COASTAL RESILIENCE SCORECARD

Waterfront Alliance and ARISE-US

SHORT FORM VERSION 1.0

WATERFRONT ALLIANCE

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PRIVATE SECTOR ALLIANCE FOR DISASTER RESILIENT SOCIETIES

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Contents

INTRODUCTION

Global Context

As of 2018, nearly 2 billion people live within 50km of a coastline, and some 1 billion within 10km[i]. Researchers estimate that over 410 million people will be at risk from rising sea levels by 2100[ii]. How oceans will rise is not a given due to uncertainty in modeling longer-term periods, however it is evident that coastlines in the immediate through medium-terms will be impacted by higher frequency, higher impact events if the planet remains committed to global warming. Human-induced climate change, driven by excess greenhouse gas (GHG) emission contribution to Earth's carbon budget, will also put 20% of global domestic product (GDP) at risk by 2100 via coastal flooding alone[iii]. Exposure and vulnerability to disruption, damage, and loss in **coastal settings**[1] is expected to increase due to faster, more frequent and intense **acute coastal disasters** as well as dynamic natural and human-induced **chronic coastal stress conditions** which require robust, continuous monitoring, evaluation, and operational response.

Structures may be built on land that is suitable at the time of construction, but the relationship between the structures (i.e., built environment), land and water's edge (i.e., natural environments) can change over time for a multitude of reasons. Meanwhile, expanding or densifying urbanization in and around **coastal zones** signifies that more people and more economic activity are effectively moving into harm's way. Unsurprisingly, with the effects of climate change already being felt by many coastal nations, states, and cities, the subject of **coastal resilience** is attracting significant attention from not only coastal and waterfront communities and residents, but also businesses, financial institutions, governments, intergovernmental, and non-governmental organizations. Due to the complexity of the considerations involved, acting upon **climate change mitigation** (i.e., halting and reversing sources of anthropogenic emissions) and **climate change adaptation** (i.e., channeling adversity into everyday design and implementation) simultaneously from the point of view of key stakeholders is overwhelming. To de-densify the complexity while meetings the needs comprehensively, **coastal disaster risk reduction** tools are required to enable swift, efficient and financially effective development of **coastal resilience** tactics and strategies.

For the Coastal City Context: Scorecard as the Start of a Partnership

The critical challenge ahead for coastal cities is to identify, assess, design, fund and implement tactics and strategies that build up to **coastal resilience** as a desired outcome or state in their particular contexts and fit-for-purpose. The **Coastal Resilience Scorecard**

[1] The Scorecard uses and repeats various working terms (**bolded in blue throughout document**) that require elaboration in advance as they will be used and repeated throughout the ten chapters of the Scorecard and its affiliated material (see Appendix A for Glossary).

(or "the Scorecard") was designed to be an early, adaptive and catalytic enablement tool for responsible teams within city boundaries (however defined) to access technical expertise and encyclopedic knowledge sets in a single platform dedicated to **coastal disaster risk reduction**.

Cities were particularly targeted as the first-generation user group given their natural role of intermediating between bottom-up (i.e., physical implementation on ground-level), top-down (i.e., design, governance and policy), and cross-stakeholder (i.e., communities, businesses) resilience initiatives. We use the term "city" as a shorthand to refer to any level of entity from informal settlement up through global mega city in size and scale. The Scorecard's completion lays the foundation for development of a future **Coastal Resilience Toolkit**, effectively Phase 2 for the **Coastal Resilience Partnership**, which will showcase local and regionalized planning and implementation resources (i.e., coastal resilience products & services) that enable cities to turn insights from the scorecard into feasible, measurable and defensible action.

The Scorecard's Intended Use

City professionals and key stakeholders are encouraged to utilize this Scorecard to evaluate general 'readiness levels' for the prevention, response and recovery periods of **coastal disasters** and **chronic coastal stress conditions**. The self-scoring outputs will serve as a foundational and preliminary input to developing viable coastal city resilience plans for the immediate and longer terms. As cities evaluate their readiness levels against the considerations laid out in this and the comprehensive, longform Scorecard, they will identify both strengths and weaknesses in planning & implementation, in policy and finance prioritization, and in education and awareness.

Framework & Standards Alignment

The Scorecard is based on the UNDRR's **Ten Essentials for Making Cities Resilient** (see Figure 1 on next page), developed to accelerate implementation of the **Sendai Framework for Disaster Risk Reduction** (2015–2030) at a local level. There is a set of questions native to each Essential, however cross-cutting themes and references make themselves evident throughout the document. The Essentials serve as chapter headings for the Scorecard, guiding users directly to the key areas of **coastal disaster risk reduction** and **coastal resilience** capacity-building. It is the breadth of the Ten Essentials that makes the Scorecard unique - while there are other instruments focused on coastal risk reduction, to date none, so far as we know, offers the breadth of coverage that the Scorecard provides for the extreme nature of **coastal disaster risk reduction**.

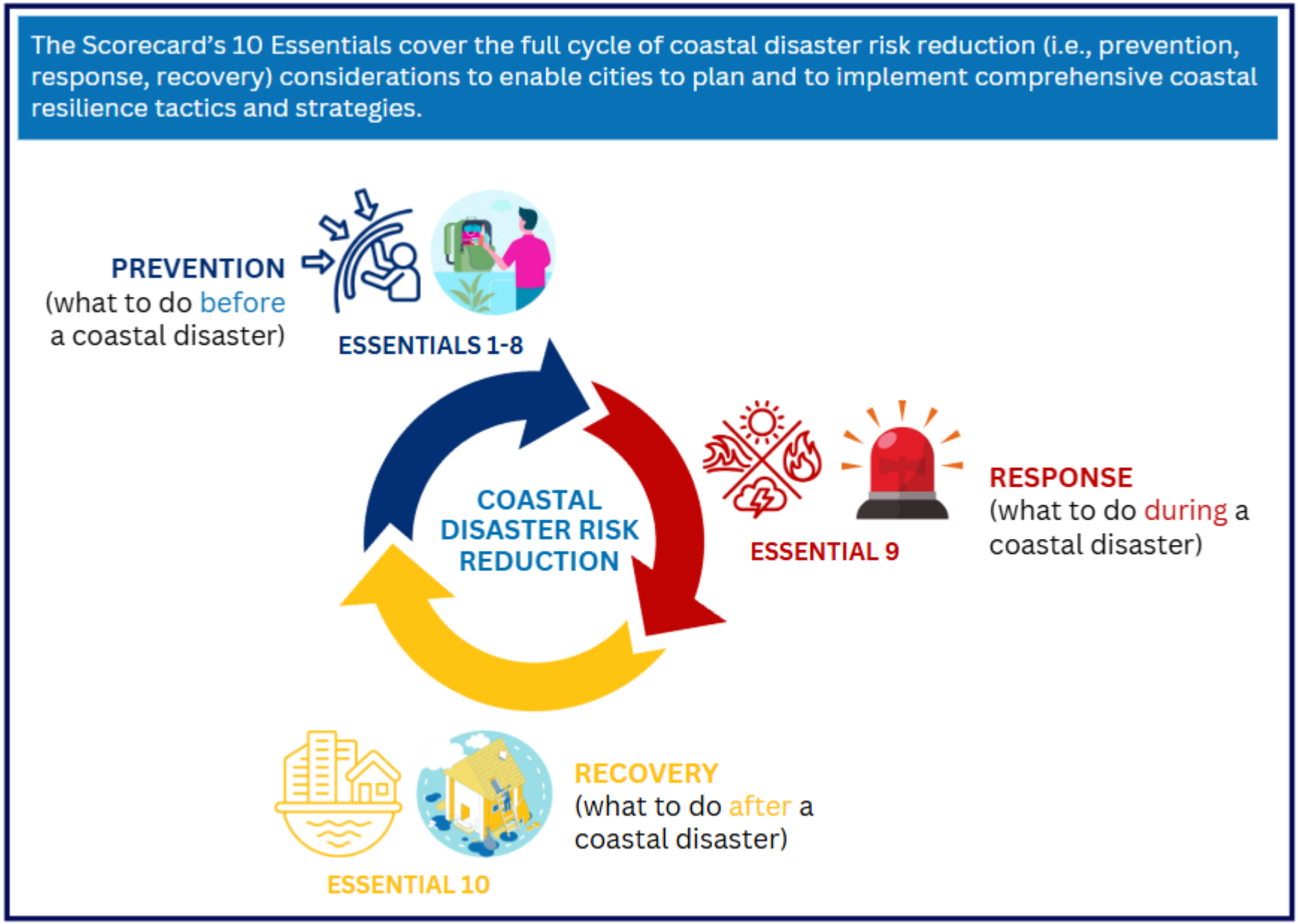
To support implementation in users' local contexts, each Essential is further amplified using relevant credits from the **Waterfront Edge Design Guidelines Version 3.0** (**WEDG®**) standard created and stewarded by **Waterfront Alliance, Inc**. By combining the

globally comprehensive remit and structure of the Ten Essentials with the site-specific, design-oriented guidance of WEDG, the Scorecard becomes a practical and holistic tool for assessing **coastal disaster risk reduction** and directly informing resilient coastal and waterfront planning and implementation.

The **Prevention Period** for **coastal disaster risk reduction** is naturally emphasized in Essentials 1-8 including a focus on Governance (Essential 1, Essential 3) since maximum **resilience dividends** realize *before* events occur. The **Response Period** is the key time for ensuring that human health and safety escalate to top priority during a coastal emergency while the **Recovery Period** emphasizes how to rebuild in the post-disaster aftermath by advancing enablement environments for success.

Figure 1: Ten Essentials for Making Cities Resilient by 2030[iv]

Figure 2: The Periods of Coastal Disaster Risk Reduction (Cycle)



Coastal Disaster Risk & Resilience

Any event or condition consisting of a **coastal hazard** combining with exposures and vulnerabilities to cause major damage or disruption to people, natural and physical assets and economic activity is referred to in the Scorecard as a **coastal disaster**. **Coastal Disaster Risk**, like other kinds of risk, refers to the potential for events to have adverse consequences such as loss of life or injury, disruption, damage or loss of social, economic, and/or natural capital in **coastal settings**.

Coastal Disaster is used throughout the Scorecard to refer to an **acute coastal disaster** (i.e., event such as a tropical cyclone) and/or a **chronic coastal stress condition** (i.e., severe land subsidence in a **coastal setting**). The broad definition refers to the impact manifestation of **coastal disaster risk** – whether acute or chronic. An acute event has the benefit of being more precise to measure in time while a chronic condition challenges users to evaluate slower-moving catastrophes with less precision. The Scorecard, by design, narrows in on extreme **coastal hazards** that stress understanding, capabilities and ultimately assets – natural or human-built – so that **coastal disaster risk profiles** can be improved with resilience design and implementation interventions.

Coastal Disaster Risk Reduction starts with risk identification and assessment before plans to develop **Coastal Resilience** can be formed. As such, the physical determinants of **coastal disaster risk** are required data points – **coastal hazards**, **coastal exposures**, and **coastal vulnerabilities** – for measurement using quantitative methods such as scenario tools and models that determine baseline and target **coastal disaster risk & resilience profiles** (see Essential 2). The Scorecard presents **coastal disaster risks** as those that can be quantified and qualified by models applying the IPCC's determinants of physical climate risk[v]:

Coastal Hazard

- Hazard refers to potential human-induced or naturally occurring elements that can cause harm in a **coastal setting**. Hazards are drivers of risk – not risks themselves. The Scorecard primarily categorizes **coastal hazards** into geohazards, hydrological, and meteorological to simplify understanding for city end users

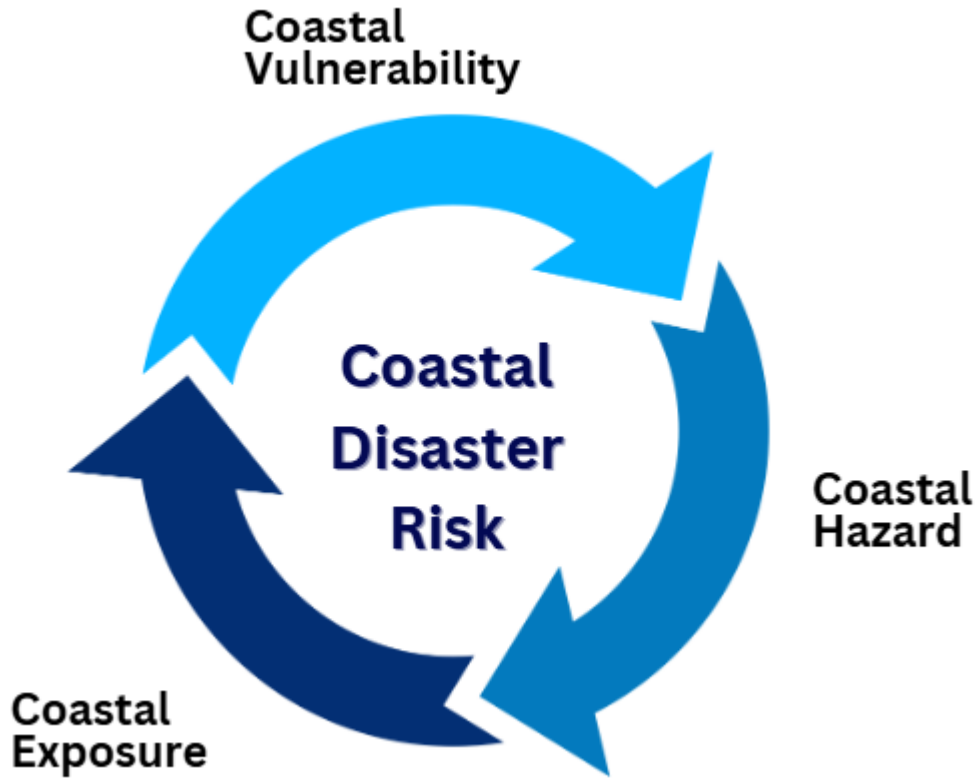
Coastal Exposure

- Exposure refers to what lies in harm's way – including people, buildings, infrastructure, and natural assets/ecosystems

Coastal Vulnerability

- Vulnerability is best defined as the likelihood that a hazard will cause harm, as well as how well structures and systems can cope, recover and adapt based upon extenuating factors such as material composition and physical location

Figure 3: The Interplay of Coastal Disaster Risk Determinants (adapted from IPCC)



Coastal Disaster Risk is the composite of measurable uncertainty that may arise when these three elements interact analytically to quantify and qualify baseline and target state **coastal disaster risk profiles**. With these determinants in mind, the most significant and universal **coastal hazards**, **coastal exposures** and **coastal vulnerabilities** examined in producing the Scorecard are comprehensively displayed in Appendix B.

The Scorecard's lead authors exhaustively reviewed **coastal hazards** in particular – both human-induced or naturally occurring – to summarize and provide the most universal ones that coastal cities will face irrespective of geography (see Appendix C for Universal Coastal Hazards). The Scorecard assesses the extent of a city's knowledge of hazards and exposures; and the strengths and weaknesses of the city's preparations (mitigation, adaptation) to reduce vulnerability.

Coastal Resilience

The Scorecard's definition of **coastal resilience** is adapted from the IPCC definition of resilience[vi]: "the capacity of interconnected social, economic and ecological systems to cope with a hazardous event, trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure".

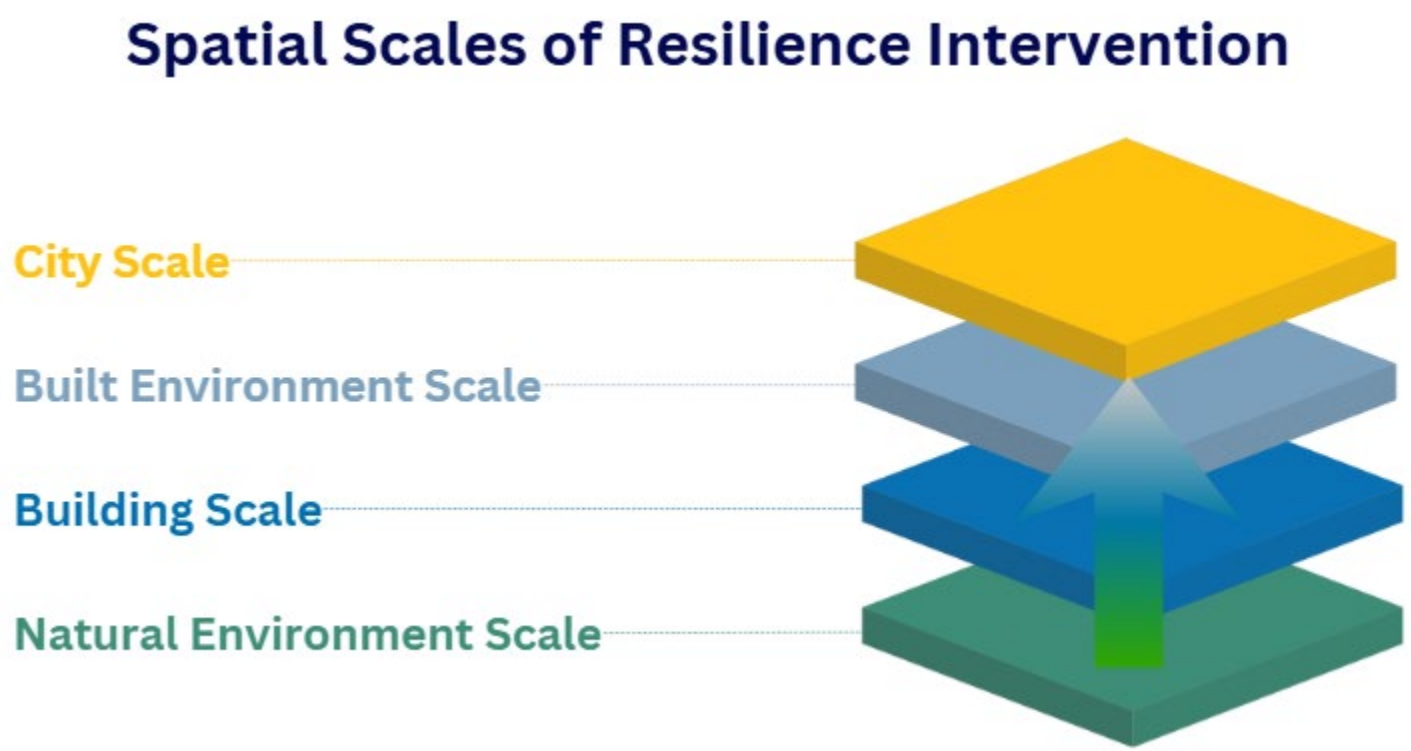
Achieving **coastal resilience** is a "system-of-systems" change mission with an emphasis on the ocean, weather, people, economies, nature and coastal physical assets. Building **coastal resilience** in a city requires intervening in multiple natural, physical, socio-economic, governmental, political, and cultural systems, and managing the relationships between these systems.

