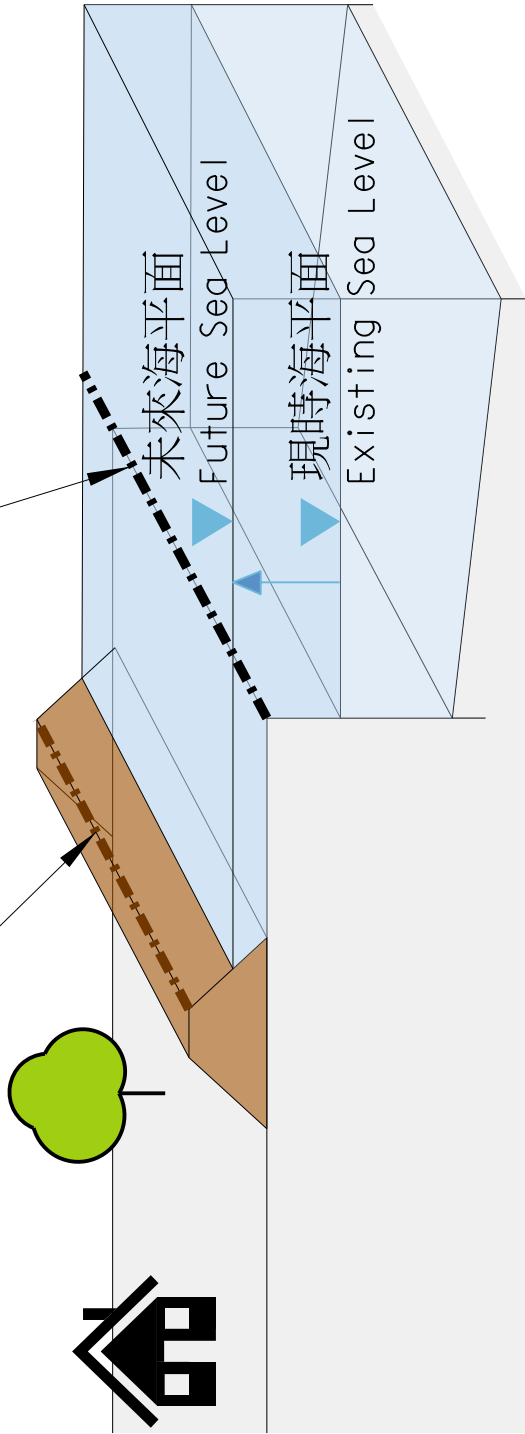
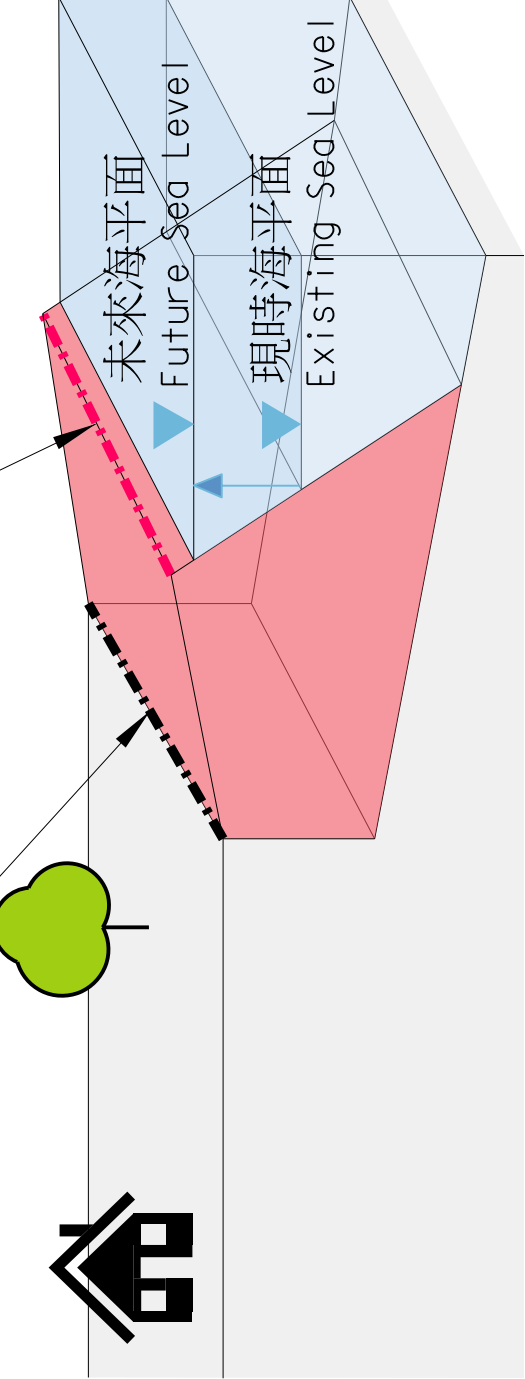

