CORRIGENDUM No. 1/2026

This corrigendum contains updates to the Port Works Design Manual, 2002 Edition, and shall be read in conjunction with Corrigenda 1/2006, 1/2014, 1/2018, 1/2020, 1/2022 and 1/2025.

(A) Shoreline Management Guideline for Coastal Development

PART 1 – General Design Considerations for Marine Works

(a) CONTENTS

Add the following section:
Section 2.11 Shoreline Management Guideline for Coastal Development

Add the following appendix:
APPENDIX E SHORELINE MANAGEMENT GUIDELINE FOR COASTAL DEVELOPMENT

(b) Section 2.11 Shoreline Management Guideline for Coastal Development

Add the following section:

Section 2.11 Shoreline Management Guideline for Coastal Development

Shoreline areas are facing hazards caused by extreme weather events. These extreme weather events are influenced and worsen by climate change, leading to stronger winds, more serious storm surge, increased wave overtopping and sea level rise which all contribute to greater risks in shoreline areas. As a result, the risk of coastal flooding, coastal erosion and damage to shoreline are increasing along the shoreline areas of Hong Kong.

The Shoreline Management Guideline for Coastal Development (SMG) is proposed to provide guidance for coping with coastal risks arising from climate change and extreme weather events. Strategies and measures are recommended to enable the development of coastal defence comprising engineering infrastructure and integrated management approaches to create a usable, safe, resilient and adaptable waterfront for new and existing shorelines.

The SMG provides a step-by-step process consisting of identifying the nature of coastal hazards, conducting risk assessment, examining the extent of the risk caused by these hazards, adopting desirable principles and measures in shoreline planning to mitigate those risks, and the monitoring and reporting of the performance of the recommended principles and measures.

Three approaches are introduced to provide risk treatment in the form of coastal adaptation, resilience and management measures for future generations. The approaches, namely Avoid the Risk, Protect Against the Risk, and Accommodate the Risk, would be chosen through assessment of the risk exposure and review of the consequences of those risks.

The strategic approach and guiding principles for the SMG are drawn from local and overseas coastal practices to enhance the capabilities for adaptation, resilience and management of Hong Kong's shoreline. The means of implementation can be considered as follows:

(i) Adaptation: Implementing coastal improvement works in an orderly manner by adopting the Progressive Adaptive Approach to reduce flooding impact;
(ii) Resilience: Adopting temporary or non-structural measures to control flood risks or reduce flooding impact for speedy society recovery; and
(iii) 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 and emergency response.

Considering the recommended standards and methodologies for the design of marine works provided in the Port Works Design Manual and other relevant standards, manuals, technical circulars, and practice notes, the SMG is provided in Appendix E.

The proponent for coastal development is responsible for conducting a coastal impact assessment in accordance with the SMG provided in Appendix E. Deviation from this guideline should be justified with sound technical reasons demonstrating impracticality. The proponent is defined as the department, agency or body, directly responsible for the project development at different stages of activities. If a project (including public works projects and private sector projects) involves coastal development, or if coastal risks to the project have been reasonably foreseen (e.g. by making reference to the recent coastal flood/damage records, etc.), the proponent shall conduct a coastal impact assessment. Existing condition should be considered as the given condition by the proponent when carrying out the coastal risk assessment as well as the planning and design of the development. This assessment shall be provided to support the relevant submissions when they are circulated to the Port Works Division of the Civil Engineering and Development Department (PWD of CEDD). In particular, for private sector projects, the assessment shall be included as part of the supporting document submitted with the statutory submissions for the project to relevant authorities (e.g. the Planning Department, Lands Department, and Buildings Department, etc.), who will further consult PWD of CEDD accordingly under the current circulation mechanism. Whether a development is a coastal development depends on various factors, such as its geographic location and formation level, etc. In general, a development is considered a coastal development when any part of the project is within 30 metres from and behind the copeline of existing/proposed seawall for artificial shoreline, or from and behind the line of the high water mark for natural shoreline. PWD of CEDD shall be consulted if the proponent is in doubt about the need to submit the coastal impact assessment.

(c)	APPENDIX E SHORELINE MANAGEMENT GUIDELINE FOR COASTAL DEVELOPMENT	**Add Appendix E as shown in the enclosure.**

PART 4 – Guide to Design of Seawalls and Breakwaters

(a)	Section 3.4 Eco-shorelines	**Replace the last two sentences with the following:** The CEO Publication "*Guidelines on Design, Installation and Maintenance of Eco-engineering Features*" and the Greater Bay Area Standard No. WQ 1-262 "*Technical Guidelines for Ecological Design of Sea Dikes*" are available on the CEDD departmental website and the Guangdong-Hong Kong-Macao Greater Bay Area Standard Information Public Service Platform (https://www.gbsrc.org.cn/standardSearchDetail?bzNumber=T%2FCHES%20139-2024), respectively. Project proponents should, where site conditions permit, follow the relevant guidelines to incorporate eco-shoreline elements into their projects. Deviation from the relevant guidelines should be justified with sound technical reasons demonstrating impracticality.

enclosure

APPENDIX E
SHORELINE MANAGEMENT GUIDELINE FOR COASTAL DEVELOPMENT
in PART 1 – General Design Considerations for Marine Works

APPENDIX E

SHORELINE MANAGEMENT GUIDELINE FOR COASTAL DEVELOPMENT

CONTENTS

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E.1 BACKGROUND

E.1.1 Introduction

E.1.1.1 Hong Kong has a coastline of over 1,100 kilometres, of which approximately 200 kilometres are artificial, offering a wide variety of attractive coastal environments. While climate change is driving more severe and intensified tropical cyclones and storm surges, the HKSAR Government has taken proactive steps to formulate the strategies that ensure these waterfront areas remain safe for public enjoyment.

E.1.1.2 According to the Climate Action Plan 2050, effective action against climate change requires not only the implementation of decarbonisation strategies to achieve carbon neutrality before 2050, but also the strengthening of adaptation and resilience measures to safeguard lives, health and property from extreme weather events. To manage Hong Kong coastal risks due to climate change, CEDD has been adopting multipronged approach, including to update design manual, complete territory-wide studies, implement action plans in typhoon season, and enhance public awareness. In particular, CEDD completed the Coastal Hazards Study which identified 26 coastal low-lying or windy residential areas in Hong Kong and formulated improvement works and management measures to safeguard public safety. The improvement works have been progressively taken forward.

E.1.1.3 To further develop the long-term shoreline management integrated strategy, CEDD completed the Study on Shoreline Management Plan, which analysed the impacts of storm surges, waves and sea level rise to the coastal areas in Hong Kong under climate change. Taking the study recommendations, this "Shoreline Management Guideline for Coastal Development" (SMG) is developed for the purpose of providing guidelines on planning and implementing urban coastal development and protection measures. To this end, a long-term planning approach has been adopted through the introduction of the SMG, which provides a framework for managing coastal risks under climate change. The SMG outcomes will contribute to enhancing Hong Kong's climate resilience and adaptation in line with the Climate Action Plan 2050, supporting Hong Kong's vision of greater liveability, sustainability, and resilience. 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. The community can refer to this guideline to formulate appropriate defence measures according to actual needs and circumstances, thereby enhancing capabilities of the relevant facilities against climate change. Details of the abovementioned studies are available in the following CEDD's website.

CEDD website – Coastal Enhancement and Shoreline Management
https://www.cedd.gov.hk/eng/our-projects/topics-in-focus/index-id-39.html

E.1.1.4 This SMG serves to set out processes to identify the coastal risks and to formulate measures for existing developments and new developments (including re-developments) along the shoreline to enhance coastal resilience against extreme weather events exacerbated by climate change. The SMG prompts the users to consider the coastal risks such as sea level rise and more severe storm surge and wave effects in the present day and in the future time horizons, and to formulate an approach to best provide a resilient coastline serving the people and places nearby.

E.1.1.5 The purpose of the SMG is not to limit or dictate land use planning or design for coastal developments, but to assist the relevant practitioners for new and existing developments in identifying risks and adopting suitable practices to enhance coastal resilience, while maintaining an appropriate balance among safety, development and harbourfront enjoyment. The SMG highlights consideration of coastal hazards, provides guidelines on hazard assessment, and introduces commonly adopted strategies and practices for addressing coastal risks and climate change. Recognising the unpredictability of extreme weather events, the international community generally agrees that solely investing in infrastructure to completely prevent flooding is neither the most effective nor the most cost-efficient approach. In this regard, this guideline advocates the adoption of a comprehensive and multipronged integrated strategy (i.e. Adaptation, Resilience and Management) to address flood risks arising from extreme weather and to further enhance Hong Kong's adaptive and resilient capabilities. Considering the variable nature of the marine environment, the design of coastal structures should rely on sound engineering judgement and practical experience. The relevant practitioner is encouraged to explore alternative methods suited to site-specific conditions and to recognise that design approaches will continue to evolve as more data and research findings become available.

E.1.1.6 Deviation from this guideline should be justified with sound technical justifications demonstrating impracticality. The SMG does not exempt coastal developments from compliance with any relevant statutory requirements or any provisions of land leases. Project proponent for coastal development should follow the applicable statutory and administrative procedures and requirements as appropriate at the implementation stage. Relevant practitioner in existing coastal area can also refer to the SMG when formulating protection measures in enhancing resilience against coastal risks.

E.2 SHORELINE MANAGEMENT GUIDELINE FOR COASTAL DEVELOPMENT

E.2.1 Coastal Hazards

E.2.1.1 A summary of consequences from coastal flooding, tidal inundation, and coastal erosion can be considered as follows:

- direct inundation of coastal areas, ponding and elevated groundwater levels
- overtopping of coastal barrier or coastal shore-protection structures by high-tides
- breaching or over-washing of dunes, gravel barrier or shore-protection structures
- inundation via beach access points and boat ramps
- inundation via seawater backflow of stormwater systems

- wave overtopping of coastal barriers or coastal shore-protection structures
- inundation of underground structures
- scouring of marine structures

E.2.2 Step-by-step Guide using Risk-based Approach

E.2.2.1 The process for assessment, planning and design is to be completed step-by-step following a risk-based approach, taking into account the likelihood of coastal hazards and severity of consequence, in order to consider appropriate measures to mitigate coastal risks to suit the specific site.