The Scorecard's definition does not imply simply returning to the status quo after a **coastal disaster** merely to some viable equilibrium. Adaptation to climate change and urbanization means that many aspects of coastal living may need to be modified: in this sense, resilience is more about "bouncing forward" than just "bouncing back". It's a future-proofing transition not unlike the changing role for hydrocarbons in city primary and secondary energy supplies.

The most foundational part of **coastal resilience** is physical location and natural geography. As used in this Scorecard, **coastal zone** refers to the zone immediately interfacing with the sea (or inlets of the sea such as estuaries, harbors and ports). Ecologically, this will include beaches, salt-flats, marshes and tidal areas; it will also include any land or settlements that might be impacted by tidal flooding, storm surge, tsunami, wave action or erosion. A **hinterland coastal zone** is situated behind the **coastal zone** stretching as much as 100 miles (or more) back from the sea itself and reaching into the floodplains/watersheds. This zone may be safe from the above issues but may nevertheless be affected by factors such as high winds and extreme rainfall caused by coastal storms or may be disrupted by the loss of infrastructure closer to the coast such as ports, railway lines or roads. For this reason, both **coastal zone** and **hinterland coastal zones** together are considered **coastal settings** when referenced as such throughout the Scorecard. Users have the option to focus on their areas of highest priority/effectiveness for their city's intervention in resilience-building.

The following pages will visualize the spatial and temporal scales of risk & resilience (i.e., staging for design and implementation interventions) as cities will make challenging choices while they face constraints – social, physical, and financial – to achieve city-scale resilience against **coastal disasters**.

Figure 4: Spatial Scales of Resilience Intervention for Key Stakeholders



The **natural environment scale** provides the foundation for the pre-settlement natural coastal domain conditions developed over epochs. It can be broadened further into the ecological health underpinning the success of built environment assets and include factors such as topology, geology, hydrology, ecology, meteorology, and chemistry, among other disciplines.

The **building scale** layers in asset- and site-specific factors (i.e., design, materials, construction) unique to structures built in **coastal settings**. The **built environment scale**, layers in broader factors such as operations and maintenance of key infrastructure in, around and between key coastal assets and sites.

The **city scale** zooms out the most to expand the built environment scale concept into a network of sites and/or assets within and around the coastal city, and adds layers of governance, engagement and socio-economic context to planning and implementation in service to **coastal resilience**.

Figure 5: Interplay of Coastal Disaster Risks

Coastal disaster risks manifest and interact in both acute and chronic time frames – the **coastal resilience** investments in prevention, response, and recovery must adequately adapt to similar time horizons. Acute events impact chronic conditions and vice versa.

Reducing **coastal disaster risk** requires intervening at different time scales. Some required actions may take decades - bringing a housing stock up to a new code or restoring a mangrove forest, for example, or even moving a city. Some actions, such as improving evacuation routes or building deeper city awareness and concerted neighborhood action, will take less than decades but still rests on the order of years.

As you complete the Scorecard you will find illustrative guidance across the interplay of risks and resilience and benefit from framing your design and implementation to the three periods of **coastal disaster risk reduction**.

Sustainable Blue Economy

The genesis of the **Coastal Resilience Partnership** and its Phase 1 Scorecard was a roundtable workshop that took place on March 13th, 2024 as part of the third Aspen Ideas Climate Festival in Miami Beach and moderated by Waterfront Alliance. It became readily apparent that coastal adaptation & resilience remained a heavily under-invested area of climate action. Shortly after, ARISE US approached Waterfront Alliance to create a city-level scorecard following up on the success of various scorecards such as the Wildfire Disaster Risk Reduction Scorecard released in 2023.

In parallel to the core development of Phase 1 of the partnership (i.e., making the Scorecard), the lead author team has participated in various conferences globally to showcase the Scorecard concept including Economist Impact Regional Ocean Summit in Dead Sea, Jordan (May 2024), UNFCCC COP 29 Resilience Hub in Baku, Azerbaijan (November 2024), Disasters Expo USA in Miami (March 2025), Economist Impact World Ocean Summit in Tokyo (March 2025), Third United Nations Ocean Conference in Nice, France (June 2025) including the Ocean Rise & Coastal Resilience Summit, and lastly the global release event happening at the World Ocean Council's Sustainable Ocean Summit alongside the Tomorrow Blue Economy Expo in Barcelona (November 2025).

The Role for Large Ocean States

Much focus on sustainable blue economy finance and implementation to date has rightly been on small island developing states (SIDS), which are now being referred to as large ocean states. Coastal cities and communities in large ocean states live with the ocean and water's edge in more advanced and time-tested ways than their counterparts in highly developed coastal cities. One goal of the Scorecard's Phase 2 will be to transfer socio-cultural and indigenous techniques to the nature-based restoration of **coastal conditions** that support human life in developed economies. The urgency of impending extreme sea level rise and the existential threat it poses to large ocean states has heavily guided the peer review process of the Scorecard to make it more relevant and useful for audiences outside of the United States.

Call to Action!

Self-scoring is not the end point, rather the beginning of a journey to reduce the likelihood and impact of acute **coastal disaster** events and **chronic coastal stress conditions**. That journey will take some years. The Scorecard will aid you with encyclopedic knowledge to set your spatial and temporal priorities and best determine tactical and strategic interventions that will sequentially and incrementally build up to **coastal resilience**. Since no-one can know when the next disaster will befall a coastal city, the time to start work, if you have not already done so, is now!

We wish you every success in developing meaningful, tangible and sustainable **coastal resilience** planning and implementation!

LEAD AUTHORS & KEY PARTNER INSTITUTIONS

ARISE US

Dr. Peter Williams (Coastal Resilience Partnership Co-Lead)

ARISE-US is the US network of ARISE[2], established by the United Nations Office of Disaster Risk Reduction (UNDRR) to build public-private collaboration in disaster resilience. We are a 100% pro bono organization operating in 30 countries worldwide, with some 450 corporate members. ARISE-US has played a key role in developing the Disaster Resilience Scorecard for Cities (Scorecard or City Scorecard) in collaboration with UNDRR, now used by over 800 cities worldwide (including many in the US). It is the basis on which this Coastal Resilience Scorecard is modeled, as well as several other scorecards such as the Wildfire Disaster Risk Reduction Scorecard, action guides, and so on that will form the basis of the toolkit referred to earlier.

Waterfront Alliance, Inc.

Mr. Eugene Karl Montoya A. (Coastal Resilience Partnership Co-Lead)

Waterfront Alliance was incubated by the Municipal Arts Society of New York (MAS) following the tragic events of the September 11th, 2001 terrorist attacks in New York City. This human-induced disaster created a large loss of life because the waterfronts were not operable for evacuation. Waterfront Alliance became an independent stand-alone entity in 2007 when a group of leading activists, businesses, foundations, and civic organizations came together with the goal of making the New York and New Jersey harbor a shared, resilient, and accessible resource for all. Since its founding, the Alliance has grown to encompass more than 1,100 organizations working together to bring about real change to the region's waterways and 700 miles of shoreline, and the greater nation at large. Waterfront Alliance created the Waterfront Excellence Design Guidelines (WEDG)® which are featured throughout.

Fugro USA Marine, Inc.

Dr. Cheryl Hapke (Coastal Resilience Expert)

Fugro is the world's leading Geo-data specialist. Through integrated mapping, modelling, and monitoring, we unlock intelligence from data to mitigate risks of assets and resources, both built and natural. Our solutions support sustainable infrastructure, climate

[2] See https://www.ariseglobalnetwork.org, and https://www.arise-us.org/

change adaptation, and inland water management as part of our climate and nature strategy. We have offices in 57 countries and employ approximately 11,000 staff worldwide. By utilizing our fleet of specialized equipment and cutting-edge digital solutions, we provide a vital contribution to building a safe and livable world, which is the purpose of our company.

Global Development College

Professor Dr. Jeremy Novak (Small Island Developing States Expert)

Global Development College is an internationally accredited research and higher education institution. Global Development College specialises in providing high-quality academic and commercial research, as well as tailored training and development for individuals, communities, governments, and businesses. The areas of specialty include resilience, hazard mitigation, crisis and disaster management, UN Sustainable Development Goals (SDGs), UNDRR MRC 2030, crisis and disaster management, engineering, infrastructure and asset management, business, and project management. Global Development College has been a contributing committee member of scorecards such as the Coastal Resilience Scorecard and the Lead organization for the **Small Island Developing State (SIDS) Resilience Scorecard Addendum** and the Public Health Resilience Addendum. Other scorecards that Global Development College has been involved in include those related to gender, health, and food security, which strengthen government and community resilience worldwide."

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We would also like to thank our key contributors and global peer reviewers above. Without their critical and invaluable support, perspectives, ideation, technical content, editing, infographics, and dedication to the subject matter, the Scorecard would not be ready for cities across the globe to immediately utilize for self-identifying and self-assessing their readiness levels for coastal disaster risk reduction and coastal resilience.

ESSENTIAL 1: ORGANIZE FOR DISASTER RESILIENCE

The E1 chapter begins the Scorecard's focus on the **Prevention Period** and primarily addresses a coastal city's governance approach to **coastal disaster risk reduction** and **coastal resilience** planning. All parties ("stakeholders") must be represented, active in organizational efforts, and engaged in the transparency, resourcing, and decision-making of public and private interests in service to **coastal resilience** plans, an objective every coastal city should aspire to develop, adequately resource, update, and maintain.

For Essential #1's development, the following WEDG® V3.0 credits provide additional guidance and illustrative practices from application to an individual waterfront project:

- **WEDG® Credit 0.3 (Develop and Implement a Plan for Equitable Stakeholder Engagement)**
- **WEDG® Credit 1.4 (Establish an Emergency Preparedness and Response Plan)**

***** See the end of Essential 1 chapter for WEDG® credit descriptions and select design strategies for coastal resilience planning and implementation.

#	Question	Guidance
1.1	**Governance**	
1.1.1	To what extent have cities actively included and engaged key stakeholders on the topic of **coastal resilience** for the development of **coastal disaster risk reduction** and resilience plans?	Any city is a complex entity in itself and will have a web of complex governance structure and dynamics. The city should invite all key stakeholder groups to participate in an approach and methodology for ensuring long-term **coastal resilience**. Disaster risk reduction (DRR) professionals must prioritize inclusive engagement in all DRR activities, ensuring that all stakeholders share equitable opportunities to participate and "own" the process and outcomes. It is essential to recognize that city resilience professionals are unlikely to have access to all stakeholders on day one. For this reason, the city should consider incremental but meaningful approaches to developing multi-stakeholder access. Cities need to engage with the widest possible selection of stakeholders accepting that it may not be possible to engage them all immediately. Effective governance requires active engagement from all stakeholders in development, planning, and implementation efforts. Governance structures should promote participation through clearly defined roles and responsibility, manageable meetings, and regular updates, optimized to different stakeholder needs. Meetings to discuss governance, planning, and **coastal disaster risk reduction** should be accessible, well-documented, and facilitate meaningful co-investment in action. Cities need to ensure consistent inclusion across all participating stakeholders.

#	Question	Guidance
		Stakeholder groups who have an interest or role (or both) in **coastal disaster risk reduction** may include (but are not limited to) the categories and examples below, which must be localized. **Residents/Citizens** • Homeowners & renters (individuals, companies) • Informal and unincorporated settlements (as applicable) • City groups (religious, social, and neighborhood organizations) • Affinity groups (anthropological, ethnic, indigenous, cultural, linguistic, health, environmental) • Advocacy groups (alliances, coalitions, non-governmental organizations) **Commerce & Industry** • Enterprise entities (small businesses through multinational corporations) • Enterprise leadership, heads of sustainability/engineering/property management, risk management, city affairs and others (as applicable) • Chambers of commerce; industrial membership organizations **Critical Infrastructure & Utilities** • Utilities (heating, cooling, power, water, sanitation, communications) • Critical services facilities (hospitals, emergency shelters, emergency food distribution) • Flood management (districts, flood zone managers) • Other key infrastructure services - roads/transportation **Government** • Local (city and/or county) departments including emergency management, planning, fire, engineering, parks and recreation, environment, public works, finance and taxation) • Adjacent cities, especially if infrastructure, facilities and equipment are shared, or if there is a strong economic relationship • State/regional/provincial (legislators, finance, fire services, water, environment, public health) • National/federal entities where applicable (for example, in USA this would include FEMA, NOAA including coastal zone managers, USDA, EPA, BLM, Forest Service, USACE, US Coast Guard, etc.) **Emergency & Public Health** • First responders (police, fire, emergency medical services) • Public health (hospitals, clinics, health agencies) **Land & Resource Management** • Agriculture & conservation (farmers, landowners, land trusts) • Education & research (schools, universities, conservation districts)

#	Question	Guidance
		Advocacy Organizations • Alliances & NGOs (coalitions, advocacy groups) • Environmental groups **Validation**[3] • Evidence of meaningful engagement such as meetings, public referenda, consultations, benchmarking, action-oriented workshops, and focus groups, etc. • Notable absence of groups or key individuals choosing not to participate • Establishing a governance framework that defines inclusion, roles, meeting frequency, and decision-making processes and integrates diverse inputs • Availability of meeting records/minutes and clear documentation of decisions made • Providing regular updates and ensuring accessibility of public information • Ensuring participation of all stakeholders with targeted outreach to underrepresented groups
1.1.2	To what extent is there a single point of resource and communication coordination (i.e., a person or an office) for **coastal disaster risk reduction** and **coastal resilience** planning and implementation?	Ideally, there exists a single body that coordinates *all* stakeholders including local communities and businesses. In reality, there may well be separate bodies where separate government agencies are involved (public health is one common example), or where private utilities manage their own activities. In such cases the key is then the connectedness of these different bodies and their propensity and/or incentives to collaborate. Cities need to create a single overall point of coordination of all resource activities, able to work across and between organizational boundaries. **Validation** • Program office or similar, with clearly defined responsibilities for all stakeholders and buy-in from them. May be in emergency management office (EMO), or waterfront management district, or other. • If there are multiple coordinating bodies – proof that they share assumptions, communications, data and other resources with each other.
1.2	**Strategy**	
1.2.1	To what extent is there a comprehensive strategy for **coastal disaster risk reduction** or **coastal resilience**?	A comprehensive **coastal disaster risk reduction** strategy must go beyond a single tool – it requires governance, risk & resilience assessments, stable funding & financial planning, civic engagement, emergency preparedness, and long-term city-wide efforts.

[3] **Validation** is used throughout the Scorecard to capture tangible and measurable examples that prove that a coastal disaster risk reduction consideration has been addressed. It is impossible to state all possible validation criteria and other criteria beyond those stated may apply in any given instance.