Annex 1

Flood Protection Standard for Stormwater Drainage System

City	Classification	Design Return Period (Years)
Hong Kong	Urban drainage branch	50
	Urban drainage trunk	200
Shenzhen and Guangzhou	Design criteria for urban drainage	50
	Design criteria for flood protection	200
Singapore	Area with catchment of more than 1 000 ha	50
	Airport runway or any area as specified by the Board	100
Tokyo	Inland drainage	20
	City-managed rivers	100
	National-managed rivers	200
London	Surface water drainage	30
	Watercourse	100
New York	Flood control design criteria for drainage projects	100

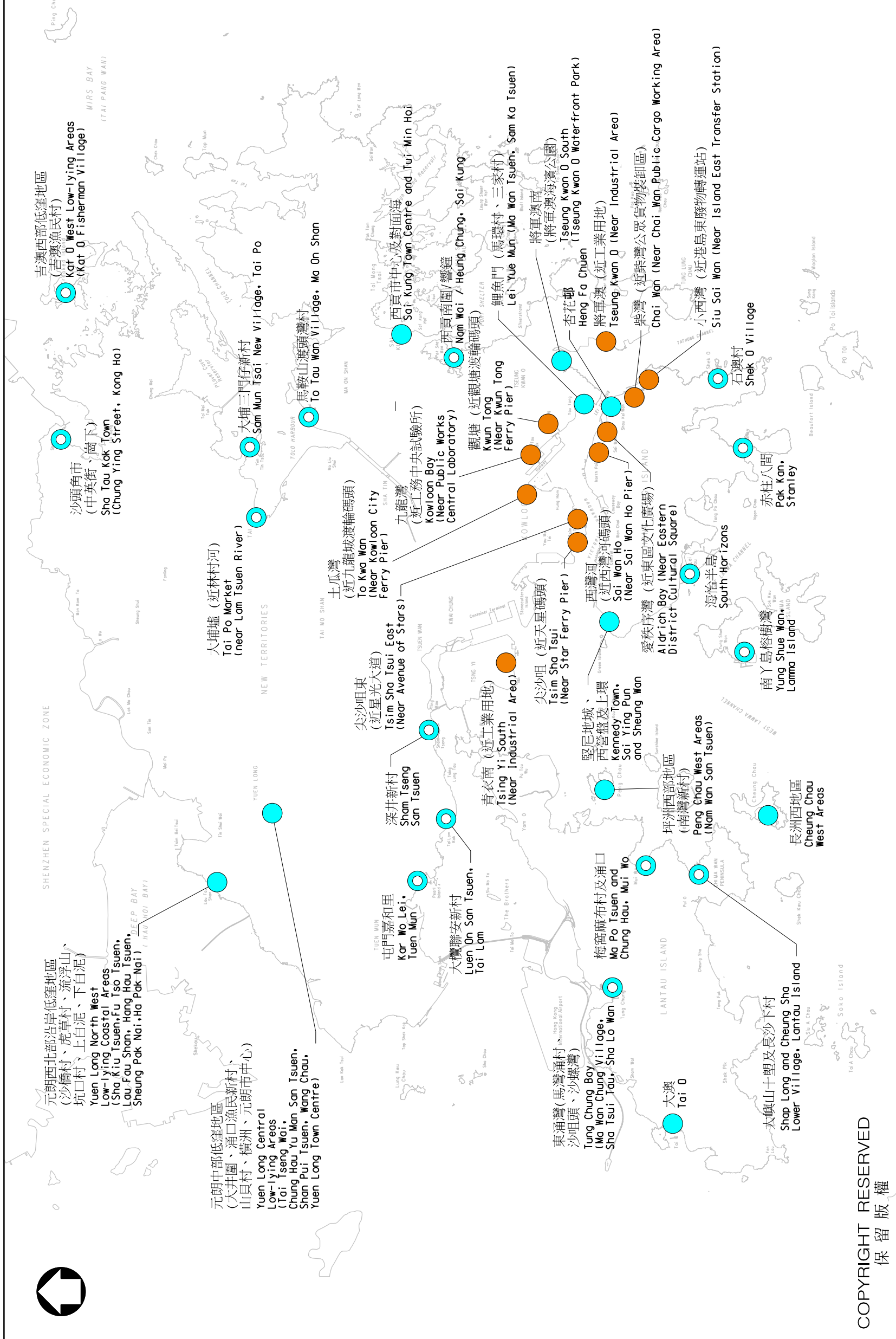
Note: The classification of the flood protection standards for stormwater drainage systems varies across cities. The above table covers the typical design criteria for the major urban drainage systems.