E.2.2.2 This guideline sets out a step-by-step approach to:

- **Step 1** – Data Collection
    - Conduct baseline review (land use, Outline Zoning Plans, land & marine traffic, marine environment, infrastructure & utilities, etc.)
    - Review of existing shoreline defence
    - Collect data for risk assessments
- **Step 2** – Assessing the Likelihood of Coastal Hazards
    - Wave overtopping, storm surge, sea level rise, coastal erosion, etc.
    - Impact on the land and marine environment, coastal process, etc.
    - Impact to adjacent or nearby shorelines, existing, or proposed developments
- **Step 3** – Examining the Severity of Consequences
    - Affected facilities – Buildings, Open Spaces / Streets, Utilities / E&M facilities, Critical / Transport Infrastructure, Edge / Offshore Structure
    - Existing shoreline condition / context (small space to shoreline, older buildings, capability to upgrade shoreline edge structure)
- **Step 4** – Approaches and Design Practices to Enhance Coastal Resilience Against Climate Change
    - Progressive Adaptive Approach (PAA)
    - Adaptation, Resilience, Management (ARM)
    - Approaches for new coastal developments
- **Step 5** – Implement Measures to Enhance Coastal Resilience Against Coastal Risks and Climate Change
    - General Approach – following usual Investigate, Design, Construct process
    - Utilise the relevant standards and guidelines for design
- **Step 6** – Monitoring and Reporting

E.2.2.3 The guideline applies to developments located along or near both new and existing shorelines. Section A under **Step 4** mainly addresses new developments, including

projects involving the construction of new buildings along new shoreline (i.e. newly reclaimed land) or the redevelopment of buildings along existing shoreline. Section B under **Step 4** focuses on existing developments, covering projects within existing buildings situated along or near the existing shoreline, such as improvement works or the establishment of businesses and events at seafront locations, etc. Nevertheless, certain design practices outlined in both sections (see E.6) are applicable to both existing and new developments.

E.3 STEP 1 – DATA COLLECTION

E.3.1.1 The relevant practitioner for new or existing development should first conduct a baseline review of the subject development. The type of development, whether it is a new development involving reclamation or development of an existing shoreline, as well as a broad understanding of the anticipated coastal hazards should be identified to help direct the future risk assessment.

E.3.1.2 Consider the following:

- Shoreline exposure – exposed to open ocean or an embayment.
- Land use purpose – residential or commercial, utilities or transport infrastructure.
- Adjacent land uses and developments – identify possible opportunities and conflicts that may be addressed through the project development
- Lifespan of project – the time horizons for the risk assessment for new shorelines should be considered from the first day of operation, for existing shorelines the horizons would be considered from the present day when undertaking the assessment.

E.3.1.3 The table in **Annex E1** may be used for reference as to the data / information sources to support assessment. Other relevant standards and guidelines should also be referenced when undertaking the design of reclamation, infrastructure, and structures.

E.4 STEP 2 – ASSESSING THE LIKELIHOOD OF COASTAL HAZARDS

E.4.1.1 The main purpose of assessing the likelihood of coastal hazards is to obtain numerical information / data to evaluate the risk exposure to the development. Using the output of the assessments the relevant practitioner can then map the results against the development to assist in the design of coastal structures and protective works. **Annex E2** can be referred to for further detail on the assessment and outcome for the associated risks.

E.4.1.2 Assessments should seek to examine:

- Present and future coastal risks to the development, worse greenhouse gas emissions scenarios[1], and the outcome without intervention,
- Impacts on the marine environment (marine ecology, coastal processes, water movement, circulation and quality, etc.),

[1] In addition to the greenhouse gas emissions scenario adopted by the PWDM, project proponent can also consider worse greenhouse gas emissions scenarios, such as low-confidence scenarios and higher end climate projections, beyond 100-years' time horizon and up to the farthest year for which mean sea level rise projection data are available for new developments, to have a better assessment of risks in the future if the project warrants (e.g. involving long term development).

- Impacts on the land environment (disruption to services, flooding of transport network, etc.),
- Impacts on the adjacent shoreline and existing or proposed developments (change in coastal process leading to erosion or sediment deposit elsewhere, residual flooding of adjacent land, etc.),
- The history of flooding in the area including scale and frequency, the defence measures that were/are in place, and historical extreme sea level events with significant impact.

E.4.1.3 For existing developments, the time horizon for the risk assessments will refine at what point intervention is required and to what extent. While there will likely be risks faced in the present day, these risks may be constant for the foreseeable future or may worsen at some point. When conducting assessments for new coastal developments (e.g. involving long-term development), project proponent should consider carrying out assessment to test the sensitivity under a worse greenhouse gas emissions scenario and a longer time horizon (e.g. up to the farthest year for which mean sea level rise projection data are available), if the project warrants.

E.4.1.4 An outcome of the risk assessments will be mapping of the risks and the creation of a risk register to identify the location, type, and extent of risk to inform the next steps of the process.

E.4.1.5 The relevant practitioner should review the climate change development and determine a suitable point in time for intervention for upgrading the structure in future under PAA regarding the standard of protection provided.

E.5 STEP 3 – EXAMINING THE SEVERITY OF CONSEQUENCES

E.5.1 Examine Extent of Risks

E.5.1.1 Having identified and assessed the coastal hazards and risks for the development site, examine extent of the risk to the shoreline, and the severity of the consequences. Extent of the risk might be how deep and far inland the flooding may reach at each time horizon. Consequences may be the number of properties flooded or the vulnerability of the affected land. Assessing impacts may be difficult to do quantitatively due to unknowns in exact land use arrangement, value of assets, or types of properties. The relevant practitioner should apply their own judgement when considering social, economic, and environmental impacts. When identifying vulnerable shoreline areas, consideration should be made of land use, topography, transportation links, and location of critical infrastructure amongst other aspects.

E.5.1.2 The extent of the risk should be considered over the length of the time horizon assessed to help optimise the approach taken. There are challenges to managing risk over an extended time frame due to the uncertainty involved with complex climate, earth and coastal systems. Risks in the near future may be low to begin with but could be higher in future and pose a greater consequence over time. The relevant practitioner should bear in mind the potential for this development in risk, allowing for flexibility in design of structures or infrastructure to allow for future enhancement as far as practicable according to PAA. **Annex E3** provides some typical examples of outcomes of coastal risks for reference.

E.5.2 Examine Severity of Consequence

E.5.2.1 In determining the severity of consequence, due consideration should be given to the coastal risk, the land use, the types of buildings, facilities, and infrastructure that may be threatened, the proximity of the public, assets, and facilities to the risk, and the residual effect from the coastal risk. For further explanation of the severity of consequence refer to **Annex E4**. Typical examples of types of coastal risk and the possible severity of consequence to society, economy, and environment are referenced in **Annex E5**.

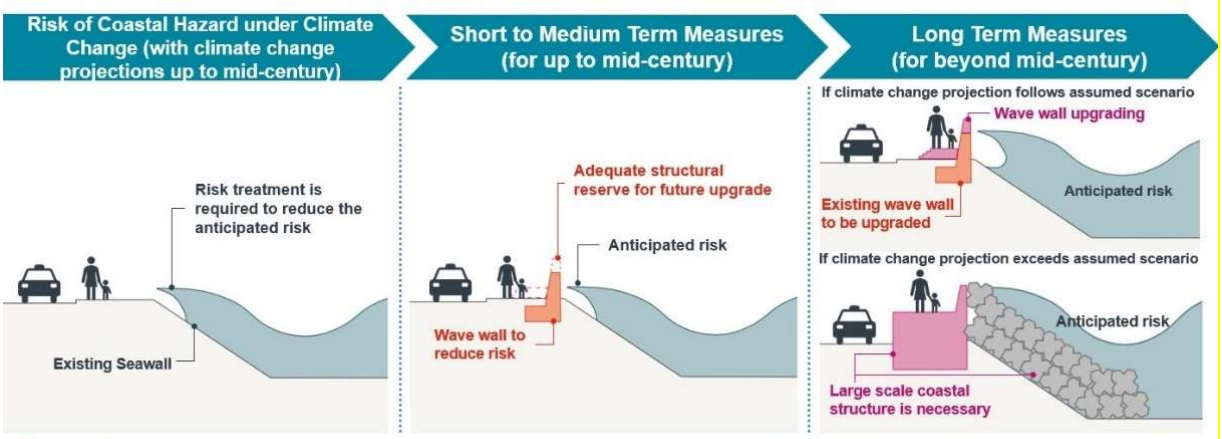
E.5.2.2 Although the severity of consequence depends on the sensitivity or resilience of the receiver (e.g., the proposed development, existing development, or surrounding environment) and may be difficult to definitively judge, there are quantitative benchmarks from past experience that can be referenced during risk evaluation. By referencing field data from previous weather events and taking into account climate change effect, coastal risks in a projected similar amplitude can be weighted with an estimated level of risk attributed, and thus appropriate risk management measures and subsequent implementation options should be selected by the relevant practitioner.

E.6 STEP 4 – APPROACHES AND DESIGN PRACTICES TO ENHANCE COASTAL RESILIENCE AGAINST CLIMATE CHANGE

E.6.1 Progressive Adaptive Approach (PAA)

E.6.1.1 Due to the uncertainties of climate change particularly towards the end of century and when selecting the approach case sensitivity, design practices should have a degree of flexibility to allow for modification should there be a difference between the anticipated climate change and the actual outcome. The adoption of PAA in all design practices should also be considered as far as practicable such that there will be reserved capacity for upgrading to maintain adequate levels of coastal defence and resilience against climate change in future. **Diagram E.1** illustrates the PAA.

Diagram E.1 Progressive Adaptive Approach (PAA)



* Remark: Drainage enhancement, such as pumping station, might be needed at the back of the wall

E.6.2 Adaptation, Resilience and Management (ARM)

E.6.2.1 When selecting the design practices, the relevant practitioner should determine what are the risks that they are attempting to mitigate and what assets or facilities they are looking to defend.