#	Question	Guidance
		The Ten Essentials framework can be combined into a single city-specific strategy document wherein each Essential (i.e., Chapter) is compositional and representative of the prevention, response and recovery dimensions of **coastal disaster risk reduction**. • **Governance & Policy** (E1, E4): Clear roles, regulations, enforcement, and land-use policies • **Risk & Resilience Assessment** (E2): Identifying vulnerabilities at different spatial scales (property, neighborhood, landscape) • **Financial Capacity** (E3): Sustainable funding sources, incentives, and innovative financing • **Natural & Built Environment** (E5): Protecting natural buffers • **Institutional Capacity** (E6) • **Social & Cultural Capacity** (E7) • **Civic Engagement** (E7): Inclusive participation, education, and stakeholder buy-in • **Infrastructural Capacity** (E8): hardening and/or duplicating physical infrastructure • **Response Capacity** (E9): Access to critical response resources, coordination responsibilities, and readiness for human health and safety considerations • **Recovery Capacity** (E10): Post-event economic and social rebuilding, long-term mitigation measures Cities need to create a comprehensive strategy for **coastal disaster risk reduction** in service to **coastal resilience**. **Validation** • Evidence of a documented **coastal disaster risk reduction strategy** that incorporates elements of the 10 Essentials, supplemented by local policies and cultural contexts, funding mechanisms, and long-term adaptation plans
1.2.4	To what extent are **coastal disaster risks** separately considered in new policymaking?	It is essential to consider material **coastal disaster risks** in new policymaking, just as the operational and financial risks would routinely be considered. Cities need to ensure that **coastal disaster risk** issues and impacts are considered in all categories of policymaking not only in disaster risk-specific policies. **Validation** • Evidence of city meeting minutes and standing orders demonstrating that **coastal disaster risks** are routinely considered in developing new policies

Develop and Implement a Plan for Equitable Stakeholder Engagement (WEDG® Credit 0.3)

Description

When organizing for coastal resilience, a city should engage stakeholders in the vision, design, and implementation periods of coastal resilience planning to create a welcome and equitable coastline for all. Coastal cities need to recognize the needs, priorities and concerns of a diverse set of city residents and other stakeholders.

Design Strategies

- Establish a **stakeholder engagement plan** from the beginning that enables city residents and other stakeholders to participate in the visioning process, multiple stages of the design process, and all the way through implementation.

For more details, see the **WEDG® Version 3.0 Manual**, pages 23-27.

Establish an Emergency Preparedness and Response Plan (WEDG® Credit 1.4)

Description

Clear communication and outreach about coastal hazard risks can increase human safety during and after emergencies. Projects should create an emergency preparedness plan for human safety prior to an extreme weather event, particularly considering the most vulnerable communities, such as those with impaired mobility, overburdened communities, or environmental justice communities.

Design Strategies

- Establish an **emergency network** of on-site team leaders, as well as applicable local, city, state, and federal entities.
- Create an **education and outreach strategy** about the risks before, during, and after an extreme event. For example, identify and communicate about your hurricane or tsunami evacuation zone, nearby shelters and resources, and process for monitoring evacuation order. Consider relevant language barriers.
- **Conduct annual training** of employees, managers, and residents to present flood risk avoidance information and provide informational brochures or newsletters.

For more details, see the **WEDG® Version 3.0 Manual**, pages 54-55.

ESSENTIAL 2: IDENTIFY, UNDERSTAND USE CURRENT AND FUTURE RISK SCENARIOS

The E2 chapter focuses on the **Prevention Period** and primarily addresses the completeness and adequacy of a city's understanding of **coastal disaster risks** framed by spatial and temporal considerations used in scenario tools/models.

Spatial Scales of Resilience Intervention

- The **natural environment scale** where Scorecard users can and should utilize scenario tools to quantify and qualify current and future plausible states of foundational natural asset systems in and around **coastal zones** (e.g., land, mangroves, coral, seagrass, salt marsh, etc.)
- The **building scale** where Scorecard users can and should utilize scenario tools study physical structures (standalone, attached) in and around **coastal zones**. The natural environment layer must be retained in all scenarios to ensure foundational relevance.
- The **built environment scale** where Scorecard users can and should utilize scenario tools to quantify and qualify current and future plausible states of collective performance broader than **building scale** such as infrastructure, transportation networks, public spaces, etc. The natural environment layer must be retained in all scenarios to ensure foundational relevance.
- The **city scale** where Scorecard users can and should utilize scenario tools to quantify and qualify current and future plausible states of natural, built and socioeconomic system performance interaction. The natural environment layer must be retained in all scenarios to ensure foundational relevance.

Temporal Scales for Resilience Intervention

- Functionally, acute time scales are immediate and very near-term or short-term time periods. Understanding the drivers and impacts of disasters pre-event will support response and recovery capabilities assessments for resilience against single or multi-hazard scenarios.
- Likewise, chronic time scales extend into medium and longer-term periods that potentially overtake conventional city and key stakeholder planning. As such, chronic **coastal disaster risks** and dynamic **chronic coastal stress conditions** will be challenges to model but are essential in relaying how resilience investment (i.e., **prevention period**) translate into value enhancement

For Essential #2, the following WEDG® V3.0 credits can provide additional guidance and illustrative practices from application to an individual waterfront project:

- **WEDG® Appendix A (Initial Assessments)**
- **WEDG® Credit 1.1 (Avoid or Reduce Flood Risk from the Waterbody)**
- **WEDG® Credit 1.2 (Reduce Pluvial Flooding and Stormwater Discharge)**

***** See the final section of Essential 2 chapter for WEDG® credit description and select design strategies for coastal resilience planning and implementation.

Coastal Disaster Risk Assessments and **Coastal Resilience** Plans should be integrated within a city's overall disaster risk reduction plan and/or sustainability plan Users are encouraged to reference the **Physical Determinants of Coastal Disaster Risk & Resilience** table (see Appendix B) and the **Universal Coastal Hazards** table (see Appendix C) to ensure comprehensive identification, classification and inclusion of **coastal hazards** relevant to their coastal city setting.

<table>
<tr><th>#</th><th>Question</th><th>Guidance</th></tr>
<tr><td>2.1</td><td colspan="2">Natural Environment Scale</td></tr>
<tr><td>2.1.1</td><td>To what extent has the city adequately mapped the coastal natural environment with respect to coastal hazard variability?</td><td>To adapt to and mitigate coastal disaster risks, it is essential to understand key factors driving the natural coastal conditions that could exacerbate (or mitigate) the physical determinants of coastal disaster risks (hazards, exposure, vulnerability).

For example:

<table>
<tr><th>May exacerbate coastal hazard</th><th>May mitigate coastal hazard (see also E5)</th></tr>
<tr><td>Topography
Low elevation
Decaying seawalls
Poor drainage
Coastal areas that are prone to failing and/or eroding
Narrow inlets (may amplify storm surge or tsunamis)
Bathymetry
Shallow, low slope shelf (amplifies waves).
Lack of or low relief offshore sandbars
Lack of natural or human-made reefs or breakwaters or other wave mitigation
Coastal Typology
Narrow beaches
Adjacency to rivers which may increase flooding, water accumulation
Lack of dune system
Compromised mangrove fringes (cleared or cropped canopy), narrow fringing marshland
Land Cover (natural and built)
Overdeveloped coastal system(s)
Inadequate storm water management systems
Development too close to water body
Diminished vegetation cover
High ratio of impervious to permeable surfaces</td><td>Topography
(Absence of exacerbating factors)
Height above sea level.
Bathymetry
Steep nearshore zone
Multi-bar system
Natural or human-made reefs or breakwaters
High-resolution bathymetric data for predictive models
Coastal Typology
Wide beaches and dunes
Well vegetated dune system
Wide fringing marshland or mangrove forest
Land Cover
Natural coastal system with no impediments to coastal processes
Coastal development set far back from the water body
Extensive vegetation cover
Low ratio of impervious to permeable surfaces
Weather
(Absence of exacerbating factors)</td></tr>
</table>
</td></tr>
</table>

#	Question	Guidance
		Weather • Location in or near hurricane or storm zone • Long periods of drought impacting strength of dykes **Factors that increase or reduce exposure and vulnerability** • It will be seen that some of these factors are relatively dynamic (especially human activities). The disaster risk assessment therefore ideally would not be a "once every five years" exercise - it needs updating annually, to account for changes. • It is also important to continue to project the assessment into the future, as climate change continues to impact and as urban boundaries expand in and around the **coastal zone**. Define and update most severe and most probable incidents and associated mitigation actions. **Validation** • Evidence of complete mapping of natural coastal environment to identify hazards, exposures, and vulnerabilities in and around the **coastal zone** • Some public data sources are included in the footnote below[4].
2.2	**Building & Built Environment Scales**	
2.2.1	To what extent does the city understand the impact of building patterns and densities on its **coastal disaster risk profile?**	On one hand, more densely packed buildings and row-homes increase exposure: they are more prone to being caught up in a single **coastal disaster** incident (for example being blown over onto one another). On the other hand, however, if building density means less open land, it may in some ways reduce hazard (for example flooding) in the first place. **Validation** • Building patterns are mapped and annotated for **coastal hazard** and exposure implications
2.3	**City Scale (incl. Socioeconomic Perspective)**	
2.3.2	To what extent is the economy of the city at risk of permanent or semi-permanent economic impairment or adverse socioeconomic impacts from a **coastal disaster**? (Business continuity and structural damage insurance can offset total vulnerability – see E3).	Coastal cities reliant on tourism, fisheries and shipping are especially exposed to disasters like floods and storm surges. Damage to ports, infrastructure and ecosystems can halt economic activity and threaten jobs. Additional investments in **coastal disaster risk reduction** protects these vital sectors, ensuring economic resilience and reducing long-term recovery costs. The impact on a city's economy can be measured in terms of GDP, employment, or if composed wholly of small businesses, a simple count of businesses. Keep in mind that permanent or at least long-term damage to the city's economy may still result even if the city rapidly clears immediate damage and starts to rebuild.

[4] World Meteorological Organization (WMO) Climate Data NOAA National Centers for Coastal Ocean Science (NCCOS) World Bank Climate Change Knowledge Portal

#	Question	Guidance
		The answer to this question may depend on the answers to other questions throughout the scorecard. Therefore, you may wish to complete this assessment last. Cities need to compile estimates of economic risk as part of building the case for investing in **coastal resilience**. This can be validated through sector-specific GDP data, employment, figures and past disaster impact reports. Combined with climate risk modeling and stakeholder input, these tools help to justify risk reduction measures. **Validation** • Evidence of reasoned estimate of economic risk, considering risk factors, land use and readiness indicators laid out in this scorecard • Evidence of reasoned estimate of economic impact averted by current and planned readiness levels for **coastal disasters**
2.3.3	To what extent are features in the social fabric of city that may influence **coastal vulnerability** understood?	In order to enable effective financial planning (E3), land use planning (E4 and E5), data, data sharing and skills needs (E6), city mobilization (E7), infrastructure investment (E8), emergency panning (E9) and post event response planning (E10), it is recommended that risks be assembled into scenarios. Ideally there will be a minimum of two – a "moderate" case and a catastrophic, worst case. They should address hazard, exposure and vulnerability; and they should be updated regularly. In addition, scenarios should consider multi-hazard potential (for example, storm surge and fluvial flooding, combined with landslide), along with disaster consequences such as human health impacts. Cities should attempt to assemble coastal disaster scenarios. It may help to seek scientific, engineering and other professional input when assembling these. **Validation** • Presence of at least the two scenarios just described, updated in the last 12 months • Presence of multi-hazard scenarios • Evidence that the scenarios are being used for planning.
2.4	**Scenario Design & Tool Use**	
2.4.1	To what extent has the city assembled all known **coastal hazards**, **exposures** and **vulnerabilities** into specific scenarios to help to assess the adequacy of proposed interventions	In order to enable effective financial planning (E3) land use planning (E4 and E5), data, data sharing and skills needs (E6), city mobilization (E7), infrastructure investment (E8), emergency planning (E9) and post event response planning (E10), it is recommended that risks be assembled into scenarios for **coastal disaster risk assessments**. Ideally there will be a minimum of two – a "moderate" case and a catastrophic, worst case. They should address hazards, exposure and vulnerability, and they should be updated regularly to ensure ongoing effectiveness. The most probable and most severe incidents should be defined and distributed as baseline conditions in order to develop **coastal resilience plans**.

#	Question	Guidance
	to prevent and/or mitigate **coastal disasters**?	Cities should assemble **coastal disaster scenarios**. It may help to seek scientific and other professional input when assembling these. **Validation** • Evidence of at least the two scenarios described above, updated at least once every 12 months • Evidence that the scenarios are being used for city planning across relevant time scales – short, medium, and long

WEDG® Appendix A provides methods for completing site-level baseline assessments. It contains suggested methods and levels of analysis to support baseline analysis of site context. It is neither exhaustive, comprehensive, or directly applicable to city-wide assessment.

Design Strategies

- For the purposes of resilience, within Appendix A, communities should focus on:
  - City and Historical Context
  - City Profile
  - Discharge Rate
  - Emergency Preparedness
  - Extreme Temperatures
  - Heat Island Vulnerability
  - Ice
  - Offshore Depth
  - Precipitation
  - Risk and Vulnerability to Extreme Events and Sea Level Rise
  - Slope and Shoreline Shape
  - Snow and Ice Melt
  - Stability, Soils, Propwash, Sediment Transport, and Marine Asset Condition
  - Stormwater Infrastructure
  - Tidal Range
  - Transportation Access

For more details, see the **WEDG® Version 3.0 Manual**, pages 20-22.

Avoid or Reduce Flood Risk from the Waterbody (WEDG® Credit 1.1)

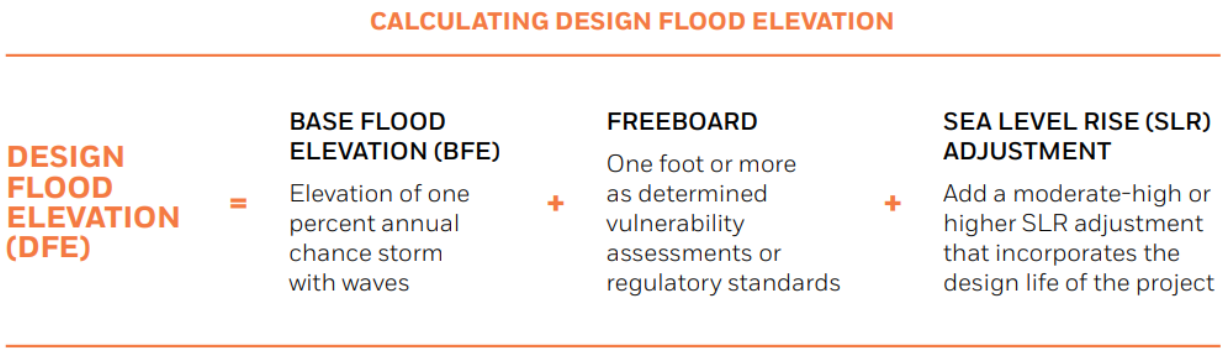
Description

When designing and using current and future risk scenario tools for coastal resilience, a city should seek to reduce human health and safety risks and potential damage to site structures from coastal, lacustrine, and riverine flooding threats. Coastal resilience plans should develop the risk strategies that protect cities against applicable flooding types: storm surge, fluvial, tidal/nuisance, waves, and flooding caused by shoreline erosion, as well as compound flooding which is when multiple drivers of flooding occur simultaneously, amplifying the effects of floodwaters and potential damage.

Design Strategies

- **Increase sites' Design Flood Elevation** (**DFE**), the minimum elevation to which a structure must be elevated or floodproofed for flood protection. The elevation should be based on a specific design storm (e.g., the 1% annual chance flood event) with added elevation to accommodate sea-level rise and additional freeboard (additional height for safety)
- **Setbacks** or simply moving away from the water, offers the highest level of structural protection and risk reduction
- **Dry Floodproofing** ensures that structures are effectively sealed to prevent floodwater intrusion and fortified to accommodate the pressures that floodwaters can put on a structure. Wet Floodproofing is a design in which the building is designed to allow floodwaters to enter a structure safely, without causing serious damage or compromising structural integrity
- **Landscape protections** and nature-based features such as wetlands, armoring, and berms can provide effective protection against flood threats while also providing ecological benefits
- **Floodplains** may have been heavily modified in urban centers. Reconnecting floodplains to waterbodies can reduce flooding across large scales by facilitating natural movement of water. Floodable spaces, such as parks designed to take on flood waters, can provide storage for floodwaters that reduces regional flooding, particularly in riverine environments
- **Increase the durability and future adaptability of structures** to enable more rapid repairs and the ability to reduce costs of future adaptation projects; critical infrastructure redundancy and elevation should be considered for all sites

For more details, see the **WEDG® Version 3.0 Manual**, pages 33-44.



Reduce Pluvial Flooding and Stormwater Discharge (WEDG® Credit 1.2)

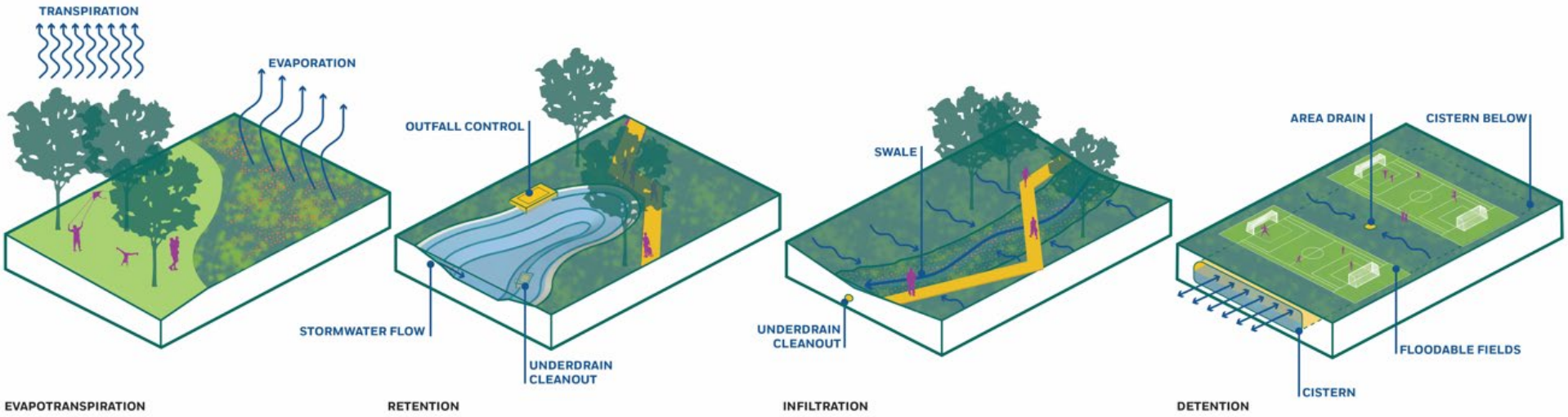
Description

When defining/ identifying, understanding and using current and future risk scenario for coastal resilience, seek to reduce the risk of pluvial flooding and the overall volume of stormwater discharge whenever feasible.