<div><div>內陸 Landside</div><div>現有海岸線位置 Existing Shoreline</div><div>海 Seaside</div></div>  <div><div>(i) 「不干預」 No Active Intervention</div><div>保留現有海岸線 Retain the existing shoreline</div></div>		<div><div>內陸 Landside</div><div>現有海岸線位置 Existing Shoreline</div><div>維持或提升現有防線 Maintain/Improve Existing Defence Line</div><div>海 Seaside</div></div>  <div><div>(ii) 「堅守防線」 Hold The Line</div><div>維持或提升現有海岸防線的防禦能力 Maintain or enhance coastal defence along the existing shoreline</div></div>	
<div><div>內陸 Landside</div><div>現有海岸線位置 Existing Shoreline</div><div>海 Seaside</div></div>  <div><div>(iii) 「往內陸移」 Managed Realignment</div><div>將海岸防線向內陸後移 Relocate the coastal defence line further inland</div></div>		<div><div>內陸 Landside</div><div>現有海岸線位置 Existing Shoreline</div><div>新防線 New Defence Line</div><div>海 Seaside</div></div>  <div><div>(iv) 「向海推進」 Advance The Line</div><div>向海建立新海岸防線以保護內陸地方 Establish a new coastal defence line seaward to protect inland areas</div></div>	
<div>圖則名稱 drawing title</div> <div>主要海岸管理策略 Major Shoreline Management Strategies</div>		<div>圖則編號 sketch no.</div> <div>PW-SK25-026</div>	
<div>office</div> <div>PORT WORKS DIVISION 海港工程處 CIVIL ENGINEERING OFFICE 土木工程處</div>		<div> CIVIL ENGINEERING AND DEVELOPMENT DEPARTMENT 土木工程拓展署</div>	



沿岸改善工程の参考例子:
Typical Examples of Coastal Enhancement Works :



圖則名稱 drawing title

已識別作沿岸改善措施及計劃作超前部署的地點

Locations for Coastal Enhancement Works and Planned for Advance Preparation

圖則編號 sketch no.

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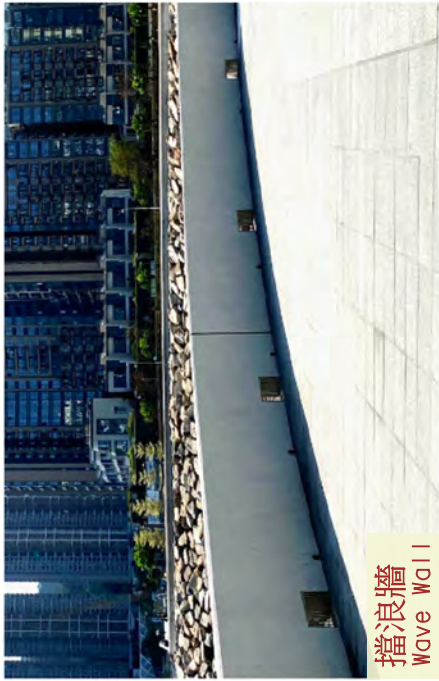
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AND DEVELOPMENT
DEPARTMENT**
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適應 Adaptation



應變 Resilience



管理 Management



圖則名稱 drawing title

改善措施例子
Examples of Enhancement Measures