E.6.2.2 The intention is that each design practice can be applied for any land use, facility, asset, or time horizon. There are three aspects to consider when selecting and implementing the design practice which are:

- **Adaptation:** Continue to systematically implement various types of coastal improvement works, such as wave walls, or flood walls, to mitigate flooding.
- **Resilience:** Use temporary or non-structural measures to control flood risk or mitigate the impacts of flooding, allowing society to recover quickly after flooding, such as various types of water barriers.
- **Management:** Including educating the public on coastal hazards, the effects of climate change, the measures public may take to stay safe or secure their property, or an emergency control centre providing forecasting, warning and alert systems, or publicity of works, events and information through television, radio, social media, mobile applications and public displays. Management measures include enhancing emergency preparedness and response, innovative technology, information dissemination, guidelines/standards, and public safety awareness to manage flood risk and minimise flood damage and impacts.

E.6.3 Multi-layered Protection

E.6.3.1 A multi-layered protection design, which comprises a combination of design practices in adaptation, resilience and/or management aspects, can be adopted to mitigate coastal flood risks and reduce the impacts of flooding. **Diagram E.2** illustrates the multi-layered protection design. The multi-layered protection design includes:

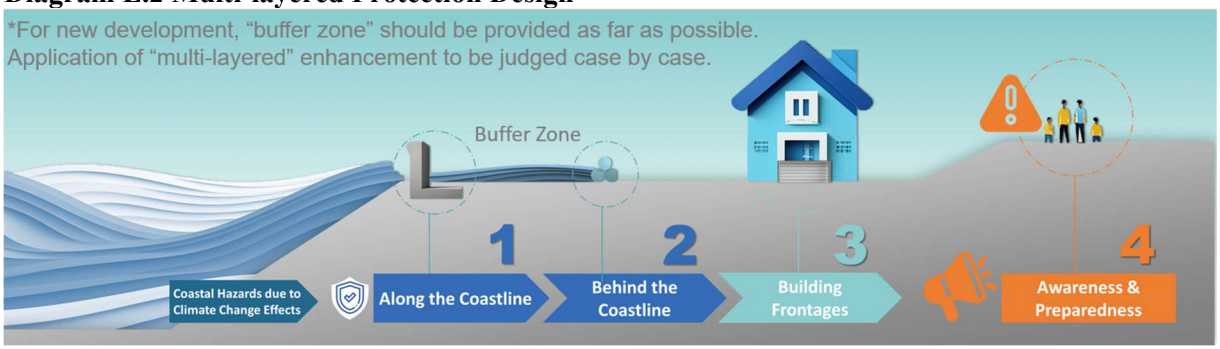
i. Adopting adaptation measures along the coastline as the first line of defence to reduce the coastal hazards, for example, constructing or raising wave walls;

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.

Diagram E.2 Multi-layered Protection Design

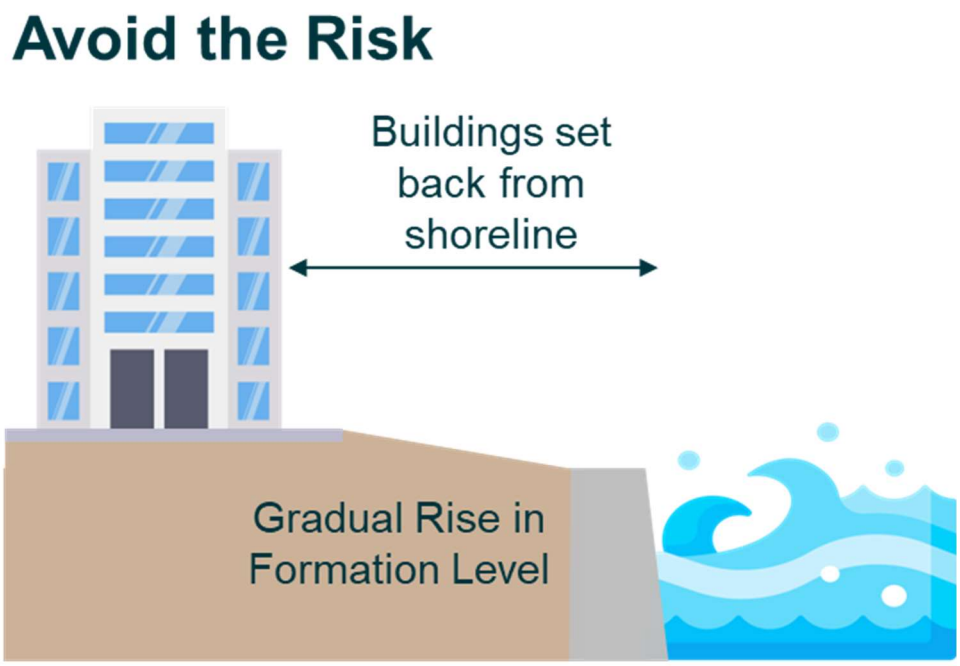


E.6.4 Section A – New Coastal Development

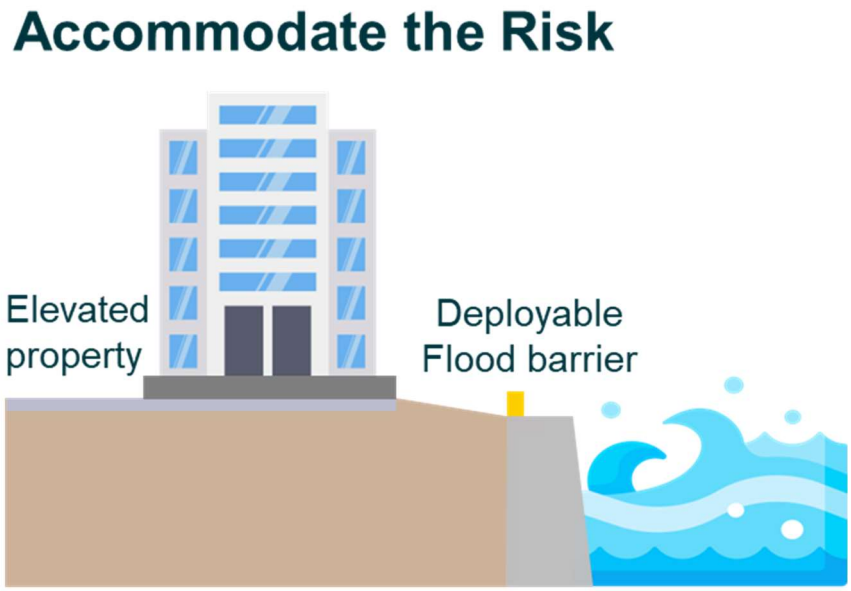
E.6.4.1 Risk treatment provides a response to the projected likelihood and the anticipated consequence. For new coastal developments, there are generally more opportunities and flexibility in terms of site conditions and configuration, allowing for the design and incorporation of various kinds of measures for coastal defence. By continuously applying ARM measures in combination and a multi-layered protection design, the project proponent of new development can mitigate risks to an acceptable level. Upon examination of the factors affecting the section of shoreline to be developed and following analysis and assessment, one of the three approaches may be selected to provide risk treatment.

E.6.4.2 The approaches are namely: **Avoid the Risk**, **Protect Against the Risk** and **Accommodate the Risk**. Design practices include formation levels, edge structures, PAA, buffer zone, nature-based solutions, management measures, etc. These are the group headings underneath which are the individual enhancement measures for considerations. The approaches are further detailed below.

Table E.1 Three Approaches for New Coastal Development

Approach	Explanation	Design Practice
Avoid	• Develop away from shoreline to avoid impact of coastal risks. • Resiliency dependent on distance to shoreline and extent of inundation. • Adopt a formation level that is high enough to avoid the impact from sea level rise and/or storm surge	• Establish a buffer zone to keep vulnerable properties away from seafront • Use formation level to create natural gradient and surface measures such as barriers and channels to direct flooding back to the sea
		

Approach	Explanation	Design Practice
Protect	• Construct to reduce the coastal risks to negligible impact. • Allow for future upgrade as required, depending on development of climate change. • Alternatively protect up to, or beyond requirements for foreseeable future.	• Raised edge structure / wave wall • Wave return included to mitigate strength of wave attack
		

Approach	Explanation	Design Practice
Accommodate	• Implement options to manage the impact of coastal risks to a tolerable level. • Resiliency dependent on self-protection and continuous future upgrade.	• Hard paving to mitigate damage from overtopping • Elevated properties / infrastructure • Elevate utilities within buildings
		

E.6.4.3 Selecting the appropriate approach depends on the expected risks and the severity of those risks, and the intended land use for new developments. The intention is that each approach can be applied for any land use. The determination of selection of the approach is shown in the **Table E.2** for reference.

Table E.2 Selection of Approach

Risk Exposure	Severity of Consequence	Recommended Approach
High	High	Avoid / Protect
High	Low	Protect / Accommodate
Low	High	Avoid / Protect
Low	Low	Accommodate

E.6.5 Section B – Existing Development

E.6.5.1 In comparison, measures for existing developments are often limited by spatial and environmental constraints, etc. Although ARM and multi-layered protection design are applicable to existing development, due to the site limitations, some design practices may be more practical or cost effective than the others. For example, implementation of temporary or non-structural protections, which will cause relatively less impacts to the daily life of the residents or operations of the business in the existing development, may be more suitable for mitigating coastal risks taking into account the existing site conditions. Some design practices are illustrated in E.6.6.

E.6.6 Illustrative Examples

E.6.6.1 The relevant practitioner can consider multiple design practices to create a multi-layered approach, not reliant on one form of defence. Sufficient space should be provided between the shoreline and buildings to ensure the development behind the buffer zone can avoid overtopping and inundation impacts. Edge structures should be designed in appropriate height to protect against storm surge and projected sea level rise. Similarly, consideration should be given to the suitability of the design for the approach and development. For example, promenades used by the public for recreation should consider an integrated, holistic and multi-functional design which should not adversely affect the public enjoyment, e.g. fixed barriers may integrate with benching or planters with finishes to beautify the appearance. The project proponent should consult the Harbourfront Commission on any new development design within Victoria Harbour.