Design Strategies

- Define strategies to manage anticipated point source and non-point source stormwater
- Retain, infiltrate, evapo-transpire, reuse, divert, store or detain stormwater to manage precipitation to the maximum event feasible
- Utilize Green infrastructure for stormwater management as well as reducing urban heat, improving aesthetic value and supporting biodiversity habitat. Examples: bioswales and rain gardens with native plant species, rainwater harvesting, green roofs, permeable pavements, planter boxes, vegetated filter strips, wetlands, and trees.
- Design for storm events, in in particular the capture and active management of stormwater will vary depending on local conditions, policies and regulations, technical feasibility, environmental considerations, and the type of stormwater infrastructure that local municipalities use
- Reduce unmanaged stormwater and reduce peak flows and adjusted designs to accommodate climate projects and coastal risk profiles; grey infrastructure can also achieve desired stormwater goals alongside green and blue infrastructure

For more details, see the **WEDG® Version 3.0 Manual**, pages 45-50.



ESSENTIAL 3: STRENGTHEN FINANCIAL CAPACITY FOR RESILIENCE

The E3 chapter focuses on the **Prevention Period** and primarily addresses the financial architecture of a city's **coastal resilience** universe – understanding of sources, quality and stability of funds, provision of tax and grant incentives, identification of monetizable co-benefits/**resilience dividends** to incentivize the business case for **coastal disaster risk reduction**, capital budgeting and the securing of specific resilience funding. **Coastal resilience** funding should allocate to both capital expenditures and operating expenses to pursue sustainable profitability. (Note: Insurance support may be extremely limited in some regions)

For Essential #3, the following WEDG® V3.0 credits can provide additional guidance and illustrative practices from application to an individual waterfront project:

- **WEDG® Credit 2.3 (Support Industrial Water-Dependent Uses)**
- **WEDG® Credit 2.7 (Create Maritime or Environmental Employment Opportunities)**
- **WEDG® Credit 2.10 (Support Diverse and Sustainable Maritime Activity)**

***** See the final section of Essential 3 chapter for WEDG® credit description and select design strategies for coastal resilience planning and implementation.

#	Question	Guidance
3.1	**Funding Mechanisms (Public, Private, Blended)**	
3.1.1	To what extent has the city researched and explored possible funding sources for the long-term work required to reduce **coastal disaster risk** and increase **coastal resilience**?	**Coastal resilience** enhancement requires consistent multi-year actions that utilize both capital reserves and annual operating funds. Many cities lack a comprehensive understanding of potential **coastal resilience** funding sources, resulting in missed opportunities for financing necessary improvements. Financing methods and sources may include, but are not restricted to: • Public Funding: federal, state and local government grants (including matching grants), development financial institutions, international aid organizations • Special city assessments to address acute needs • Debt Capital & Investment instruments[5]: green, climate, social, sustainability, and resilience bonds, municipal bonds, green and blue bonds and tax increment funding (TIF) programs • Private Sector & Philanthropy: foundations, NGOs, corporate funding (e.g., insurers, large companies), public-private partnerships • Innovative & alternative models: Leasing, crowdfunding, development fees, blended finance

[5] For further resources on issuing sustainable debt capital (bonds/loans) for blue purposes, see the recently-released Ocean Investment Protocol framework and focus on the blue bond project categories when engaging with city treasury officials to raise capital for coastal resilience interventions at any scale

#	Question	Guidance
		• Targeted Government Collaboration: cost-sharing by and between public and private sector organization including Agency funding for **coastal resilience**-related projects (e.g., a transportation agency funding a bridge that enhances evacuation routes) • Tax-based Approaches: surcharges, special resilience taxes • **Resilience dividends**: capturing "co-benefits" from proactive resilience investments (see below) **Validation** • Proof of a review of financial reserves and other financial sources purposed towards **coastal disaster risk reduction** and **coastal resilience** purposes
3.2	**Funding & Financing Plans**	
3.2.1	To what extent does the city have an integrated financial plan for the work required to reduce its **coastal disaster risk** and enhance **coastal resilience**?	Combined funding must be adequate for **coastal resilience** needs and deployed "as if" there were a single source and a single plan. If there are separate subsidiary plans (e.g., transportation, coastal zoning, or sustainability plans), these need to be coordinated, complete, and mutually consistent. **Validation** • Evidence of an integrated financial plan that aligns funding sources with specific **coastal resilience** objectives ensuring coordination of all efforts to address **coastal disaster risk reduction** needs • Evidence that plans will persist – even if changed or updated – through electoral cycles
3.3	**Insurance, De-Risking & Financial Innovation**	
3.3.1	To what extent is insurance availability and affordability considered in the event of a **coastal disaster** the city? Is it understood what is covered by insurance? What protection gaps remain?	Insurance is a valuable resource for protecting assets and revenues in both public and private sectors, but there may be protection gaps - defined as the difference between insured and uninsured losses. The ability of individual property owners to repair or rebuild their homes (and those homes they may be renting) is a critical determinant of the probability of long-term city recovery from a **coastal disaster**. If residents or companies cannot afford to repair or rebuild, the city will suffer economically and socially. In most cities this will require adequate flood and wind insurance, either provided by the private sector or underwritten by a state or national government. Both public and private sector organizations should have a basic insurance coverage plan. The insurance market in some countries is beginning to develop approaches to insurance that reduce coverage costs based on adaptation and/or mitigation work carried out. Many city residents may underestimate the costs of rebuilding and replacing their possessions. They may also wrongly assume that their health insurance will cover disaster-related health issues. Cities need to: • Understand the level of insurance cover for their residential properties. • Understand government funds that might be available and the remaining gap • Persuade and/or help the uninsured and under-insured to get the cover they need.

#	Question	Guidance
		If data is not available on flood, wind, or hurricane coverage levels, surveys, or working with local insurance brokers to assess total insurance market penetration may help. Persuasion should be part of city engagement activity (E7) and all government-to-individual communications; help may be through targeted help for individuals, or neighborhood and landscape-scale action to mitigate risk in advance. **Validation** • % of homes with confirmed adequate insurance cover for loss of/repairs to premises in the worst case scenario in E2 • % of residents with life insurance, for example such that youth who lose one or both parents in an event are able to survive and recover • % of residents with health insurance • Assistance for the financially vulnerable who cannot otherwise afford insurance • Delivery of city messaging on domestic insurance options • Availability of resilience-based premium discounts or incentives
3.3.6	To what extent is business insurance adequate in the city for **coastal disaster risks** (if applicable to region)?	The ability of coastal businesses to repair or rebuild after hurricanes, storm surges, or flooding, and to survive the loss of cash flow (business interruption/continuity losses) while doing so, is crucial to the long-term recovery of cities. If businesses cannot restart, the local economy will suffer: for example, it took over a decade for the economy of New Orleans to fully stabilize after Hurricane Katrina in 2005. Insurance for property, stock loss and business continuity losses can make the difference between going out of business and survival. This is especially true for small businesses that may have limited cashflow and limited resources to pay for re-stocking or purchasing new premises or equipment. As with residential insurance, adequate coastal risk insurance for businesses may need to come from the private sector or be supported through state, national, international government and blended finance programs. In some regions, the insurance market is evolving to offer coverage incentives for businesses that invest in **coastal disaster risk reduction** measures such as floodproofing, elevating buildings, or reinforcing structures against wind damage. It may also be possible to cover cashflow losses with parametric insurance that usually pays out more rapidly than conventional insurance, albeit with a higher uninsured portion based on sizing and scoping of contracts. Insurance cover will need to be sized to offset the likely increase in costs after a **coastal disaster**. Cities need to: • Assess the level of **coastal hazard** insurance coverage available for businesses' stock losses, property or asset damage and business continuity • Educate business owners on what insurance coverage they may need, including business interruption insurance • Assist uninsured and underinsured businesses in exploring and obtaining appropriate coverage

#	Question	Guidance
		If data on coastal business insurance coverage is lacking, surveys or collaboration with local insurance brokers can help assess market penetration. Encouraging businesses to obtain adequate coverage should be a key part of city engagement activity (Essential 7), including outreach through Chambers of Commerce, business networks, and municipal planning efforts. **Validation** • Delivery of city and business-level insurance needs • Assistance for smaller businesses that would not otherwise afford insurance • % of businesses with adequate insurance cover for loss of/repairs to premises and loss of business in the worst case scenario in E2 • % of local GDP protected
3.4	**Financial Incentives**	
3.4.1	To what extent has the city created financial incentives to help homeowners reduce their vulnerability and exposure to **coastal disaster risks**?	Incentives for **coastal disaster risk reduction** can come from multiple sources including, as examples: • Free resilience advice on floodproofing, wind mitigation, and elevation strategies • Discounts at local hardware stores for storm shutters, flood barriers, and reinforced roofing materials • Tax credits and rebates for home elevation, seawall improvements, rain gardens, permeable landscaping or other adaptation actions • City-provided discounts on services such as home inspections and storm preparedness programs • Tax incentive funding • Expedited (and discounted) permitting and inspections for home resilience improvements • Matching grants or direct funding for property hardening measures • Low-interest or no-interest loans for home retrofitting projects • Property tax reductions for homeowners who implement flood and wind resistance upgrades • Organized crowdfunding **Validation** • Evidence of compelling incentives for homeowners (and renters) to harden properties against acute and chronic **coastal disaster risks**; incentives should partner between state and local governments, financial institutions and private organizations
3.4.4	To what extent does the city regulate adverse financial incentives that work against **coastal disaster risk reduction**?	Just as the city should encourage, by whatever means, **coastal disaster risk reduction**, it should avoid providing incentives for individuals, businesses, and activities that will increase **coastal disaster risk** or create moral hazard, where financial incentives lead to riskier short-, medium- and long-term adverse outcomes. Activities and perverse incentives that increase **coastal disaster risk** might include using funds to enable: • Subsidizing development in high-risk flood zones • Providing incentives for rebuilding in repetitive loss areas rather than promoting orderly relocation and/or retreat

#	Question	Guidance
		• Failing to require climate-resilient or green infrastructure as a condition for new developments • Offering tax breaks or insurance subsidies for high-risk coastal properties without mitigation requirements where property owners assume they will be bailed out • Encouraging shoreline hardening techniques (e.g., bulkheads, seawalls) that may increase coastal erosion and long-term vulnerability rather than benefitting from sustainable nature-based methods (see Essential 8) Cities need to review their policies and incentives to ensure they do not deliberately or accidentally encourage behavior that undermines **coastal resilience**, in particular with critical infrastructure. **Validation** • Evidence of such a review and absence of adverse incentives • Evidence of policies discouraging repetitive-loss development in high risk coastal areas • Incentive programs tied to resilience-building measures including **Resilience Dividends**

Support Industrial Water-Dependent Uses (WEDG® Credit 2.3)

Description

When strengthening financial capacity for coastal resilience, a city should support water-dependent uses such as commercial shipping to promote associated economic, coastal recreational uses, military and coastal protection assets while providing economic, environmental and public health benefits. Water-dependent industrial uses can revitalize waterways and provide economic and social benefits. Coastal resilience and resilience is both a capital investment priority as well as operation funding responsibility.

Design Strategies

- Loading and shipping raw materials or large components that are difficult to transfer on land such as cement or offshore wind structures, uses requiring large amounts of water for processing and cooling such as hydroelectric power plants, shipping operations that replace truck or air freight with barges or ships, as well as light industry operations such as fisheries, offshore wind maintenance, or tug operations.

For more details, see the **WEDG® Version 3.0 Manual**, pages 66-67.

Support Diverse and Sustainable Maritime Activity (WEDG® Credit 2.10)

Description

When strengthening financial capacity for coastal resilience, a city should promote low-impact, safe design for critical coastal domains that accommodates a diverse range of vessels, facilitates educational programming and supports sustainable blue economy activities.

Design Strategies

- Floating Docks, Pier Renewals, Mooring Fields

For more details, see the **WEDG® Version 3.0 Manual**, pages 82-85.

ESSENTIAL 4: PURSUE RESILIENT URBAN DEVELOPMENT AND DESIGN

This E4 chapter focuses on the **Prevention Period** and primarily addresses adequacy of the city's land use and building codes with respect to **coastal disaster risk reduction** and **coastal resilience** and enforcement thereof.

For Essential #4, the following WEDG® V3.0 credits can provide additional guidance and illustrative practices from application to an individual waterfront project:

- **WEDG® Credit 1.1 (Avoid or Reduce Flood Risk from the Waterbody)** – (See E2)
- **WEDG® Credit 1.2 (Reduce Pluvial Flooding and Stormwater Discharge) –** (See E2)
- **WEDG® Credit 1.3 (Improve Stormwater Discharge Quality)**
- **WEDG® Credit 1.5 (Reduce Contribution to Urban Heat)**
- **WEDG® Credit 2.6 (Increase Transportation Access to the Waterfront)**
- **WEDG® Credit 2.8 (Increase Waterfront Pathways and Greenway Connectivity)**
- **WEDG® Credit 3.1 (Choose an Appropriate Edge Composition for the Context and Intended Use)**
- **WEDG® Credit 4.1 (Site with Ecological Sensitivity)**

***** See the final section of Essential 4 chapter for WEDG® credit description and design strategies (highlights) applicable to coastal resilience planning and implementation.

#	Question	Guidance
4.1	**Land Use**	
4.1.1	To what extent has coastal land use zoning been defined or considered? (See E2 for summary % of properties and of economy at risk)	Many cities in **coastal hazard** areas were initially laid out with little or under-appreciated consideration of flooding or landslide risk future evolution and as a result find themselves seriously exposed with stationary assets today. Zoning should consider both current **coastal disaster risks** and hazards, as well as potential future, climate-amplified **coastal disaster risks**, such as sea level rise, increasing storm intensity, unstable soil types, and areas expected to become prone to landslides because of coastal erosion. Cities need to acknowledge these **coastal disaster risks**, where present, in their planning and, especially (but not only) for new development or construction. Cities should be open to new ideas about offsetting mitigation practices. These may delay full retreat from the coastline by many years while evaluating the challenging topic of managed retreat in particular geocodes. **Validation** • Land use zoning defined with the **coastal disaster risks** identified in E2 in mind

#	Question	Guidance
4.2	**Building & Construction Standards**	
4.2.1	To what extent do building codes and construction materials mandate flood, wind, and landslide-resistant features in all residential, public, municipal and business constructions?	While each coastal city will have its own building codes the key is to be certain that they maximize protection against of flood, wind and landslide risks, for example (not exhaustive): • Flood-resistant materials (that can endure prolonged water exposure) • Pollutant capture to prevent road runoff and other sources from contaminating drinking water, or marine and freshwater aquatic ecosystems (e.g., filtration strategy for both small and large particulates) • Elevated construction • Hurricane- or cyclone-resistant roofs, windows and doors • Sealed gaps where utilities enter each property • Slope stabilization and retaining walls • For landslides (if included) - slope stabilization techniques, retaining walls, etc. • Rockfall barriers and netting in rockslide-prone areas • Early warning systems Cities need to ensure that their codes for residential and commercial construction embody provisions of this type, and that they are adequate for the city's **coastal resilience** needs. **Validation** • Evidence of codes suitable for advanced flood, wind and geohazard risk mitigation • Flood elevation design and implementation as well as wind-resistant reinforcement • Some U.S. public data sources are included in the footnote below[6]

[6] **FEMA**: Home Builders' Guide to Coastal Construction, December 2010; **FEMA**: Building Science Resource Library

Improve Stormwater Discharge Quality (WEDG® Credit 1.3)

Description

When pursuing resilient urban development and design for coastal resilience, a city should reduce impacts of stormwater. Stormwater, particularly in urban areas, can acquire particulates, chemicals, litter, excessive nutrients, and other pollutants. Stormwater can accrue heat running over impervious surfaces before discharging into adjacent waterbodies, contributing to pollution of waters.

Design Strategies

- Avoid fertilizing and pesticide/herbicide uses during the wettest periods of any calendar year
- Contain and control storage of petroleum and chemical products
- Align with regional water quality plans
- Where appropriate, the restoration or reintroduction of wetlands can aid in filtration and velocity reduction of stormwater entering the waterbody. If wetland capacity cannot accommodate total maximum daily load requirements, consider approaches that combine natural and engineered systems.
- Use buffers or natural shorelines at the water's edge and between waterbodies and impervious surfaces to infiltrate, filter, and cool stormwater before it enters the waterbody.

Photo: Stormwater Retention and Filtration Basin, **Credit:** Waterfront Alliance

For more details, see the **WEDG® Version 3.0 Manual**, pages 51-53.

Reduce Contribution to Urban Heat (WEDG® Credit 1.5)

Description

When pursuing resilient urban development and design for coastal resilience, a city should reduce contributions to impacts of impervious and heat-absorbing surfaces. In the built environment, the cumulative impact of heat-absorbing materials (e.g., asphalt pavement, roofing material) and local industrial and air-conditioning processes, which increase heat into the air, can drive localized temperatures even higher than regional averages, impacting human health and environment and increasing energy demands. Urban heat is not only an environmental concern but also contributes to environmental injustice.

Design Strategies

- Reduce Impervious Surfaces; utilize permeable surfaces for streets, roads and parking lots as part of storm water management strategy
- Use High-Albedo Materials
- Employ green infrastructure to extent feasible
- Employ the Cooling Effects of Wind
- Increase Shade and Evapotranspiration

For more details, see the **WEDG® Version 3.0 Manual**, pages 56-57.

Increase Transportation Access to the Waterfront (WEDG® Credit 2.6)

Description

When pursuing resilient urban design and development for coastal resilience, a city should improve public access to coastal sites by expanding and encouraging sustainable transportation options, especially waterborne transportation. Increased transportation options provide multiple benefits for city access and evacuation. Subsurface transportation rail systems may not be operable during flooding but may be used for temporary stormwater retention

Design Strategies

- Land-based Transportation
- Waterborne Transportation

For more details, see the **WEDG® Version 3.0 Manual**, pages 72-73.

Increase Waterfront Pathway and Greenway Connectivity (WEDG® Credit 2.8)

Description

When pursuing resilient urban development and design for coastal resilience, a city should increase connectivity of green and blue spaces along the waterfront to promote physical activity, health and well-being and encourage non-motorized transportation options.

Design Strategies

- Pedestrian Pathways
- Biking and Pedestrian Greenways
- Elevated Paths and Boardwalks
- Stabilization and Adaptability

Photo: Greenway, **Credit:** Waterfront Alliance

For more details, see the **WEDG® Version 3.0 Manual**, pages 76-78.

Choose an Appropriate Edge Composition for the Context and Intended Use (WEDG® Credit 3.1)

Description

Ensure the structural integrity and sustainability of the shoreline and near-shore area using a waterfront edge that has the greatest possible positive impact while also managing for erosion, coastal protection, and site use.

Design Strategies

- Assess erosion risks at the site and its primary contributors to understand whether the waterfront must be stabilized.
- Determine what requirements or erosion pressures the future site use may put on the waterfront.
- Reduce the potential for scour (erosion around a structural component like a wall or support wall) from multiple angles.
- Provide functionality for multiple water levels, such as through the use of floating docks.

For more details, see the **WEDG Version 3.0 Manual**, pages 87-89.

Site with Ecological Sensitivity (WEDG® Credit 4.1)

Description:

Prevent adverse ecological impacts and increase resilience to the effects of climate change by establishing proper buffer zones between development and sensitive habitats including the waterfront.

Design Strategies

- Consider the protection of waterfront sites through conservation easements, transfer of development rights, or other preservation methods.
- For projects on undeveloped lands, site structures and modifications away from intact habitats.
- Consider predictions for channel and shoreline migration during the design life of the project.
- Consider buffers away from the water: 200 feet from Mean Higher-High Water for tidal zones, 100 feet from the beach vegetation line, 100 feet from Mean Higher-High Water in estuary zones, and 50 feet from vulnerable ecological features such as dunes or bluffs.

For more details, see the **WEDG Version 3.0 Manual,** pages 99-100.

ESSENTIAL 5: SAFEGUARD NATURAL BUFFERS TO ENHANCE ECOSYSTEMS' PROTECTIVE FUNCTIONS

The E5 chapter focuses on the **Prevention Period** and primarily addresses the protection and enhancement qualities of ecosystem services that serve to reduce **coastal disasters risks** and in aggregate build towards scalable, effective city-wide **coastal resilience**.

For Essential #5, the following WEDG® V3.0 credits can provide additional guidance, illustrative practices and design strategies for application an individual waterfront project:

- **WEDG® Credit 3.1 (Choose an Appropriate Edge Composition for the Context and Intended Use)**
- **WEDG® Credit 3.2 (Maintain or Emulate Natural Shoreline Shape and Slope)**
- **WEDG® Credit 3.4 (Ecologically Enhanced Structural Components)**

- **WEDG® Credit 4.1 (Site with Ecological Sensitivity)**
- **WEDG® Credit 4.2 (Create, Restore, or Maintain Habitats and Ecosystem Services)**
- **WEDG® Credit 4.3 (Preserve and Increase Ecosystem Connectivity)**
- **WEDG® Credit 4.4 (Support Native Habitat Complexity and Biodiversity)**
- **WEDG® Credit 4.5 (Avoid Human Disturbances to Natural Resources)**
- **WEDG® Credit 4.6 (Redevelop and Clean Up Degraded Sites)**
- **WEDG® Credit 4.7 (Practice Sustainable Fill and Soil Management)**
- **WEDG® Credit 4.9 (Reduce Emissions through Carbon Management)**
- **WEDG® Credit 4.10 (Practice Environmentally Responsible Construction)**
- **WEDG® Credit 4.11 (Reduce Water Use)**

***** See the final section of Essential 5 chapter for WEDG® credit description and design strategies (highlights) applicable to coastal resilience planning and implementation.

#	Question	Guidance
5.1	**Coastal Ecosystem Services**	
5.1.1	To what extent does the city identify and assess **coastal ecosystem services** today to provide **coastal disaster risk reduction**?	Ecosystem services (where deliberately encouraged, also called nature-based methods or blue/green infrastructure) can play a critical role in enhancing **coastal resilience** by harnessing or extending ecological features to attenuate wave energy, mitigate flood risks, reduce erosion, reduce storm surge, and improve ecological health, among other benefits. Cities are increasingly deploying such approaches, including:

#	Question	Guidance
		• Living shorelines (marsh creation, mangrove restoration) • Green roofs, greenways and quick-draining/permeable pavements to manage urban stormwater charge, discharge, and runoff • Wetland restoration to absorb excess runoff and act as a natural buffer between natural and built environments Blue-green infrastructure may be used in conjunction with more traditional grey engineered infrastructure - see below). Cities need to understand the potential for ecosystem services to reduce **coastal disaster risk profiles** and plan to integrate these into their **coastal resilience** activities. **Validation** • % total **coastal disaster risk reduction** through use of nature-based methods (if calculable) • % of relevant land area and properties made more flood-resilient in some way through use of nature-based methods • % of large landowners and land area with material nature-based solution plans
5.3	**Balancing Green-Blue-Gray Infrastructure**	
5.3.1	To what extent are **coastal nature-based solutions** (i.e., green and blue) balanced with human-built engineering (i.e., gray)?	Nature-based methods should be considered as one set of strategies, whose use should be maximized, but not to the exclusion of hardened traditional engineering approaches where these may be required. Ideally, they will be used in combination as in hybrid approaches. For example: • Dunes may be restored and replanted but with a more resistant engineered core or one that utilizes biopolymer enhancement, or backed by a concrete seawall • Mangroves may be restored with carefully placed breakwater features to perform wave attenuation for defensive purposes • Reefs may be restored with both natural and artificial approaches Cities need a clear set of policies and plans for considering, and balancing the city's nature-based or "blue/green" methods, with "gray" methods. **Validation** • Evidence of such policies and evidence of their application in implementation

Choose an Appropriate Edge Composition for the Context and Intended Use (WEDG® Credit 3.1)

Description

When safeguarding natural buffers to enhance coastal ecosystems' protective functions, a city should ensure the structural integrity and sustainability of the shoreline and near-shore area using a waterfront edge that has the greatest possible positive impact on the environment and city, given the intended use and context.

Design Strategies

- Consider shifts to structural stability (e.g., shear strength of soils) and shape due to increased inundation frequency over time as well as appropriate adaptive management and maintenance strategies; Consider the effects of potential flooding behind structures and analyze impacts to the adjacent structures and shorelines
- Consider width and slope available accounting for land elevation and tidal range, future high tide level, changing lake levels, flood conditions and other water level changes.

Natural assets like mangroves (shown above) can play critical ecosystem services roles and protect coastal communities from disruption, damage and loss. For more details, see the **WEDG® Version 3.0 Manual**, pages 87-90.

Maintain or Emulate Natural Shoreline Shape and Slope (WEDG® Credit 3.2)

Description

When safeguarding natural buffers to enhance coastal ecosystems' protective functions, a city should support native biodiversity and reduce the impacts of channelization by maintaining or mimicking local, natural shoreline shape, slope, material and heterogeneity to the extent possible.

Design Strategies

- Identify local areas that demonstrate the likely shape and slope of the shoreline prior to human intervention, which can serve as a natural reference condition for sites within a city's coastal resilience plans. Reference conditions may contain natural or designed living shorelines. Hydrological projections will be needed to understand erosion, flooding, sediment transport, wave regime, current velocity and other impacts.

For more details, see the **WEDG® Version 3.0 Manual**, pages 91-92.

Ecologically Enhance Structural Components (WEDG® Credit 3.4)

Description

When safeguarding natural buffers to enhance coastal ecosystems' protective functions, a city should lower the impact and improve the biodiversity of human-made edges by mimicking the structural heterogeneity and materials of the local natural shoreline. If human-made stabilization is needed to support the intended use and context, incorporating complexity and living material into the structures improves the habitat value and reduces the impact of their construction.

Design Strategies

- Use rough, textured, surfaces or varied gradation of rock that create interstitial spaces of varied size and shape, using a material with a pH that fosters attachment or provides refugia for native aquatic organisms. Examples include habitat and reef modules, oyster reefs, form liners, molds, pile casings, and structural enhancements.

For more details, see the **WEDG® Version 3.0 Manual**, pages 95-97.

Before and after photos when ecologically enhanced concrete is deployed. **Credit:** ECOncrete

Site with Ecological Sensitivity (WEDG® Credit 4.1)

Description

When safeguarding natural buffers to enhance coastal ecosystems' protective functions, a city should prevent adverse ecological impacts caused by structures to important habitat areas and increase resilience to effects of climate change.

Design Strategies

- Marine, estuarine, riverine, lacustrine, palustrine and other types of natural habitat buffers can be developed
- Consider how habitat buffers protect existing habitat spaces from human impacts, but over time climate change, river channel migration and water-level changes can shift the location of habitats upland, in a phenomenon known as habitat migration or wetland migration.

For more details, see the **WEDG® Version 3.0 Manual**, pages 99-100.

Create, Restore, or Maintain Habitats and Ecosystem Services (WEDG® Credit 4.2)

Description

When safeguarding natural buffers to enhance coastal ecosystems' protective functions, a city should foster biodiversity and ecosystem services by creating, restoring, or maintaining habitat space.

Design Strategies

- Maintain intact and significant habitats and ecosystem services
- Create or restore habitat

For more details, see the **WEDG® Version 3.0 Manual**, pages 101-104.

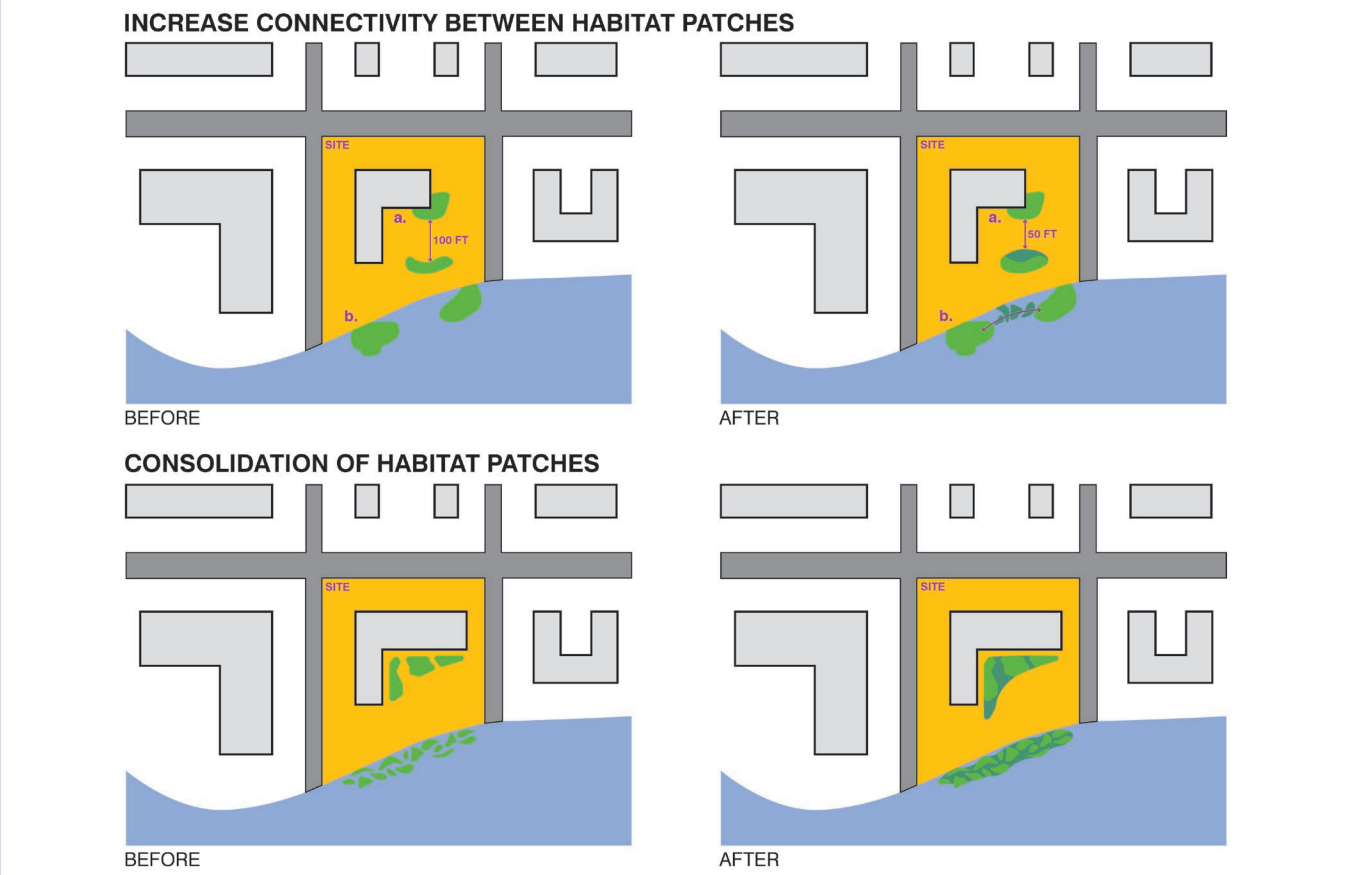
Preserve and Increase Ecosystem Connectivity (WEDG® Credit 4.3)

Description

When safeguarding natural buffers to enhance coastal ecosystems' protective functions, a city should increase the diversity of habitats, restore continuity of ecosystems, and reduce fragmentation.

Design Strategies

- **Habitat patch** (i.e., contiguous naturalized areas) creation and maintenance in both upland and in-water settings



For more details, see the **WEDG® Version 3.0 Manual**, pages 105-106.

Support Native Habitat Complexity and Biodiversity (WEDG® Credit 4.4)

Description

When safeguarding natural buffers to enhance coastal ecosystems' protective functions, a city should support native, rare and biodiverse ecosystems through planting plans and management.

Design Strategies

- Incorporate the use of locally native and habitat-appropriate plants throughout sites, considering those that are supportive of priority habitats for locally, regionally, or nationally important species where feasible.

For more details, see the **WEDG® Version 3.0 Manual**, pages 107-108.

Avoid Human Disturbance to Natural Resources (WEDG® Credit 4.5)

Description

When safeguarding natural buffers to enhance coastal ecosystems' protective functions, a city should avoid disturbance to wildlife due to human activity throughout the life of the project.

Design Strategies

- Avoid Ongoing Disturbance
- Use Sensitive Lighting
- Use Bird-Friendly Building Design

For more details, see the **WEDG® Version 3.0 Manual**, pages 109-110.

Restore and Redevelop industrial and abandoned properties (WEDG® Credit 4.6)

Description

When safeguarding natural buffers to enhance coastal ecosystems' protective functions, a city should reduce contamination to the environment.

Design Strategies

- Use environmental assessment results to determine key coastal areas of contamination for remediation
- Remediation approaches range from conventional (such as engineering controls to limit exposure to contaminated soil and pump-and-treat systems for groundwater contamination) to innovative (such as thermally enhanced soil vapor extraction to in-situ chemical oxidation of groundwater contaminants).

For more details, see the **WEDG® Version 3.0 Manual**, pages 111-112.

Practice Sustainable Fill and Soil Management (WEDG® Credit 4.7)

Description

When safeguarding natural buffers to enhance coastal ecosystems' protective functions, a city should reduce environmental impacts associated with fill use and management.