E.6.6.2 The non-exhaustive list of design practices is illustrated in **Table E.3** below with a selection of enhancement measures available for consideration by the relevant practitioner. Some practices may involve planning layout development or large-scale works, making them generally more practical or cost-effective for **new developments with fewer site constraints, which are marked with the icon "🏗" in the table**. On the other hand, some practices are suitable for **both new and existing developments are marked with the icon "🛠" in the table**.

E.6.6.3 The design practices are to be used in combination to create a multi-layered solution. For example, edge structures at the shoreline and deployable barriers at building entrances can minimise the impacts from wave overtopping and inundation to buildings close behind. A buffer zone with graded formation level can maintain aesthetic appearances of open spaces while directing overtopped water away from structures back towards the sea.

E.6.6.4 The relevant practitioner should evaluate the efficiency and the cost-benefit of design practices, which include planning, design, construction, and associated lifecycle costs such as operation, maintenance, and management of the measures. Additionally, responsibilities for future monitoring of the effectiveness of these measures and potential upgrades to the works should also be taken into account.

Table E.3 List of Design Practices

Formation Level

Benefit

Coastal Protection	Flood Protection

Timing for Inclusion

Existing Development – Consider which shoreline areas have capacity to be raised. Develop designs that can be utilised now or in future, where possible.

New Development – Formation set during design / construction, critical part of design.

Future Implementation – Locally raised formation would be difficult to achieve once reclamation and construction have been completed. Monitor future shoreline projects for suitability to implement.

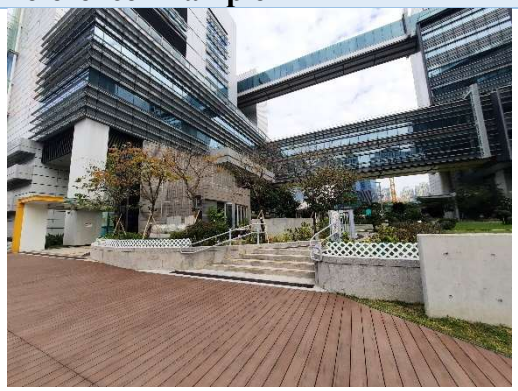
Description

For new developments, refer to Port Works Design Manual (PWDM) Part 3 and Drainage Services Department (DSD) Stormwater Drainage Manual for further guidance on the design of the formation level for reclamation projects. The formation level should be determined with considerations in multiple aspects such as the drainage capability, availability and cost of fill material or the level of adjacent existing land as well as the result of the risk assessments. The formation of the reclamation should be designed so that in the event of flooding the runoff can be routed away from vulnerable areas and back towards the source of the flooding. Whilst forming a new land at a much higher level than required can avoid or eliminate coastal risks to the new developments, this method may not always be practical.

For existing developments, the possibility of raising the existing formation level will be determined through multiple aspects such as the seawall strength, the level of adjacent existing land, the result of the risk assessments, and the available space behind the shoreline to do so. When choosing to raise the edge level, consideration should be given to providing public access to the crest level and maintaining shoreline access to places like beaches to create a mixed-use design. Re-grading the formation level of land behind the shoreline may also be an option, to create natural pathways and barriers to channel seawater inundation away from vulnerable areas. This method may not always be suitable but should be considered where there is demolition, removal, or movement of structures of infrastructure.

Formation Level (Cont'd)

Reference Example



High formation level to mitigate sea water inundation.

Stepped or sloped surface to enable runoff and maintain access at different levels.

Graded to create retention / detention basins.

Addition of berm behind shoreline to raise height of shoreline in future in place of raising whole formation level.

A higher ground level behind the waterfront.

Progressive Adaptive Approach

Benefit

Risk Resilience	Coastal Protection	Flood Protection

Timing for Inclusion

Existing Development – Design of enhancement measures should adopt PAA as far as possible.
New Development – Design of enhancement measures must adopt PAA.
Future Implementation – Implementation of upgrading works under PAA as required with regard to changing risks.

Description

Refer to PWDM Corrigendum No. 1/2022 for further guidance on Design Allowance with Progressive Adaptive Approach to Enhance Climate Resilience. PAA should be flexible and adaptive enough that measures can be changed or updated as conditions change or if impacts due to climate change are different from those anticipated. PAA should always be included in the design of risk treatment measures to provide future generations with the capability to further improve upon coastal resilience measures as required.

Reference Example

Install wave return wall at shoreline edge to raise height of shoreline defence and reduce risk of wave overtopping. Adequate structural reserve for future upgrade to raise height further.

Demountable flood barrier to further raise height of seawall, to be deployed as required while maintaining views from the promenade during normal weather conditions.

Buffer Zone

Benefit

Flood Protection	Open Space

Timing for Inclusion

Existing Development – Include as far as practical. Develop existing spaces using landscape design to provide resilience.
New Development – Recommended to include during design / construction.
Future Implementation – Extend buffer zone further inland as development of shoreline allows, or where reclamation occurs consider how much newly developed land can be utilised as buffer zone.

Description

Buffer zones should also always be considered when seeking to provide or improve coastal resilience when space is available. The extent of the buffer zone may vary for each location as required and depending on available space. The provision of a buffer zone creates space between the source of flooding and the people and assets close to the shoreline reducing the risks of direct impact from flooding. A buffer zone also serves as a reserved space that can be developed in future to provide further defensive measures. For existing development, increasing the available space is difficult or impractical. However, the spaces behind shorelines can still be developed to create usable spaces that can provide protection and recreation uses.

Reference Example

Hard landscaping for promenade to minimise damage from overtopping waves.

Allowing nearshore area to serve as coastal buffer zone when space is allowed to mitigate flooding impact to inland area behind.

Nature-based Solutions

Benefit

 Environment	 Coastal Protection

Timing for Inclusion

Existing Development – Eco-engineering integrated into shoreline structures mainly for enhancing biodiversity. Consider shoreline exposure, wave energy and seawall type to select best available option.

New Development – Include hybrid infrastructure for both enhancing biodiversity and coastal resilience.

Future Implementation – Monitoring of implemented features to ensure growth of habitats is successful. Restoration / Nourishment of beaches as required, plating of oyster reefs, sea grasses, eco-blocks as site conditions allow.

Description

Nature-based solutions (NbS) are means of using nature to provide environmental, climate, social and economic benefits to projects. NbS aim to be cost-effective by utilising natural resources to create a diverse and resource-efficient and resilient environment. NbS can provide coastal resilience and flood risk reduction through eco-engineering and coastal restoration techniques, as well as other benefits such as habitat creation / restoration and carbon offsetting.

NbS can be adaptable to climate change outcomes and can be relatively low-cost maintenance. NbS can be integrated into existing defences to create hybrid structures, sometimes known as green-grey infrastructure, to provide biodiversity and ecosystem benefits.

NbS can help mitigate coastal erosion, improve the marine ecology, and beautify coastal areas. They can be incorporated into the existing seawall or water channel structure as ecological armouring units or provided as a mangrove eco-shoreline that may help trap sediment for coastal accretion purposes, as well as improving water quality and also reducing the strength of tidal surge.

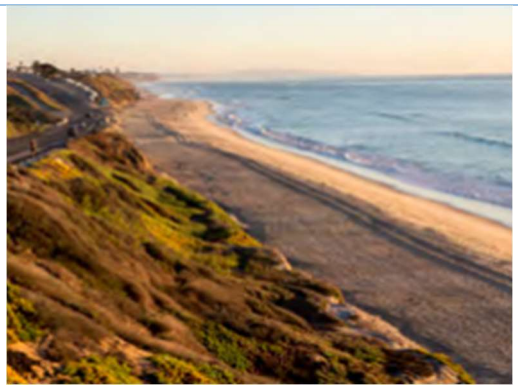
When considering NbS the shoreline context needs to be considered carefully. Some solutions are better suited to areas with greater wave energy, whilst others require more shelter to thrive. The efficiency of mangroves for example can be reduced if a channel is present nearby, whilst species may struggle to grow on eco-tiles facing direct sunlight and so must be placed in the shade or turned to face the seawall. Design of NbS will need special consideration to suit local environments and conditions, making reference to relevant guidelines (e.g. CEDD's Guidelines of Design, Installation & Maintenance of Eco-engineered Features on Artificial Shorelines, Greater Bay Area Standard No. WQ 1-262 "Technical Guidelines for Ecological Design of Sea Dikes", etc.).

Nature-based Solutions (Cont'd)

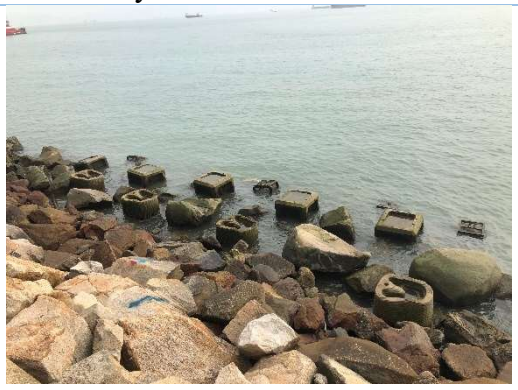
Reference Example

Mangrove planting to reduce strength of tidal surge and benefit marine environment.

Eco-engineering such as blockwork seawall with eco panels / oyster basket to improve marine ecology and mitigate sediment transport. Existing defences can be integrated with eco-engineering to create hybrid infrastructure.



Coastal restoration through beach nourishment can be combined with eco-blocks to help the growth of seaweed. Management involves restoring eroded areas and stabilising others using fencing, thatching and vegetation planting techniques.



Large precast habitat-enhancement units can also be deployed in sub-tidal or inter-tidal areas, helping dissipate wave energy as well as supporting a variety of marine species. Pools can be an effective way of providing habitats for intertidal organisms in artifical environments.

NbS may be designed to dissipate wave energy.

NbS can be integrated into existing defences to create hybrid structures

Edge Structure

Benefit

Coastal Protection	Flood Protection

Timing for Inclusion

Existing Development – Determined by type of risk, time horizon and shoreline construction / structure. Include PAA where possible.
New Development – Consideration of PAA during design of seawalls to raise edge height or allow for installation of wave wall or similar.
Future Implementation – PAA to increase height or provide further functionality.