Design Strategies

- Reuse Materials On-Site
- Beneficial Reuse of Dredged Material
- Use Locally Sourced Fill Material

For more details, see the **WEDG® Version 3.0 Manual**, pages 113-114.

Employ Mitigation Techniques to Reduce Emissions through Carbon Management (WEDG® Credit 4.9)

Description

When safeguarding natural buffers to enhance coastal ecosystems' protective functions, a city should reduce material embodied and operational greenhouse gas (GHG) emissions and remove greenhouse gases through nature-based and/or engineered carbon dioxide removal.

Design Strategies

- Reduce Energy Demand and Increase Efficiency
- Use Materials with Low Life Cycle Carbon
- Incorporate Carbon Sinks and Negative Emissions Design

For more details, see the **WEDG® Version 3.0 Manual**, pages 117-120.

Practice Environmentally Responsible Construction (WEDG® Credit 4.10)

Description

When safeguarding natural buffers to enhance coastal ecosystems' protective functions, a city should reduce the environmental impact of construction practices.

Design Strategies

Create a **construction environmental impact reduction plan** to address various strategic elements:

- Reduce in-water construction time and work within approved timeframe, use modular construction, use energy-efficient machinery, protect water bodies from contaminants, minimize environmental harm
- Consider how to mitigate stormwater runoff

For more details, see the **WEDG® Version 3.0 Manual**, pages 121-122.

Reduce Water Use (WEDG® Credit 4.11)

Description

When safeguarding natural buffers to enhance coastal ecosystems' protective functions, a city should reduce impact on freshwater resources as well as load to municipal systems and potential for combined sewer outflows.

Design Strategies

- Reduce Outdoor Water Use
- Treat Sewage Using Green Infrastructure
- Reduce Indoor Water Use

For more details, see the **WEDG® Version 3.0 Manual**, pages 123-124.

ESSENTIAL 6: STRENGTHEN INSTITUTIONAL CAPACITY FOR RESILIENCE

The E6 chapter focuses on the **Prevention Period** and primarily addresses two key elements of institutional capacity for **coastal disaster risk reduction** – the availability of skills and the sharing of data on mitigation status, current status and **resilience plans** (see E2 for more information on data sharing). Institutional capacity refers to a key stakeholder's ability to support the city across the five key **disaster risk reduction** areas: understanding, prevention, mitigation, response and recovery. Understanding and mitigation are layered into onto the three previously discussed periods of **coastal disaster risk reduction**. Cities need to be certain that the institutions that support them have the people, resources and capabilities that they need to provide the necessary engagement, advice and technical inputs and outputs to **coastal disaster risk reduction** to enhance **coastal resilience**.

For Essential #6, the following WEDG® V3.0 credits can provide additional guidance and illustrative practices from application to an individual waterfront project:

- **WEDG® Credit 0.4 (Create a Maintenance and Adaptive Management Plan)**
- **WEDG® Credit 4.12 (Engage a Partner to Study or Monitor the Site)**

***** See the final section of Essential 6 chapter for WEDG® credit description and design strategies (highlights) applicable to coastal resilience planning and implementation.

<table>
<tr><th>#</th><th>Question</th><th>Guidance</th></tr>
<tr><td>6.1</td><td colspan="2">Skill Availability</td></tr>
<tr><td>6.1.1</td><td>To what extent does the city have access to the types of skills in the quantity and quality needed to reduce coastal disaster risk and enhance coastal resilience?</td><td>For effective coastal resilience efforts in cities, specific competencies and skills are vital, especially in the context of coastal cities where hazards and risks can be unique and heightened. For example, emergency preparedness and response skills are needed in developing and implementing emergency response plans, including evacuation procedures, first aid, search and rescue operations, and basic disaster medical support.

Skills that a city may need to reduce its coastal disaster risk include, but are not limited to the following table:

<table>
<tr><th>Skill Area</th><th>Expertise</th></tr>
<tr><td>Natural Hazards and Environment</td><td>• Geological and geotechnical
• Oceanographic
• Climate
• Meteorology</td></tr>
</table>
</td></tr>
</table>

#	Question	Guidance		
			• Landscape ecology, biology, botany - especially relating to regenerative techniques • Arboriculture, forestry and landscaping • Climate adaptation	
		Design, Construction, Planning and Engineering	• Civil, mechanical and electrical engineering • Seashore protection and restoration - green/blue and grey infrastructure engineering • City planning, design and layout • Disaster (flood, wind) resistant construction techniques • Building and construction (residential, commercial – new build, mitigation retrofits, etc) • Infrastructure design and operation (roads, energy, water, sanitation and others) • Building code interpretation and analysis	
		Risk and Insurance	• Risk analysis, assessment (property, area-wide) and modeling - hazards, exposures and vulnerabilities • Insurance markets and buying • Risk communication	
		Finance	• Economics and investment appraisal • Valuation of ecosystem services • Budgeting and financial management/accounting • Payment management • Grant applications	
		Health	• Medicine • First aid • Public health and epidemiology • Mental health - stress management and psychological first-aid	
		Emergency Response	• Emergency management • First responders - police, fire etc. • Logistics • Property damage assessments • Event response • Traffic management • Area recovery	
		Governance and Program Management	• Governance and organization structure • Planning, program and project construction and management	

<table>
<tr><th>#</th><th>Question</th><th>Guidance</th></tr>
<tr><td></td><td></td><td>
<table>
<tr><td></td><td>• Lobbying</td></tr>
<tr><td>City Engagement</td><td>• Local history and cultural history
• City engagement, leadership development and activism
• Languages spoken in the area
• Communications and social media
• Expertise in local industries (e.g., farming and livestock)
• City Emergency Response Teams (CERT) or equivalent</td></tr>
<tr><td>General</td><td>• Data science and analysis
• Communication skills
• Problem-solving and critical thinking
• Collaboration and networking
• Training and capacity building</td></tr>
</table>

Few, if any, cities will have all these skills available immediately. Potential sources for them may include:
• Universities and technical colleges
• Government agencies
• Non-governmental organizations (NGOs), Non-profits
• Consultancies
• Volunteers
• Partnering and sharing with neighboring cities
• Local employers

Validation
• Proof of a full skills needs assessment for coastal resilience purposes
• % of coastal resilience skills needs known to be met</td></tr>
<tr><td>6.2</td><td colspan="2">Data, Analytics and Technological Resources</td></tr>
<tr><td>6.2.1</td><td>To what extent does the city have access to the data it needs to reduce its coastal disaster risk profile – including understanding, hazard, exposure, vulnerability, and mitigation capabilities, etc.?

(See also E1 for political and organizational constraints on sharing data)</td><td>In addition to data on current and future hazards, exposure and vulnerability (see E2), cities' data needs for coastal disaster risk reduction will be extensive. For example, data needs may include:

• Future development plans and approvals (see E1 and E4)
• Budgets and financial sources (see E3)
• Status of code compliance (see E4) and property scale mitigation – hardening (see E6)
• Status of landscape-scale mitigation (see E5)
• Skills levels (this Essential)
• City demographics (see E7)
• Status of city engagement efforts (see E7)
• Geodatabases of those needing extra help to evacuate (see E7 and E9)</td></tr>
</table>

#	Question	Guidance
		• Capacities and capabilities of utility response mechanisms (e.g., backup provisions, service restoration capabilities, etc. – see E8) • Identification, location and ownership of/responsibility for critical assets (infrastructure and other) and dependencies between these (see E8) • Status of those assets (see E8) • Capacities and capabilities of the local health system (see E8 and E9) • Emergency communication and public alerting systems (e.g., methods, devices, coverage data, functionalities, etc.) (see E9) • Capacities and capabilities of first responders and law & order (see E9) • Names, geo-codes/locations and capacities of emergency accommodation (see E9) • Contact and contract details for all those likely to be involved in post-event response (see E10) Data needs to be of sufficient resolution (for example, bathymetric data for predictive models) to enable useful and specific conclusions to be drawn. In particular, Geographic Information System (GIS) software helps cities assess changing **coastal disaster risk profiles** by mapping flood risk from sea level rise, tidal energy changes, and storm surge and their intersectionality with the built environment. It combines elevation, land use, and water data to model impact zones and guide evaluation (e.g., adaptation pricing). Cities need to create an inventory of their data needs, data sources, and owners to meet these needs and agreements on what shall be shared with whom, keeping in mind that some of it may be publicly available on an open-sourced basis. Despite it being open-source, it may still require the build-out of platforms to make it accessible to all key **coastal resilience** stakeholders. **Validation** • Evidence of inventory of information needs, data availability and permitted uses for it • Absence of unmet data needs in **coastal disaster risk reduction** and **coastal resilience** • Some public data sources are included in the footnote below[7]
6.2.2	To what extent is the data that the city requires complete, accurate, current and in a useable and shareable format for **coastal disaster risk reduction** and **coastal resilience**?	Saying that the data is available is one thing - the ability to actually use it may be quite another, due to issues with quality and completeness, or with the compatibility of its format with what the city already has. As well as ascertaining data availability, cities should evaluate the quality and useability of that data, if necessary with assistance from data professionals or analysts from local educational institutions. **Validation** • Inventory of **coastal disaster risk reduction** and **coastal resilience** data needs (see above) is graded for quality and usability • Absence of data quality issues with in-use dat sets for **coastal resilience** purposes

[7] World Meteorological Organization (WMO) Climate Data; NOAA National Centers for Coastal Ocean Science (NCCOS); World Bank Climate Change Knowledge Portal

#	Question	Guidance
6.3	**Collaboration to Pool Experience and Resources**	
6.3.1	To what extent is there sufficient expert participation to drive well-informed collaboration on **coastal disaster risk reduction** and **coastal resilience**?	Stakeholders working on **coastal disaster risk reduction** need access to subject matter expertise in areas such as engineering, climate science, emergency management, environmental planning, capital planning, asset management and city resilience. If direct access is limited, they should utilize resources from research institutions, government agencies, industry reports, and international frameworks. Coastal Sustainability and Resilience plans need to be integrated with operational plans. Cities need to take steps to access the expertise they need to deal with the multiple dimensions of **coastal disaster risk reduction** – hazard, vulnerability, and exposure. **Validation** • Diversity of expertise present, covering key disciplines relevant to **coastal disaster risk reduction** and **coastal resilience** • % of meetings with expert attendance and participation • Use of external resources, such as government reports, academic research, or industry guidelines, when direct expert participation is not available • Peer city participation in the development of plans and actions

Create a Maintenance and Adaptive Management Plan (WEDG® Credit 0.4)

Description

When strengthening institutional capacity for coastal resilience, a city should ensure the maintenance, ongoing performance, and adaptive management of plans directly integrate climate resilience, ecological health, and city accessibility.

Design Strategies

- Establish a **combined maintenance and adaptive management plan** specific to a city's needs that**:**
    - Includes operations and maintenance life cycle considerations for critical coastal infrastructure
    - Identifies responsible parties for undertaking operational tasks, maintenance tasks and ongoing monitoring
    - Plans to monitor performance and associated intervals, including applying monitoring protocols and key performance indicators (KPIs)
    - As applicable, sources long-term funding to secure monitoring and adaptive management capabilities

For more details, see the **WEDG® Version 3.0 Manual**, pages 28-31.

Engage a Partner to Study or Monitor the Site (WEDG® Credit 4.12)

Description

When strengthening institutional capacity for coastal resilience, a city should expand capacity for tracking, monitoring, and evaluating coastal and waterfront areas and contribute to a broader body of knowledge about coastal and waterfront issues and best practices.

Design Strategies

- Academic or Research Institution Partnerships
- Citizen Science Organizations
- Non-profit Organizations
- Other Entities such as for-profit companies that supply or install shoreline enhancement products such as ecologically beneficial materials, may have an interest in monitoring the success of these products in the environment overtime.

For more details, see the **WEDG® Version 3.0 Manual**, pages 125-126.

ESSENTIAL 7: UNDERSTAND AND STRENGTHEN SOCIETAL CAPACITY FOR RESILIENCE

The E7 chapter focuses on the **Prevention Period** and primarily addresses the city's civic and social engagement and the ongoing effectiveness thereof[8].

For Essential #7, the following WEDG® V3.0 credits can provide additional guidance and illustrative practices from application to an individual waterfront project:

- **WEDG® Credit 2.1 (Provide Quality Public Access Areas on the Waterfront)**
- **WEDG® Credit 2.2 (Design Sites to Improve Visual and Other Sensory Connections to the Water)**
- **WEDG® Credit 2.4 (Reduce Industrial Impacts to Human Health and Wellbeing)**

***** See the final section of Essential 7 chapter for WEDG® credit description and design strategies (highlights) applicable to coastal resilience planning and implementation.

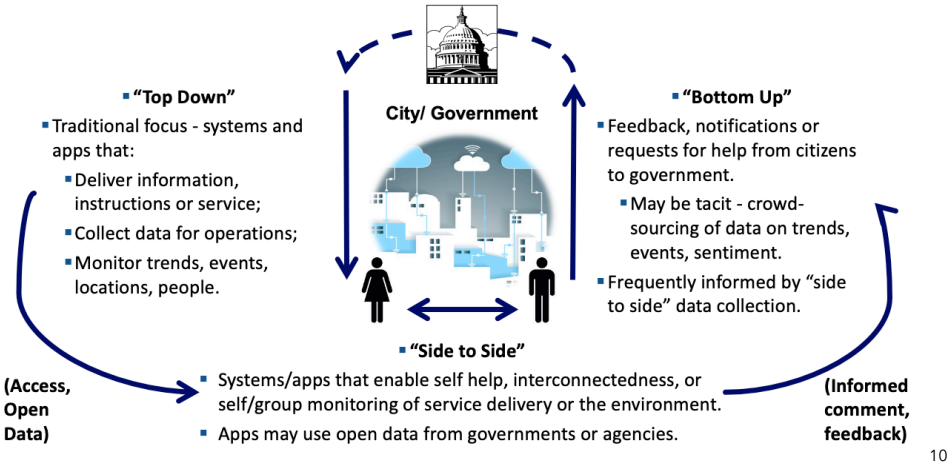
#	Question	Guidance
7.1	**City-level Engagement with Key Stakeholders**	

7.1.1	To what extent is the city's **coastal disaster risk reduction** and **coastal resilience** planning connected and cohesive with a multi-stakeholder, collective action mentality? Is cross-city cohesion developed and maintained?	City connectedness refers to the propensity of a city's population to interact with one another in multiple contexts (such as markets, church, sports, etc.) and assist each other in times of disaster or stress. Connectedness is known to be crucial to any form of resilience, including coastal; the problem is that it can be difficult to measure and assess. The metrics below are proxies for connectedness that may be helpful.
		• Evidence of mutual help from prior emergencies, or in working on **coastal disaster risk** currently - is there city or neighborhood planning or just self-preservation? Examples:
		  ○ Neighborhood buddy plans
		  ○ Friends or relatives that each family could call upon for shelter in the event of evacuation
		  ○ Tradition of extended families caring for their members, or cities of care
		  ○ Collaboration on mitigation planning, implementation and measurement
		  ○ Frequency and level of attendance at meetings
		• High levels of volunteering
		• Active civic organizations such as Rotary, Kiwanis, etc.
		• Frequency of, and levels of participation in neighborhood events generally
		• Evidence that the above spans different minority groups, where applicable
		  ○ Individuals or groups choosing not to participate

[8] Chapter 3 of **ARISE-US Action Guide** addresses city engagement

#	Question	Guidance
		○ High resident turnover ○ Crime and violence (within families and/or the city) ○ Poverty and food insecurity ○ High score on CDC/ADSR Social Vulnerability Index, or in the Social Vulnerability component of the FEMA National Risk Index[9] ○ High incidence of mental health issues ○ High incidence of physical health issues ○ Specific obstacles to engagement – language barriers, lack of meeting places, family role structures etc. ○ Absence of evidence that any of the above worsened after a previous disaster When assessing connectedness, consider block, neighborhood and city scales. Individuals' willingness and ability to mitigate **coastal hazard** risk is addressed below. Cities need to attempt to understand their level of connectedness either using the metrics above, or others. **Validation** • Proof of assessments or evidence of city connectedness analysis • Past evidence of mutual self-help/collective action efforts within the city for **coastal resilience** purposes
7.1.2	To what extent has the city (i.e. the entire population of the area in question) been informed about its **coastal disaster risk profile**? Fully engaged? (City Information – see E6)	City engagement will be through organizations working directly on **coastal disaster risk** and resilience issues, but also organizations serving other purposes that may also serve as "channels" – homeowners associations (HOAs), churches, Kiwanis, Rotary Clubs, 4H, sports teams, etc. who may simply pass on messages, or weave awareness, mitigation and response into their activities. Engagement encompasses all three dimensions shown in the model below – enabling "top-down" dissemination of information and policies from government to citizens; enabling "side-to-side" (neighbor to neighbor, group to group) collaboration and information sharing; and enabling "bottom-up" communication and feedback back to government.

[9] Available from: https://www.fema.gov/flood-maps/products-tools/national-risk-index. This index operates down to the census tract level.

#	Question	Guidance
		 10 Engagement needs to not only be about emergency response actions or flood-proofing, but about all aspects of **coastal disaster risk reduction** - risk data, expectations of what government can actually do and what individuals or families, or businesses, need to do. Engagement can be amplified through collaboration with the education system and employers – see below. Cities need to maximize the engagement of their residents on the dimensions just described. **Validation** • Evidence of at least one organization in each neighborhood working directly on **coastal resilience** issues actively and effectively, both as part of governance (see E1) and in their own "patches" • Use of city organizations (churches, homeowner associations, city centers, Kiwanis, Rotary Clubs, sports teams, etc.) as communications channels to/from local residents. (Also schools and employers – see below) • Evidence of public awareness of - and trust in - emergency communication systems and actionable signals (e.g., sirens, SMS, radio) • Materials/media (see below) in all first languages in the city are available and being used • Evidence of issue-specific communications and discussion • Evidence of effective coordination and leadership from among the many organizations – absence of conflicts, duplication, gaps etc. and clarity as to which org is doing what

[10] **Visual Author:** Dr. Peter Williams, ARISE US

#	Question	Guidance
7.2	**City-level Engagement with Education & Academia**	
7.2.1	To what extent do local schools participate in city **coastal disaster risk reduction** and **coastal resilience** efforts, using students to educate and motivate parents?	Some schools today have instruction on natural hazards (hurricanes, tsunamis, wildfires, earthquakes) and personal responses to these. This can be expanded to include **coastal disaster risk**: for example, the dangers of driving through flood water, storm surge dangers, and other climate-related risks. For older students it could then include consideration of the factors that drive flooding or landslides, potential responses in individual homes, neighborhoods and in the landscape, as well as dividends or side benefits (See E3) from flood mitigation, social engagement, and other factors. These themes can be woven into civics, science, sociology, economics, business studies and other classes, as well as into volunteer activities such as canvassing or preparation of materials. Schools may want to partner with non-governmental organizations (NGOs). Cities need to engage with their education providers - schools, city colleges - and in turn utilize them as a means of engagement. **Validation** • Evidence of **coastal disaster risk reduction** material in curricula • Evidence of school and city-college volunteer activity
7.3	**City-level Engagement with Business**	
7.3.1	To what extent do local businesses, large and small, identify **coastal disaster risks** as an area that needs to be engaged with?[11]	Sadly, it is all too common for businesses to take the view that natural disasters are "someone else's problem", despite the obvious risks of disruption, loss of income, loss of premises, loss of supplies and equipment, and loss of workforce – and despite the often-obvious fact that local governments cannot mitigate the issue away, and cannot deal with it alone. Securing business engagement is therefore critical. Cities need to engage with businesses (and also other large employers such as military bases) directly. **Validation** • % of local businesses engaged meaningfully in **coastal disaster risk reduction** and preparation for their own activities and assets and/or in the city • % of national companies in the local area engaged meaningfully, as above
7.4	**City-level Engagement with Landlords & Landowners**	
7.4.1	To what extent have local landlords and landowners been engaged as	Landlords (whether residential or business) and landowners have a responsibility to help their tenants understand and engage with **coastal disaster risk reduction** and emergency response. This is aside from their self-interest in doing so.

[11] ARISE-US publishes a separate scorecard to assess the effectiveness with which SMEs have been engaged on disaster risk reduction efforts. Available from: https://www.preventionweb.net/publication/sme-scorecard

#	Question	Guidance
	part of the city's outreach process in **coastal disaster risk reduction**?	Many businesses that rent their space may not have engaged with landlords to assess property risk, and landlords may resist changes to that pattern, needing persuasion. Companies that own large numbers of properties can be shown that they have insurance coverage gaps that need to be addressed for responsible risk management. Small landlords can collaborate with tenants on **coastal disaster risk reduction** opportunities. Cities need to encourage landlords to assist their tenants to engage with **coastal disaster risk reduction** and emergency response. **Validation** • % of rental properties and business and domestic tenants fully prepared for **coastal disaster risk reduction**

Provide Quality Public Access Areas on the Waterfront (WEDG® Credit 2.1)

Description

When understanding and strengthening societal capacity for coastal resilience, a city should create or improve high quality public access areas on the waterfront that maximize interaction with the water – and are shaped by city priorities – to promote equitable, engaging and healthy waterfronts. Waterfronts are often flagship sites in a city – they are desirable places to develop and provide public space; are critical to foster environmental stewardship, programming, and education; and are an essential source of city identity; and the only places where water-dependent activities like fishing and boating can take place.

Design Strategies

- Design to increase accessibility
- Design for a variety of sensory types
- Design to improve health and wellbeing

For more details, see the **WEDG® Version 3.0 Manual**, pages 59-63.

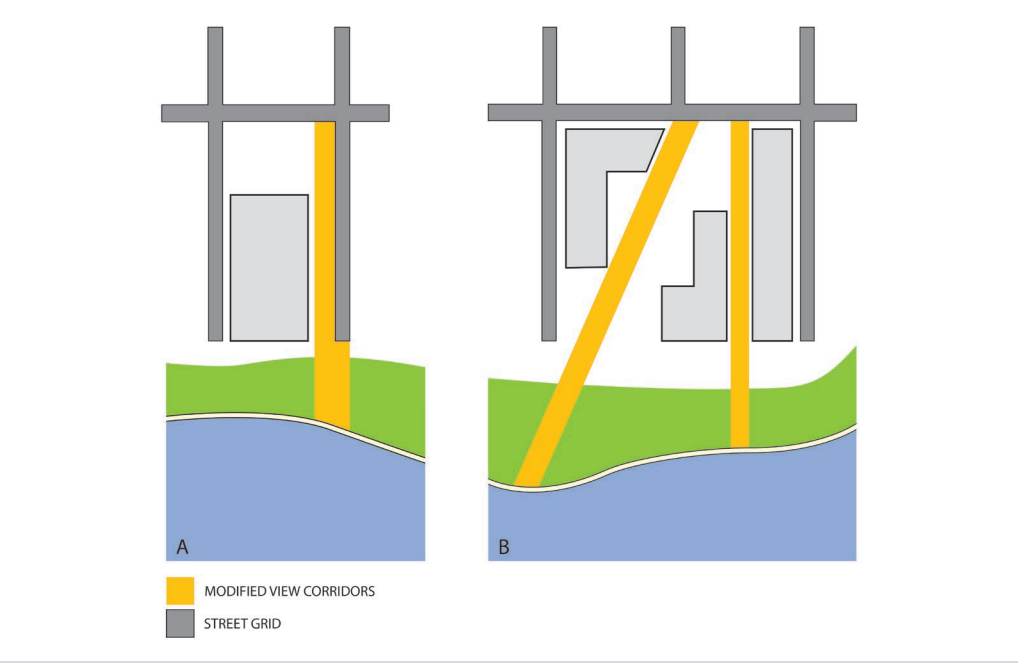
Design Sites to Improve Visual and Other Sensory Connections to the Water (WEDG® Credit 2.2)

Description

When understanding and strengthening societal capacity for coastal resilience, a city should enhance and maximize visual connections to the water from upland areas to create a welcome and inviting environment. Visual corridors provide unobstructed views from upland streets to the waterfront and help enhance city connections to the water. View corridors also promote sensory connections to water, such as the ability to see, touch, or hear water, which can improve physical and mental health.

Design Strategies

- Site and orient buildings; extend views to the water; balance publicly accessible space and view corridors; design to incorporate a range of elevations from which people can view the waterfront; create unimpeded views over landscapes, especially of natural features such as mountains or wetlands; balance expansive views and more enclosed places of refuge through taller, vertical elements; create temporal connections to views and lighting at different times of day.



In addition to alignment with the **street grid** as shown above, **view corridors** can be expanded or enhanced to provide more direct visual connections with the water. For more details, see the **WEDG® Version 3.0 Manual**, pages 64-65.

Reduce Industrial Impacts to Human Health and Welfare (WEDG® Credit 2.4)

Description

When understanding and strengthening societal capacity for coastal resilience, a city should minimize the adverse impacts of industrial operations to the surrounding city. Industrial activities on waterfront sites are often accompanied by dust, airborne debris, pollution, and odor due to engine exhaust, fumes, on-site activities, and wind carrying fine material particles. Industrial infrastructure might also obstruct views and connections to the waterfront. Additionally, operations may produce noise levels that can negatively affect nearby sensitive sites like resides and public areas.

Design Strategies

- Suppress dust and odor by relocating their sources away from sensitive sites; dampen intrusive noises by relocating their sources away from sensitive sites, incorporate visual barriers to on-site and off-site industrial operations; provide wayfinding signage for visitors; use landscaping such as berms, vegetated screens, or shade trees; update fleets to electric vehicles to reduce exhaust emissions.

For more details, see the **WEDG® Version 3.0 Manual**, page 68.

ESSENTIAL 8: INCREASE INFRASTRUCTURE RESILIENCE

The E8 chapter is the last to focus on the **Prevention Period** and primarily addresses the **coastal resilience** of key physical infrastructure systems, both those owned by the city itself and those owned by third parties such as utilities (i.e., energy, water) or life science/healthcare companies. Categories of questions are not presented in a particular sequential order from a disaster perspective.

For Essential #8, the following WEDG® V3.0 credits can provide additional guidance and illustrative practices from application to an individual waterfront project:

- **WEDG® Credit 1.1 Avoid or Reduce Risk from the Waterbody –** See E2
- **WEDG® Credit 3.3 (Protect the Working Edge)**
- **WEDG® Credit 4.8 (Use Renewable and Resilient Energy Sources)**

***** See the final section of Essential 8 chapter for WEDG® credit description and design strategies (highlights) applicable to coastal resilience planning and implementation.

#	Question	Guidance
8.1	**Infrastructure – First Response**	
8.1.1	Given the two incident types ("most probable" incident & "most severe" incident in E2), to what extent are critical infrastructure assets at risk of loss or damage in the event of an **acute coastal disaster**?	Critical infrastructure assets including emergency response stations, maintenance facilities, communications facilities, healthcare facilities, water storage facilities, and equipment storage, is essential for responding to **coastal hazards** but may be vulnerable to damage or loss. **Coastal hazards** can compromise access, damage facilities, and disrupt communications. For example, flooding may block access roads or inundate facilities, hindering response efforts. Cities must assess the vulnerability of critical infrastructure to ensure its continuous operation during **coastal disaster events**. Where vulnerabilities are identified, cities should develop adaptation strategies, such as elevating facilities, securing backup power supplies, creating water storage facilities, or lobbying facility owners (e.g., other response organizations) to implement improvements. Improvements can be permanent or temporary. For example, cities could use portable flood walls to prevent storm surge from reaching critical infrastructure and remove them when the threat passes. **Validation** • Evidence of a documented risk and resilience assessment (extent and duration of vulnerability) of critical infrastructure facilities to loss, damage or loss of service, using the same **coastal disaster scenarios** as those referenced in Essential 2, and implemented plans for reducing or managing risk to these facilities • External review by a risk management or engineering specialist confirms reduced vulnerability.

#	Question	Guidance
8.2	**Infrastructure - Communications**	

8.2.1	To what extent are the communications systems at risk of loss or damage in the event of an **acute coastal disaster**?	The vulnerability of communication systems (cellphone, internet, landlines where still used) to loss of service is a critical issue because emergency response systems, most or all other city infrastructure systems, and many economic and social systems are likely to rely upon them. Given the **coastal disaster scenarios** in Essential 2:
		
		• Which critical communications assets (cellphone towers, above-ground trunk cables, etc.) are in areas of high **coastal disaster risk** and have not been hardened against wind and flood vulnerability?
		• What areas and population segments in the city are vulnerable to loss of service from each?
		• What is the potential duration of service loss, given likely time to restore?
		• What is the potential for service to be overwhelmed/swamped by users and what recovery actions can be taken?"
		• What alternative or back-up modes of service exist (see below)?
		
		In the case of assessing risk of communication system failure, it is essential to include audible warning systems. In the event of a mobile network or internet outage, these systems often remain the last operational channel to warn the public. We recommend that cities evaluate how communication is ensured between the control center and individual sirens and assess how vulnerable this communication is in the event of disruption to mobile or internet networks. In many cases, sirens rely on GSM/LTE or IP-based communication, which may be compromised during **coastal disaster events**.
		
		Cities need to understand the potential of loss of communications service, including links to warning and alert systems, in the event of a **coastal disaster**, and they need to work with external communications companies (where applicable) to minimize potential service loss. One possibility might be to negotiate an emergency contract with Starlink, or comparable system, to provide first responders with communications for emergency response.
		
		Validation
		• Presence of a documented risk analysis (extent and duration of vulnerability) of communications systems to loss of service, using the same **coastal disaster scenarios** as those referenced in Essential 2, and implemented plans for reducing or managing risk to these facilities
		• Access to backup systems such as Starlink
		• External review by a risk management or engineering specialist confirms reduced vulnerability
		• Evidence of a technical audit of the siren communication infrastructure, with particular attention to:
		  ○ Whether redundant channels are in place (e.g., radio + GSM)
		  ○ Whether sirens can be remotely triggered during service disruption, and
		  ○ Whether local or manual activation is available as a backup

#	Question	Guidance
8.3	**Infrastructure – Energy**	
8.3.1	To what extent are the city's electricity supply systems at risk of loss or damage in the event of an **acute coastal disaster**?	The vulnerability of electricity systems to loss of service is a critical issue due to the high level of dependency upon them. Given the **coastal disaster scenarios** in Essential 2: • Which critical electricity assets (towers, substations, above-ground cables, local solar or wind generation, local energy storage etc.) are in areas of high **coastal disaster risk** (or high post-event landslide or flash flood risk) and have not been hardened? • What areas and population segments in the city are vulnerable to loss of service from each? • What is the potential duration of service loss, given the likely time to restore? • What alternative or back-up modes of service exist (see below)? Cities need to understand the risk of loss of electricity service in the event of a **coastal disaster** - both duration and extent - which may vary in different parts of their area, and they need to lobby external electricity companies (where applicable) to minimize vulnerability to service loss. There also must be greater transparency regarding the interconnections between critical infrastructure assets, such as how electricity supply disruptions can impact water treatment facilities, hospitals, etc. **Validation** • Evidence of a documented risk and resilience assessment (extent and duration of vulnerability) of electrical systems to loss of service and understanding of interdependencies between critical assets, using the same **coastal disaster scenarios** as those referenced in Essential 2, and implemented plans for reducing or managing risk to these facilities • External review by a risk management or engineering specialist confirms reduced vulnerability
8.4	**Infrastructure - Water**	
8.4.1	To what extent are the city's water supply systems at risk of loss or damage in the event of an **acute coastal disaster**?	The vulnerability of water systems to loss of service is a critical issue because of the level of dependency upon them. Water resources may be contaminated by sediment runoff or from leaks prompted by infrastructure failure, physical assets may be liable to flood or landslide damage, and water systems can be contaminated. Some cities, or at least some properties within the city, may use wells as their primary water supplies which, by virtue of being distributed, may be more resilient than centralized systems. Given the **coastal disaster scenarios** in Essential 2: • Which critical water supply assets (water resources, pipes, pumping and treatment plants, etc.) are in areas of high **coastal disaster risk** (or high post-landslide or flash flood risk) and have not been hardened? • What areas and population segments in the city are vulnerable to loss of service from each? • What is the potential duration of service loss, given likely time to restore?

#	Question	Guidance
		• Can the supply system be segmented (for example into pressure zones or district metered areas) in such a way as to isolate **coastal disaster risk** damage? • What alternative or back-up modes of service exist (see below)? Cities need to understand the risk of water supply service loss in **coastal disaster events** – both duration and extent. This understanding will enable them to lobby external gas companies (where applicable) to minimize vulnerability to service loss. **Validation** • Evidence of a documented risk and resilience assessment (extent and duration of vulnerability) of water systems to loss of service, using the same **coastal disaster scenarios** as those referenced in Essential 2, and implemented plans for reducing or managing risk to these facilities • External review by a risk management or engineering specialist confirms reduced vulnerability
8.5	**Infrastructure – Roads & Transportation**	
8.5.1	To what extent is the city's road system at risk of loss or damage in the event of an **acute coastal disaster**?	The vulnerability of the city's road network to damage or loss of access from a **coastal disaster** is a critical issue, both for evacuation and post-event recovery. Damage may come from floodwater, debris such as downed power lines or trees, or post-event landslides. Loss of access may also result from wind activity, flood overflow, or other forms of debris. Given the risk scenarios in Essential 2: • What is the vulnerability of the road system? • Are there potential choke points where, for example, parts or all of the city are only accessed by a single road that may be vulnerable to blockage in the event of a **coastal hazard**? Examples include areas at risk of flooding, landslides, or where there might be a narrow bridge that will hold up traffic and impede evacuation (see also Essential 9). • Where there are alternative routes, can these handle expected volumes of traffic when the main route is out of action? Cities need to understand the vulnerability of their road networks to damage or loss of access in the event of a **coastal disaster**, keeping in mind that vulnerable points could be many miles from the city. **Validation** • Evidence of a documented risk and resilience assessment (extent and duration of vulnerability) of the road network to loss of service, using the same **coastal disaster scenarios** as those referenced in Essential 2, and implemented plans for reducing or managing risk to these facilities • External review by a risk management or engineering specialist confirms reduced vulnerability
8.6	**Infrastructure – Healthcare & Education**	
8.6.1	To what extent is the city's healthcare infrastructure at risk of loss or damage	The vulnerability of healthcare facilities (for example, hospitals, outpatient/ambulatory care facilities, old-people's homes, assisted living, supply warehouses, ambulance stations) to loss or damage in the event of a **coastal disaster** is clearly critical for both the immediate and longer-term health of the city.