Description

Edge structures provide a first layer of defence against coastal flooding and tidal inundation as a result of storm surge, wave overtopping, and sea level rise. Depending on the chosen approach for new developments, the base formation level and the edge structures can be included either as a short height defensive measure with adaptive capability to raise the crest level in future or as a higher crest level structure to mitigate against climate change impacts beyond the foreseeable future.

Reference Example

Wave wall to minimise overtopping wave.

Wave return wall to mitigate strength of wave attack.

Blockwork seawall or rubble mound to dissipate waves.

Future – PAA may consist of raised wave wall height or large scale coastal structure, such as breakwater.

Drainage and Drainage Infrastructure

Benefit

Flood Protection	Environmental	Drainage Support

Timing for Inclusion

Existing Development – Protection for existing drainage outfalls to sea. Inclusion of drainage infrastructure to channel seawater flooding back to source.
New Development – Inclusion of bioretention systems, porous paving. Large-scale reclamation may include features such as a water channel included in design.
Future Implementation – Create new pathways at surface level to convey seawater back to source. Include flood water cleansing such as vegetated conveyance channels to transfer seawater back to source. These may suitable in commercial and industrial areas to trap pollutants that may be harmful to marine ecology.

Description

Provisions should be made to avoid backwater effect (e.g. flap valve, penstock, etc.) and discharge seawater back to sources (e.g. by openings on seawall, channels, etc.) to mitigate flood risks. Designers should determine the amount of overtopped water that would flow into the existing drainage system behind the seawall. Appropriate drainage provisions will need to be considered to avoid flooding or overloading the existing drainage system due to the overtopping wave.

Reference Example

Surface channel and surface treatment channels can be installed as PAA to help guide flood water back to the sea in future.

Non-return valve for drainage outfall to prevent backflow of tidal or sea level rise inundation into the drainage system via the outfall.

Flood gates or barriers can be used to maintain water levels for environmental features such as wetlands near to the shoreline.

Inclusion of water channels to provide pathways for existing outfall discharge. Greening/revitalisation of water channel for beautification and biodiversity.

Buildings & Infrastructure

Benefit

Flood Protection	Emergency Preparedness

Timing for Inclusion

Existing Development – Elevated or protected utilities with deployable barriers.
New Development – Raised properties / accesses, orienting the accesses / windows / opening away from exposed positions, and floodproofing of buildings which would be costly to implement after completion of construction.
Future Implementation – Elevated utilities and application of deployable barriers.

Description

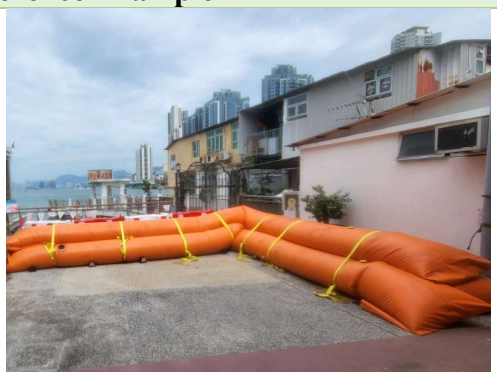
Buildings and infrastructure can be protected against coastal hazards through different practices such as wet and dry floodproofing, elevation of properties and accesses, protection of utilities, and deployable barriers. These measures can be useful and the adoption of PAA should be considered in all planning approaches. As climate change occurs over the life of the development, buildings close to the shoreline can be protected by raising utilities and accesses and placing barriers at vulnerable access points. Deployable barriers can be implemented as the second layer of defence behind wave walls to prevent flooding from reaching further inland towards vulnerable areas. Sloping struts may be installed and sandbags may be placed to enhance the stability of barriers. Alarm and warning and pumping systems can be installed alongside and interlinked with the barrier system as well.

Reference Example

	
Wet / dry floodproofing such as flood panel barriers on buildings or raising utilities to higher levels to prevent water ingress.	Wet / dry floodproofing such as portable temporary barriers on buildings or raising utilities to higher levels to prevent water ingress.

Buildings & Infrastructure (Cont'd)

Reference Example

 Manually deployed barriers, such as water filled tube barriers, to prevent further inland inundation.	 Automatically or manually deployed barriers, such as swing gates, to prevent further inland inundation.
 Elevated roads & walkways to maintain transport links / accessibility.	 Sandbag storage for remote areas to be used by local communities.

Management Measure

Benefit

Emergency Preparedness	Risk Resilience

Timing for Inclusion

Existing Development – Included in design and construction. Education of public on the risks posed by coastal hazards and climate change, and the actions available to them.

New Development – Included in design and construction. Education of professionals to include climate resilience and adaptation in designs.

Future Implementation – Review and update of plans as necessary such as evacuation plans for vulnerable locations.

Description

There are also non-physical measures that can assist in providing resilience against coastal hazards and climate change enabling communities to respond more quickly and safely. Planning and preparation for extreme weather events can include public education and messaging in residential developments near the shoreline to ensure local populations understand what coastal hazards may be faced and know what to do if they occur. This type of education and information can also be provided through sign boards in vulnerable locations to relay key information and messages. Training for building employees in the use and maintenance of defensive measures such as deployable barriers or routine inspection of visible drainage infrastructure for blockages or defects can also contribute to emergency preparedness. Emergency plans such as a coastal evacuation plan, similar to a fire evacuation plan, can also be prepared highlighting actions to be taken by employees / staff members in the event of extreme weather. Emergency plans can also be prepared by individual homeowners to provide self-protection.

Reference Example

Education and public awareness of risks and climate change such as signs in prominent locations.

Warning indicators and possible closure of vulnerable areas during extreme weather events to maintain safety.

Management Measure (Cont'd)

Reference Example

Health and Safety Plans for buildings, residences, workplaces, etc. to ensure public are aware of what to do and where to go / avoid.

Alarm systems and procedures for monitoring events before, during, and after. Installation of monitoring devices and equipment in vulnerable locations.

Established procedures during typhoon events.

Drills to be conducted to get familiar with the procedures.

E.7 STEP 5 – IMPLEMENT MEASURES TO ENHANCE COASTAL RESILIENCE AGAINST COASTAL RISKS AND CLIMATE CHANGE

E.7.1 The design practices to be implemented should follow the latest relevant standards, guidelines, technical circulars, and practice notes, such as:

- CEDD's PWDM and associated corrigenda,
- DSD's Stormwater Drainage Manual and associated corrigenda
- DSD's Guidelines on Flood Resilience

However, the design life of the enhancement measures would be subjected to structure types and overall life cycle plan of the design practices proposed. The PAA for design practices should be outlined, with the clear pathway for any potential enhancement can be achieved in future to provide further resilience. The relevant practitioner should identify parties in managing, maintaining and operating the management, maintenance and operation measures, along with an emergency plan for implementation, for example where deployable measures are included in design.

E.7.2 Stakeholder consultation should be conducted during the design of the enhancement measures to encourage a sense of ownership and promote acceptance in the local and wider communities. Consultation with Government Bureaux/Departments will be required through the normal design process. Consultation with other stakeholders with vested interest such as the District Council, Harbourfront Commission[2], and trade groups, etc. should also be included.

E.8 STEP 6 – MONITORING AND REPORTING

E.8.1 The final step of the guideline concerns the ongoing management of the shoreline following intervention. Monitoring of the measures implemented is required to ensure proper function and continued protection of assets, maintaining a suitable working condition and an adequate level of defence against coastal flooding and inundation. Reporting of monitoring activities can be recorded in a risk register or health and safety file as an ongoing action. This information can be used in future to assess the success of the enhancement measures selected if further action is required, such as upgrading the structure as enabled in PAA, and shared with other stakeholders and interested parties contributing to a shared collective understanding to better defend Hong Kong's shorelines.

[2] For enhancement measures within the Victoria Harbour.

E.9 "QUICK GUIDE" ON BUSINESS/EVENT AT THE SEAFRONT

E.9.1 This section serves as a quick guide to help the relevant parties associated with business and event at seafront to assess and manage coastal risks such as overtopping waves and storm surges, and formulate measures to mitigate the risks. All should consider taking measures and making preparations for their own buildings, such as referring to the following tips, to reduce flood loss.

E.9.2 Coastal Flood Risk

The geographical position of Hong Kong renders it susceptible to various adverse weather-related threats, including tropical cyclones, storm surges, and overtopping waves. Specifically, certain coastal areas that are low-lying and exposed to strong winds are vulnerable to coastal hazards. Furthermore, climate change causes sea level rise, and the intensification of tropical cyclones leads to increased waves and storm surges, amplifying the impact on coastal and low-lying areas. The uncertainties associated with climate change projections serve a major challenge to our adaptation work.

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, the Civil Engineering and Development Department (CEDD) has adopted a comprehensive strategy to address flood risks caused by extreme weather and to further enhance Hong Kong's capabilities in adaptation and resilience. CEDD conducted territory-wide studies to identified areas facing coastal flood risks in the present day or near the mid-century. Improvement works have been progressively taken forward or planned ahead in order to control the flood risks or reduce the flood impact for speedy society recovery. The list of these identified locations is shown in the **Table E.4** for reference.

Table E.4 List of Locations identified in CEDD's Studies

Coastal Hazards Study (Coastal low-lying or windy areas which are experiencing considerable coastal risks)		**Study on Shoreline Management Plan (Areas to be planned for improvement to cope with the coastal risks near mid-century)**
Kennedy Town, Sai Ying Pun and Sheung Wan	Sha Tau Kok Town (Chung Ying Street, Kong Ha)	Sai Wan Ho (Near Sai Wan Ho Pier)
Heng Fa Chuen	Kat O West Low-lying Areas (Kat O Fisherman Village)	Aldrich Bay (Near Eastern District Cultural Square)
Shek O Village	Sam Mun Tsai New Village, Tai Po	Chai Wan (Near Chai Wan Public Cargo Working Area)
Pak Kan, Stanley	Tai Po Market (near Lam Tsuen River)	Siu Sai Wan (Near Island East Transfer Station)
South Horizons	To Tau Wan Village, Ma On Shan	Tsim Sha Tsui (Near Star Ferry Pier)

Tung Chung Bay (Ma Wan Chung Village, Sha Tsui Tau, Sha Lo Wan)	Sai Kung Town Centre and Tui Min Hoi	Tsim Sha Tsui East (Near Avenue of Stars)
Tai O	Nam Wai /Heung Chung, Sai Kung	To Kwa Wan (Near Kowloon City Ferry Pier)
Shap Long and Cheung Sha Lower Village, Lantau Island	Tseung Kwan O South (Tseung Kwan O Waterfront Park)	Kowloon Bay (Near Public Works Central Laboratory)
Ma Po Tsuen and Chung Hau, Mui Wo	Yuen Long Central Low-lying Areas (Tai Tseng Wai, Chung Hau Yu Man San Tsuen, Shan Pui Tsuen, Wang Chau, Yuen Long Town Centre)	Kwun Tong (Near Kwun Tong Ferry Pier)
Peng Chau West Areas (Nam Wan San Tsuen)	Yuen Long North West Low-lying Coastal Areas (Sha Kiu Tsuen, Fu Tso Tsuen, Lau Fau Shan, Hang Hau Tsuen, Sheung Pak Nai, Ha Pak Nai)	Tseung Kwan O (Near Industrial Area)
Cheung Chau West Areas	Luen On San Tsuen, Tai Lam	Tsing Yi South (Near Industrial Area)
Yung Shue Wan, Lamma Island	Kar Wo Lei, Tuen Mun	
Lei Yue Mun (Ma Wan Tsuen, Sam Ka Tsuen)	Sham Tseng San Tsuen	

For quick assessment of coastal risks done by the relevant parties associated with business and event at seafront, coastal risk spots identified in CEDD's previous studies as listed above are useful indicators. Furthermore, the level of flood risk and consequence may be estimated from flooding history and records. Areas with recent flooding record should be alerted. Flood extent, flood depth, flow paths and damage made in previous events can help the evaluation of potential damage to the concerned property and disruptions to business. Details of Coastal Hazards Study (including the approximate coastal hazards extent) and Study on Shoreline Management Plan, as well as the latest information about coastal enhancement and shoreline management are available in the following CEDD's website.

CEDD website – Coastal Enhancement and Shoreline Management
https://www.cedd.gov.hk/eng/our-projects/topics-in-focus/index-id-39.html

E.9.3 Approach and Design Practices

The relevant party who wishes to enhance coastal resilience in his businesses or events can refer to the approaches and design practices outlined in Section E.6. The approaches and design practices can also be applied to commercial or residential properties, such as restaurants, shops, and promenades near the seafront. Implementing these design practices can increase resilience and mitigate the impacts of storm surges or flooding.

For **exterior design**, the relevant party should consider orienting access points, windows, and openings away from exposed areas. The selection of structural materials is crucial; rigid and flood-resistant materials, like reinforced concrete or metal, are recommended for external walls at areas with high risk. If fragile or non-flood-resistant materials (e.g. glass panel walls or porous bricks) are used, temporary protection during adverse weather, such as metal or wooden coverings, should be employed. In extreme weather conditions, demountable flood barriers can be used, supported by sloping struts and sandbags in particularly exposed locations to enhance stability. Design for recovery and adaptability, such as using modular construction for easier repairs or replacements, are also advisable. Additionally, incorporating sump and pump systems for floodwater removal, along with designing for redundancy, such as backup power sources and alternative access routes, should be prioritised. The recommendation for private developments near coastline is also provided in **Annex E6** for easy reference. **Diagrams E.3 to E.5** are some illustrative examples for external design.

In terms of **interior design and furniture arrangement**, using rigid and anti-skid flooring and mounting furniture on the floor are advisable. Power sockets should be raised higher up the wall in order to reduce the risk of short circuit. The relevant party should also consider relocating equipment, flood sensitive or valuable items from exposed areas to secure storage or higher levels. Selecting corrosion-resistant materials suitable for marine environments, as well as waterproof materials for easy drying and cleaning, is desirable. Incorporating sump and pump systems for floodwater removal at indoor places may also be considered. **Diagram E.6** shows some illustrative examples for interior design and furniture arrangement.

If building or structural designs are involved in the flood protection, the relevant party should appoint relevant professional to prepare and submit necessary documents for the approval of the relevant authorities, and related design manuals and requirements should be followed.

Diagram E.3 Illustrative Example for Coastal Shop

Diagram E.4 Illustrative Example for Restaurant by the Sea

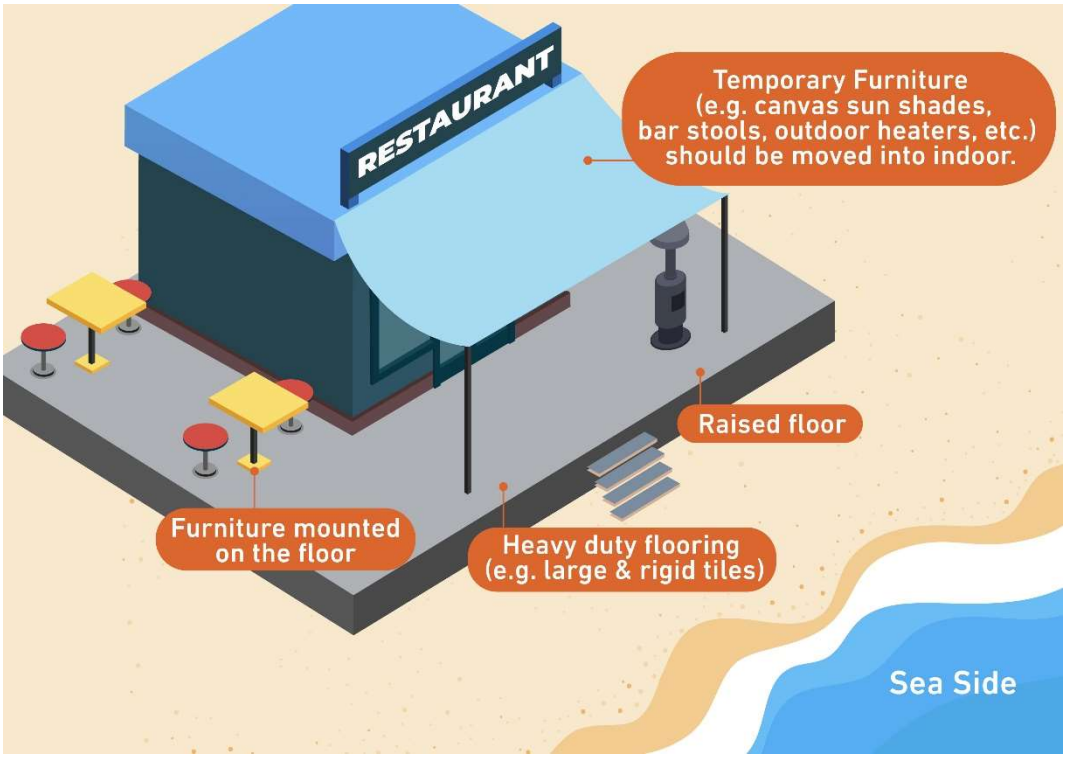


Diagram E.5 Illustrative Example for Business at the Seafront

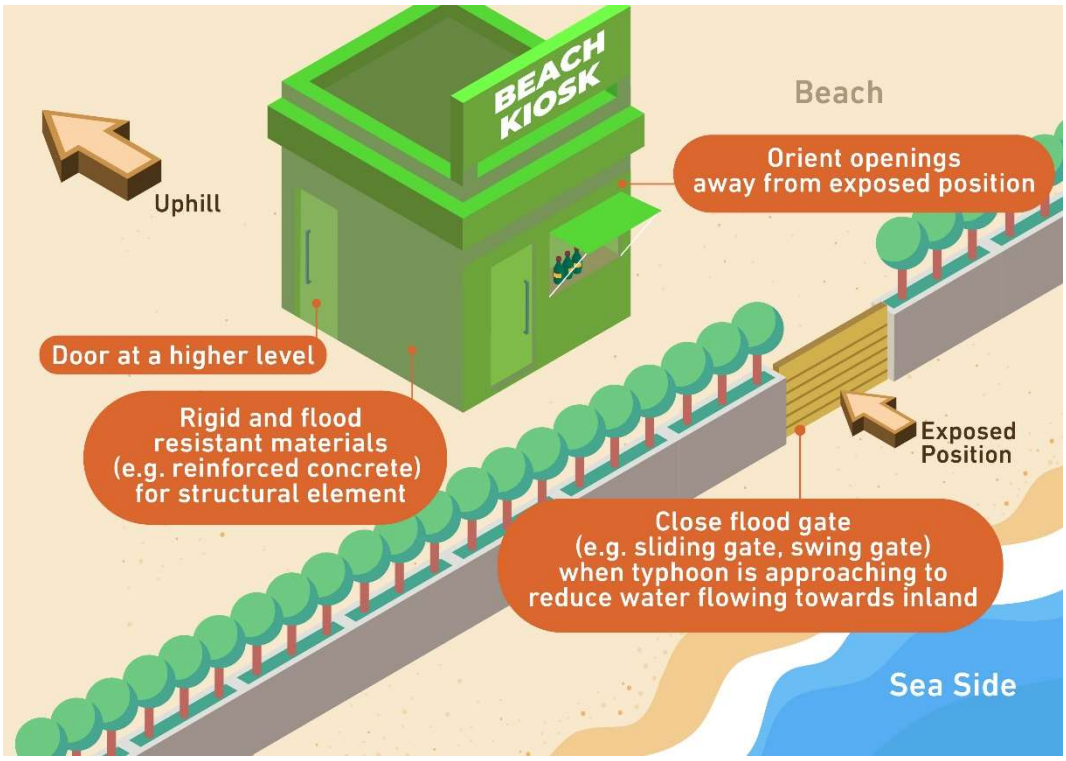
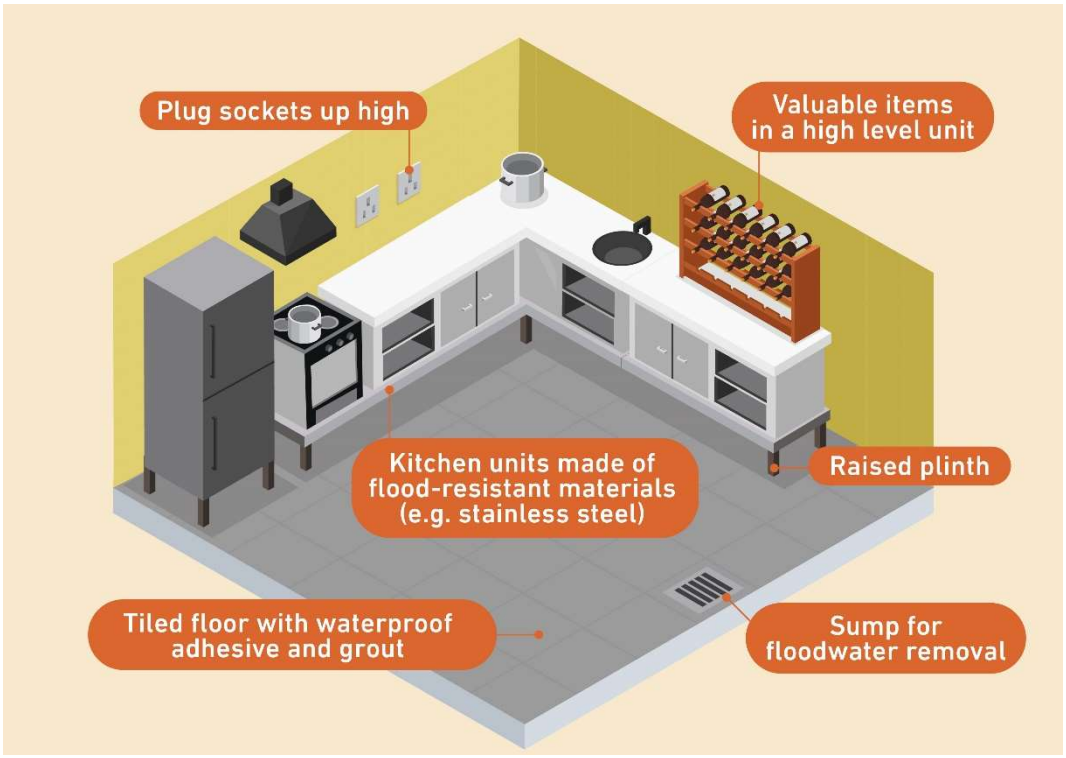


Diagram E.6 Illustrative Example for Kitchen



E.9.4 Implementation and Monitoring

The relevant party should ensure the implementation of works and measures in business premises complies with relevant ordinance, regulation, licensing

requirements from government authorities, e.g. Fire Services Department (FSD) and Food and Environmental Hygiene Department (FEHD), etc.

When typhoon is approaching, the relevant party should consider installing demountable flood barriers or placing sandbag wall at building frontage, and struts may be used to support the flood barriers to enhance stability. Glass panels may be temporarily protected by wooden coverings. Also, the relevant party should check the pumping systems, inspect and remove rubbish and debris of drainage systems to ensure those systems can function normally during adverse weather. Valuables should be lifted to indoor higher level. The relevant party should keep a close eye on the signal of typhoon, as well as announcement and warning about swell, storm surge and overtopping wave from the Hong Kong Observatory (HKO). The relevant party should listen to radio, watch TV or browse the HKO's website and mobile app for latest information of the typhoon. **Diagram E.7** shows some illustrative examples for preparation before typhoon. The relevant party should also make appropriate and prompt decision on the triggering of the planned flood protective measures and adjustment on business opening/working hours during the approach of typhoons and adverse weather events. Formulation of action plan and drill for employees / staff members in advance would help the smooth implementation of protective measures. During evacuation, people should move to high ground (i.e. vertical evacuation) or follow instructions from rescue authorities. Review on the measures should be conducted by the relevant party for timely adjustment and improvement on the established measures.

Diagram E.7 Illustrative Example for Temporary Flood Protection

E.9.5 Conclusion

In conclusion, the purpose of the SMG is to enhance coastal resilience while maintain a balance among safety, development and harbourfront enjoyment. By following the recommended approaches, the relevant practitioner can conduct preliminarily assessments of coastal risks and implement appropriate strategies to safeguard businesses and events along the seafront. Understanding and mitigating the coastal risks are essential to ensuring the safety and sustainability of costal operations. For the concerned party without the relevant engineering expertise, he is encouraged to engage professionals and keep abreast of best practices to continually strengthen resilience against coastal challenges.

E.10 REFERENCES

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E(1) ANNEX E1 – DATA SOURCES TO SUPPORT ASSESSMENT

E(1.1) The following table is for reference, containing information / data and the sources where it may be gathered for use to support the undertaking of the new development guideline. Other relevant standards and guidelines should also be referenced when undertaking design of reclamation, infrastructure, and structures.

Information / Data	Source of Information / Data	Purpose / Use
Port Works Design Manual and Corrigenda	CEDD Website	• Refer for design purpose / practice, including reclamation, seawall, climate projection and resilience, etc.
Wave Measurement Data at West Lamma Channel and Kau Yi Chau	CEDD Website	• Modelling of wave conditions of Hong Kong Waters for the production of flood map and wave isopachs
Wind Data (Daily Prevailing Wind Direction & Daily Mean Wind Speed)	Data.Gov.HK Website (Hong Kong Observatory) (HKO)	• Modelling of wave conditions of Hong Kong Waters for the production of flood maps and wave isopachs
Tidal, and Storm Surge Data	Data.Gov.HK Website, HKO	• Modelling of wave conditions of Hong Kong Waters for the production of flood maps and wave isopachs
Landslide Data	Data.Gov.HK Website, CEDD	• Preparation of hazard mapping for landslides occurring at the shoreline or as a consequence of coastal hazards
Historical Coastal Flood Data	Relevant Government Bureau / Department as required.	• Preparation of flood mapping, identification of areas prone to flooding
Historical extreme sea level events	HKO website	• Understanding of the significant impacts of extreme sea level

Information / Data	Source of Information / Data	Purpose / Use
Hong Kong Tidal Stream Prediction System	Marine Department (MD) Website (Hydrographic Office)	• Water levels and currents in the Hong Kong Waters for modelling simulation of sediment transport
iC1000 Land Boundary Map	Lands Department (LandsD) Website	• Demarcation of Government land allocations and private lots
iB1000 Topographic Map	LandsD Website	• Demarcation of government responsibilities regarding different land allocation • Production of flood maps
LiDAR Data	Data.Gov.HK Website (CEDD)	• Production of Flood Maps
Aerial Photos	LandsD Website	• Understand the existing conditions and the changing nature of the location over a long-term time period • Visual assessment of sediment transport
Outline Zoning Plans of adjacent land areas	Town Planning Board (TPB) Website	• Understanding the existing land uses of nearby shoreline areas
Latest climate change projections for Hong Kong, including climate projections up to at least 2150.	HKO website, CEDD's PWDM: Corrigendum No. 1/2022, relevant studies under CEDD and DSD, e.g. CE15/2020(CE), CE77/2021(DS)	• Understanding of the latest climate change projections • Modifications on the climate change projection parameters for the numerical model • Methods to estimate climate projections beyond 100 years' time, up to at least 2150.

Information / Data	Source of Information / Data	Purpose / Use
Government planning publication for current of waterfront development (e.g. Energizing Kowloon East, Invigorating Island South and Sustainable Lantau Blueprint)	Energizing Kowloon East Office's (EKEO), Invigorating Island South Office's (IISO), and South Development and Sustainable Lantau Office's (SSLO) / CEDD's Website	• Identify nearby projects for opportunities / conflicts
As-built drawings of existing coastal defences	Port Works Division /CEDD	• Understanding of the existing conditions of the shoreline of Hong Kong • Assessment of coastal hazards in Hong Kong

E(2) ANNEX E2 – RISK IDENTIFICATION AND ASSESSMENT

E(2.1) For detailed requirements or methods for coastal risk identification and assessment, the project proponent / designer can refer to CEDD's PWDM and use computer modelling software which are commonly accepted in the engineering industry.

Associated Risk	Assessment	Hazard Mapping	Outcome	Risk Exposure
Wave overtopping	Wave Condition during extreme weather events.	Wave Isopachs.	Determine the level and location of wave overtopping. Overtopping can be influenced by the site formation level, shape of the coastline, orientation, depth of seabed and structure of seawall. Wave heights may vary.	Consider if wave attack is a problem, estimate the height and frequency of wave attacks anticipated. Identify dominant wave direction (perpendicular or parallel to shoreline). Estimate how far inland wave attacks could reach using wave overtopping and site formation levels.
Seawater inundation (Due to Sea Level Rise & Storm Surge)	Sea Level Rise using climate projection and storm surge in both extreme weather events and normal days.	Flood mapping.	Evaluate the extent of flooding at the design formation level for the reclamation.	Examine which areas of the development are most at risk from flooding either at the shoreline
Coastal erosion	Sediment Transport across long term.	Sediment transport modelling or aerial photo comparison	Determine the scale of erosion/ nourishment of beaches/ coastline and the arrival/ deposit location of sediment. Identify nearby beaches, river mouths or rock formations that may introduce, accrete, or require sediment.	Identify dominant wave flow, placement of reclamation, shape of coastline, edge structure type, and sources of sediment to determine interruptions in coastal processes. Examine historical photographs of the area to identify changes in shape of coastline and orientation. Consider sediment transport modelling.

E(2.2) Assessments should consider the wave action, wave propagation, from deep water to shallow water, wind generated waves, tidal flow effects, water sediment transport on morphological development.

E(2.3) The effect of the proposed design options adjacent/nearby shorelines should also be considered, including the risks posed by changes in the alignment of the shoreline, differences in formation level to the surrounding area, the difference in level of protection afforded by defence measures, changes to seabed profile, etc.

E(2.4) Consider which sections of the shoreline may be more exposed to the risk either facing waves of greater height or sediment transport along the shoreline that will require mitigation. Those areas which are experiencing more, or greater risks may be considered as at higher risk and so require a greater prioritisation.

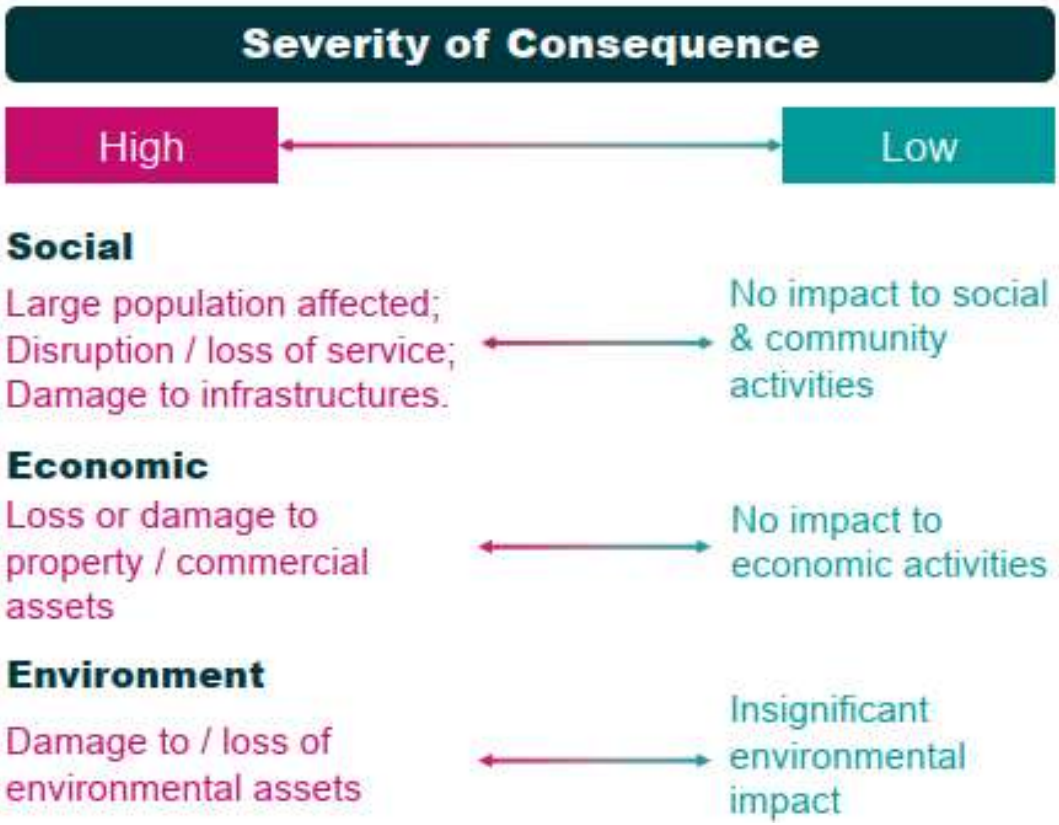
E(3) ANNEX E3 – TYPICAL EXAMPLES OF OUTCOMES OF COASTAL RISK

Coastal Risk	Typical Example (For Reference Only)
Wave Overtopping	Overtopping causing significant soil loss at the back of seawall of sewage treatment facility
	Overtopping onto exposed carriageway with high vehicular traffic density
	Damage to paved surface of promenade
	Overtopping onto cycle path causing low depth inundation
Seawater Inundation (Due to Sea Level Rise & Storm Surge)	Complete flooding of underground carpark or shopping mall
	Flooding of wetland at flood depth within its storage level
Coastal Erosion	Scouring of foundation of residential buildings
	Loss of usable area of the beaches
	Permanent habitat loss at Site of Special Scientific Interest (SSSI)

Note 1: Combined effects from future sea-level rise, storm surge, wave run-up, etc. should be considered when evaluating the severity of consequence arising from coastal risks.
Note 2: Severity of consequence is not binary (either low or high), it covers a spectrum (from low to high) and should be evaluated case by case.

E(3.1) There are quantitative benchmarks from past experience that can be referenced during risk evaluation. For wave height, maximum significant wave height measured by CEDD at Kau Yi Chau each year from 1994 to 2022 ranges from 0.97 m to 4.32 m. For storm surge, the rise in water level induced by Super Typhoon Mangkhut in 2018 was generally more than 2 – 3 m in Hong Kong according the HKO's record. By referencing these field data, coastal risks in a projected similar amplitude can be weighted with an estimated level of risk attributed.

E(4) ANNEX E4 - EXAMINE CONSEQUENCE OF RISKS



E(4.1) Having identified the risks and the risk exposure for the development site, examine the severity of the consequences if the risks are left unresolved. Consequences may be the number of properties flooded or the vulnerability of the affected land. Assessing impacts may be difficult to do quantitatively due to unknowns in exact land use arrangement, value of assets, or types of properties. Best judgement should be applied when considering:

- Social impacts – This will include the anticipated number of people who will be living close to the shoreline, the type of residential estate (high density closely grouped buildings or low density with open space between), social or community centres/buildings that may be affected, and how people move about (public transport systems, the type of roads, cycle paths, walking routes).
- Economic impacts – The value of the property or asset should be considered, as well as the type whether are they homes, workspaces, tourist or leisure areas, etc. This may include the financial cost of the asset or the anticipated return to normal operation through returning workers (i.e., delay for workers getting to offices, shops, restaurants, etc. causing losses).
- Environmental impacts – Changes to coastal processes can cause loss of marine flora, fauna, or habitats. It can also have an effect on accretion of sediment against seawalls or cause landslips elsewhere through scouring at the base of natural or man-made structures. Environmental impacts can also include cultural or heritage sites

E(4.2) The placement of critical infrastructure (CI) and the potential loss of service is a key consideration in all types of impact. CI that people may continue to try to access during extreme weather, such as a hospital will have social impacts. Alternative modes of accessibility should be considered for infrastructure or transport to maintain CI access.

E(4.3) The severity of the consequences should be considered over the length of the time horizon assessed and the anticipated lifespan of the development. There are challenges to managing risk over a long timeframe due to the uncertainty involved with complex climate and coastal systems. Risks in the near future may be low to begin with but could be higher in future and pose a greater consequence over time. The design of the development should bear in mind the potential for this change in risk or severity, allowing for flexibility in design of structures of infrastructure to allow for future enhancement as far as practicable.

E(4.4) The type of land use may also influence the severity of consequence experienced. For instance, residential areas where people may be more likely to be returning home may experience a higher consequence, whilst open spaces such as parks or recreational areas may experience less severe consequences with fewer structures or people present.

E(5) ANNEX E5 – TYPICAL EXAMPLE OF COASTAL RISK WITH SEVERITY OF CONSEQUENCE

Coastal Risk	Typical Example (For Reference Only)	Severity of Consequence		
		Social	Economic	Environment
Wave Overtopping	Overtopping causing significant soil loss at the back of seawall of sewage treatment facility	High	High	High
	Overtopping onto exposed carriageway with high vehicular traffic density	High	High	Low
	Damage to paved surface of promenade	High	Low	Low
	Overtopping onto cycle track causing low depth inundation	Low	Low	Low
Seawater Inundation (Due to Sea Level Rise & Storm Surge)	Complete flooding of underground carpark or shopping mall	High	High	Low
	Flooding of wetland at flood depth within its storage level	Low	Low	Low
Coastal Erosion	Scouring of foundation of residential buildings	High	High	Low
	Permanent habitat loss at Site of Special Scientific Interest (SSSI)	Low	Low	High

Note 1: Combined effects from future sea-level rise, storm surge, wave run-up, etc. should be considered when evaluating the severity of consequence arising from coastal risks.
Note 2: Severity of consequence is not binary (either low or high), it covers a spectrum (from low to high) and should be evaluated case by case.

E(6) ANNEX E6 – PRIVATE DEVELOPMENT NEAR THE COASTLINE

For private development near the coastline, in addition to this guideline, the project proponent should ensure all planning, design and construction of the building and building works complies with the Buildings Ordinance (BO) and the allied Regulations. If the building or building works is located in close proximity to the coastline, the project proponent should ensure that the design of the proposed building or building works has taken into account the potential impact of the storm surge and wave caused by extreme weather such that the proposed works are refrained from any damage or coastal flooding due to these factors. Particular load factors should be considered:

(1) Imposed Loads

Where the imposed loads for specific uses are not prescribed in the Building (Construction) Regulation or Section 3 of the Code of Practice for Dead and Imposed Loads 2011, the imposed loads to be adopted for design must be based on reliable information or data or as described in Section 4 of this code.

Examples of reliable information are:

(a) The "Port Works Design Manual" published by the Civil Engineering and Development Department for loading on marine structures; and
(b) The "Structures Design Manual for Highways and Railways" (SDM) published by the Highways Department for loading on highway and railway structures.

Examples of reliable data are:

(a) research results from recognised academic institutions;
(b) reference from international standards or codes of practice;
(c) reports from accredited testing laboratories; and
(d) technical literatures from suppliers/manufacturers.

(2) Exceptional loads

If in the design it is necessary to consider the probable effects of excessive loads caused by misuse or accident only those loads likely to be acting simultaneously need be considered. The loads considered should be those likely to occur before temporary or permanent measures are taken to repair or offset the effect of the damage.

For these exceptional cases all the following should be taken into account:

(a) dead load;
(b) one third of the wind load; and
(c) for buildings used predominantly for storage or industrial purposes or where the imposed loads are permanent, 100% of the imposed load; for other buildings, one-third of the imposed load.

(3) Load combinations for exceptional events

Exceptional load cases may arise from the storm surge and wave caused by extreme weather and should be included in load combinations.

Moreover, the design, materials and construction of the building and building works should follow the requirements as set out in the relevant design standards, Codes of Practices (CoP) and Practice Notes for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers (PNAPs) which are available on the BD's website (www.bd.gov.hk).

The updated Codes of Practices commonly used in the structural design and available on the BD's website are listed below:

CoPs	**BD website**
Code of Practice for Dead and Imposed Loads 2011 (2021 Edition)	 https://www.bd.gov.hk/en/resources/codes-and-references/codes-and-design-manuals/index.html
Code of Practice on Wind Effects in Hong Kong 2019	
Code of Practice for Foundations 2017 (2024 Edition)	
Code of Practice for Structural Use of Concrete 2013 (2020 Edition)	
Code of Practice for the Structural Use of Steel 2011 (2023 Edition)	
Code of Practice for Structural Use of Glass 2018	
Code of Practice for Precast Concrete Construction 2016	