#	Question	Guidance
	in the event of an **acute coastal disaster**?	Temporary loss of service may also be a key issue, for example from the loss of power, water or road access, or breakdown in the supply of key medications. It is vital to consider ambulatory care facilities, which may form the main access point for healthcare in outlying areas. In addition there are, sadly, known instances of assisted living and convalescent facilities where evacuation needs were clearly overlooked during a disaster. Given the **coastal disaster scenarios** in Essential 2, to what extent are healthcare facilities at risk? What backup systems (alternative facilities, power, water, sanitation) are available? What is the risk of access to these facilities being flooded? Cities need to understand the vulnerability of healthcare facilities and the people in them in the event of a **coastal disaster** and they need to lobby external health companies (where applicable) to minimize that vulnerability. **Validation** • Evidence of a documented risk and resilience assessment (extent and duration of vulnerability) of healthcare facilities to loss, damage or loss of service, using the same **coastal disaster scenarios** as those referenced in Essential 2, and implemented plans for reducing or managing risk to these facilities • External review by a risk management or engineering specialist confirms reduced vulnerability • Presence of backup generators for health care systems
8.7	**Infrastructure – Administrative**	
8.7.1	To what extent is the city's administrative infrastructure at risk of loss or damage in the event of an **acute coastal disaster**? (See also E3 for role of insurance if applicable to your region)	The vulnerability of the city's administrative infrastructure (offices, supply warehouses, depots, etc.) for the applicable tiers of government and other agencies to loss, damage or loss of access may be critical for emergency response and will be crucial for post-event recovery. This definition would also include post offices, welfare offices, DMVs and the like. Loss of access would also include loss of communication access (phones, internet, etc.) Cities need to understand the vulnerability of administrative infrastructure in the event of a **coastal disaster** and lobby owning agencies/departments to minimize that vulnerability. **Validation** • Evidence of a documented risk and resilience assessment (extent and duration of vulnerability) of administration facilities to loss, damage or loss of service, using the same **coastal disaster scenarios** as those referenced in Essential 2, and implemented plans for reducing or managing risk to these facilities • External review by a risk management or engineering specialist confirms reduced vulnerability

#	Question	Guidance
8.8	**Infrastructure – Cascading and Multi-System Failures**	
8.8.1	To what extent does the city understand the location of its critical assets and the interconnections between them, in the event of an **acute coastal disaster**?	Few cities have a comprehensive list of their critical assets or understand how they are interrelated, particularly in the context of **coastal hazards**. Some cities may know their major assets but not the full set and not the interconnections; others, may know all their assets, but again, not the interconnections; and still others may have data on all assets and interconnections but it has not been updated recently. Weaknesses in understanding critical interconnections can lead to cascading failures. Coastal cities must recognize the interconnectedness of critical infrastructure, such as power grids, water and sanitation, roads and traffic signals, and prepare for such cascading failure scenarios. Cities need to have an inventory of their critical assets (including those owned by other entities) that details what other "'upstream" assets each asset depends on, and in turn what "downstream" assets depend on it. Critical gaps often arise because private sector entities are reluctant to share information about their assets; this lack of collaboration needs to change to improve resilience planning. **Validation** • Evidence of a complete and up-to-date critical asset inventory for all major asset systems (those listed under this Essential) with links between them identified • Evidence of planning to deal with cascading "failure chains" known to exist

Protect the Working Edge (WEDG® Credit 3.3)

Description

When increasing infrastructure resilience in a coastal setting, a city should protect the working edge from structural damage over time due to active use and reduce the overall working edge of sites, where feasible. Working docks require adequate fendering to protect them from wear and tear over time, and particularly during storms and other high-water events.

Design Strategies

- Employ appropriate fendering strategies into the final design and consider bolstered mooring and fendering strategies to keep vessels attached with little damage during storm events, flood events, and inclement weather
- Design with low- and high-water levels in mind due to climate-induced variability
- Consider opportunities for ecological enhancements of fendering structures, such as material encasements of structural elements.
- Develop the working edge of sites with marine habitats and ecology in mind

For more details, see the **WEDG® Version 3.0 Manual**, page 93-94.

Use Renewable and Resilient Energy Sources (WEDG® Credit 4.8)

Description

When increasing infrastructure resilience in a coastal setting, a city should generate resilient and renewable energy including off-the-grid energy infrastructure for outdoor site features and auxiliary structures where feasible.

Design Strategies

- Increasing the use of renewable energy such as wind, solar, tidal or wave (hydropower), biomass or biogas, or geothermal reduces the carbon footprint of development. Generation is one concern, but distribution can be fatal flaw. Renewable energy systems are more useful if there is electricity storage capabilities; (batteries).
- For maritime operations, provide electric cold ironing which fosters reduced carbon emissions by providing shore-side electrical power to vessels at berth.

For more details, see the **WEDG® Version 3.0 Manual**, page 115-116.

ESSENTIAL 9: ENSURE EFFECTIVE DISASTER RESPONSE

The E9 chapter is the only chapter to focus on the **Response Period** and primarily addresses effectiveness of **coastal disaster** warning and emergency response capabilities.

For Essential #9, the following WEDG® V3.0 credits can provide additional guidance, illustrative practices and design strategies:

- **WEDG® Credit 1.4 (Establish an Emergency Preparedness and Response Plan)**

***** See the final section of Essential 9 chapter for WEDG® credit description and design strategies (highlights) applicable to coastal resilience planning and implementation.

#	Question	Guidance
9.1	**Detection, Alert & Warning Systems**	
9.1.1	To what extent are early warning and alert systems available that provide coverage for the entire population of the city before and during a **coastal disaster**?	Early warning systems for coastal events will vary in their timescales from several days in the case of an approaching hurricane or typhoon, to possibly a few minutes or hours in the case of a tsunami or coastal landslide. They will need to differentiate between hazards - with those differentiations thoroughly understood by the general public - as the appropriate responses may be different (a single undifferentiated siren will probably not suffice). Graduation between levels of urgency may also be needed, for example "advisory" where a hurricane is expected and it would be prudent to prepare; "alert" that evacuation may be soon be required; and "evacuate now". It is important to avoid "false positives" as these will undermine trust in the system. It is also important for neighboring cities or other alarm system operators to coordinate on action thresholds, as inconsistencies between areas will create confusion and undermine effectiveness. Digitally excluded groups (e.g., elderly, children, disabled, homeless) are often missed by mobile alerts, highlighting the need for redundant systems such as audible sirens. Warning systems need to be equipped with alternative communication channels (see below) and back-up power supplies. Improved warnings may enable an improved risk assessment in Essential 2 by allowing better preparation or enabling more people to move out of harm's way (reducing vulnerability). Cities need to ensure that their **coastal hazard** warning and detection systems offer clear, differentiated, coordinated and timely warnings.

#	Question	Guidance
		Validation • 100% of city area covered by timely, high specificity detection systems for event monitoring purposes • Evidence of avoidance in signaling false positives
9.2	**Emergency Response - Planning**	
9.2.1	To what extent are there up-to-date emergency response plans that address the **coastal disaster scenarios** identified in Essential 2?	Emergency response plans need to cover, as a minimum: • Command and control - overall command, coordination with other agencies and cities, roles, responsibilities procedures (see Essential 1) • Evacuations for hospitals, jails, schools (see below), hotels and other places with large numbers of (possibly, vulnerable) occupants • Communication systems and backup systems • Critical asset management (including likely "failure chains" – see Essential 8) • Fire service response • Medical response • Law and order response • All external resources • Public information • Triage policies Plans need to be updated regularly to take account of changing risks and local factors (for example, road closures due to repair work, wind directions, storm surge projections). Cities need to create and maintain effective emergency response plans. **Validation** • Evidence of recently up-to-date emergency response plans for **coastal disaster scenarios**
9.3	**Emergency Response - Implementation**	
9.3.1	To what extent can emergency responders access, from their own resources or via mutual aid, the equipment they need to deal with the **coastal disasters** within the required response time?	Emergency responders need to be able to access the equipment (vehicles, earthmovers, aircraft, pumps, tools, communications, personal safety gear and all associated logistics, etc.) they need to respond, should the risks identified in Essential 2 materialize. These may come from their own resources, neighboring cities (perhaps via mutual aid agreements), other tiers of government, or private sources (perhaps via Memoranda of Understanding). Cities must ensure that responders' equipment needs are met promptly. **Validation** • Equipment needs are identified and availability is known to be adequate for average and worst-case **coastal disaster scenarios** in Essential 2
9.4	**Evacuation Plans, Shelter & Staples**	

#	Question	Guidance
9.4.1	To what extent does the city have viable evacuation plans for all population segments and in all **coastal disaster scenarios**?	Evacuation demands will depend on the event itself, where people are located, the road layout, access to vehicles, the ability to drive, the terrain and so on. They may also depend on the willingness of people to evacuate, even in the face of evident and undeniable personal danger. Cities need evacuation plans that take full account of their circumstances as described above, including assumptions about residents that won't heed even mandatory evacuation warnings. **Validation** • Evidence of credible evacuation plans for all population segments of the city in the event of a **coastal disaster**
9.4.2	To what extent do individuals in the city have a coastal flood response plan that includes evacuation plans?	All city residents need an emergency plan for dealing with **coastal disaster events** that includes: • Gathering family members • Gathering up pets, personal documents and key possessions • Securing houses and apartments, to the extent possible • Evacuation - both the route and destination • Emergency kit, with minimum contents defined by a standard reference list **Validation** • % of households with such a plan, regularly re-measured or re-assessed
9.4.4	To what extent does the city have safe emergency shelter available on a ready, communal basis for those affected by a **coastal disaster event**? (See also E10 for personal or family accommodation needs)	Cities may need to rely on schools, churches, sports centers, malls and the like to provide very short-term communal emergency shelters before people move on to their own emergency accommodation (see Essential 10 - in some cases people and families may be evacuated directly to their own accommodation). Shelters need to take account of the specific needs of men, women, children and the disabled, and to provide for servicing and public order. Shelters may also be locations for the distribution of emergency funds. Third party owners of shelters should be engaged in advance of any hazardous **coastal disaster event** through MOUs or similar. Cities should estimate the likely need for this type of shelter and plan. **Validation** • Evidence of emergency accommodation plan, sized with credible reference to estimated need

Establish an Emergency Preparedness and Response Plan (WEDG® Credit 1.4)

Description

When ensuring effective **coastal disaster response**, a city should protect health and safety of its residents by planning for emergency conditions, which includes effective communications and operations both prior to and following extreme events. Create an emergency preparedness plan for human safety prior to an extreme weather event, particularly considering the most vulnerable cities, such as those with impaired mobility, overburdened cities, or environmental justice cities.

Design Strategies

Establish an **emergency preparedness and response plan** specific to a city's needs that:

- Defines goals for safety and recovery after an extreme event
- Establish an emergency network of on-site team leaders, as well as applicable local, city, state and national entities
- Create an education and outreach strategy about the risks before, during, and after an extreme event
- Establish a pre- and post-emergency communication network between all relevant stakeholders to ensure holistic event response
- Maintain a map of vulnerable assets and hazardous substances within the floodplain and a list of strategies for elevating or securing those assets prior to an event.
- Ensure that critical infrastructure is protected
- Outline "Go-bag" components to be used in an emergency and encourage residents to have their supply kit stocked and available.

For more details, see the **WEDG® Version 3.0 Manual**, pages 54-55.

ESSENTIAL 10: EXPEDITE RECOVERY AND BUILD BACK BETTER

The E10 chapter is the only chapter mainly focused on the **Recovery Period** and primarily addresses the extent to which preparation has been made in advance for the immediate and longer-term aftermath of a **coastal disaster event**.

For Essential #10, the full WEDG® V3.0 manual and its appendices and case studies can provide additional guidance, illustrative practices and design strategies on building waterfront sites bottom-up and connecting networks of assets that can build resilience and perform together during and after **coastal disasters**.

#	Question	Guidance
10.1	**Housing & Emergency Services**	
10.1.1	To what extent have accommodation arrangements been made in advance with hotels and deployable lodgings, etc. for the local population in the immediate recovery period – whether in the local area or in surrounding regions?	One of the observed after-effects of major **coastal disasters** is the scramble for evacuees and displaced people to find accommodation, at reasonable rates, once they leave emergency shelters. This can be addressed through identification in advance of potential accommodation and agreement on nightly rates to prevent gouging. Cities need to identify sources of emergency housing for when residents leave emergency shelters. Emergency housing can also include vessels (i.e., cruise ships). **Validation** • Memoranda of Understanding (MOUs) exist for emergency accommodation at specified nightly rates for evacuees, sized to deal with the worst-case **coastal disaster scenario** in E2 and with all necessary infrastructure • Understanding exists of how far off a dispersal will be needed in any given area based on the order of magnitude of evacuations • If applicable, track record of rapid response to disasters in this geographical/physical area
10.2	**Healthcare Services**	
10.2.1	To what extent has the risk of loss and damage to critical healthcare infrastructure (hospitals, clinics, convalescent facilities, elderly care facilities) been planned for the **recovery period**?	Hospitals, medical centers, outpatient facilities, doctors' offices and pharmacies can be, and have been, damaged or destroyed in **coastal disasters**, resulting in loss of ready access to care and medications, especially in remote areas. Staff living in the area directly affected by the event may not be available – they may be attending to their families or homes, or they may have had to evacuate, just when a surge capacity is needed to deal with additional injuries and the likely increase in hospitalizations from all causes that are known to accompany **coastal disasters**. Cities need to confirm that the plans of service providers include adequate remediation and service delivery capability, including facilities, staff, supplies and medications. **Validation**

#	Question	Guidance
		• Evidence of credible service provider plans and provisions to provide service (may require mutual aid with other providers) in the worst-case **coastal disaster scenario** from E2, and to provide temporary facilities • If applicable – track record of rapid response to disasters in this geographical/physical area
10.3	**Critical Infrastructure**	
10.3.1	To what extent have the requirements to repair communications infrastructure after a **coastal disaster event** been anticipated and planned for? (Temporary backup communications - see E8 and E9)	Especially if above ground, phone, cellphone and internet infrastructure will be at risk of damage from flooding, wind, and perhaps landslides, hindering recovery. Communications staff living in the area directly affected the event may not be available – they may be attending to their families or homes, or they may have had to evacuate. Cities need to confirm that the plans of telecommunications service providers include adequate and timely remediation and service delivery capability. **Validation** • Data on backup generator run time – see E8 • Evidence of credible service provider plans and provisions to remediate damage (may include mutual aid) sized to deal with worst case **coastal disaster scenario** from E2 • If applicable – track record of rapid response to disasters in this geographical/physical area • Presence of backup communications (e.g. satellite) for the city
10.3.2	To what extent have the requirements to repair the power infrastructure after a **coastal disaster** been anticipated and planned for?	Especially if above ground, power infrastructure will be at risk of damage from wind and trees, which can hinder recovery. Wires left dangling into flood water can pose an electrocution hazard. Energy staff living in the area directly affected by the event may not be available – they may be attending to their families or homes, or they may have had to evacuate. Cities need to confirm that the plans of power service providers include adequate remediation and service delivery capability. **Validation** • Presence of credible service provider/utility plans and provisions to remediate damage (may include mutual aid) sized to deal with worst case **coastal disaster scenario** from E2 • If applicable – track record of rapid response to disasters in this geographical/physical area • Presence of backup energy supplies for the city

#	Question	Guidance
10.3.3	To what extent have the requirements to repair the water supply infrastructure after a **coastal disaster** been anticipated and planned for?	Especially if above ground, water infrastructure will be at risk of damage from flooding and other damage, hindering recovery. Additionally, above- or below-ground water supplies and systems may be contaminated, requiring flushing that can take weeks or months. As with water resources (above) there may be a need for backup water resources (tanks, bottles) which can be arranged in advance on as "as required" basis. Cities need to confirm that the plans of water supply companies/agencies include adequate remediation and service delivery capability. **Validation** • Presence of credible service provider/utility plans and provisions to remediate damage to utility infrastructure (may include mutual aid) sized to deal with worst case **coastal disaster scenario** from E2 • Plans identify arrangements for alternative trucked water supplies, via MOUs with suppliers and agreed-upon fees/rates • If applicable – track record of rapid response to disasters in this geographical/physical area • Presence of arrangements for backup water supplies (e.g. portable water, storage tanks) for the city
10.4	**Economic & Financial Recovery**	
10.4.1	To what extent are there comprehensive plans for the recovery period that restarts economic and social activity after a **coastal disaster**?	Experience has shown that post-event planning is one of the most neglected areas of any in the UN DRR City Disaster Resilience Scorecards. Many issues can be foreseen and planned for in advance – those that arise in the immediate aftermath, and those that are part of the longer-term recovery. **Validation** • Evidence of comprehensive plans addressing the issues in this essential at the required scale • If applicable, experience of implementing those plans after a **coastal disaster event**
10.5	**Environmental Damage Remediation**	
10.5.1	To what extent have requirements to repair likely environmental damage been anticipated and planned for	**Coastal disaster** damage to woodland, vegetation, habitats and other natural features or ecosystem services may well arise, for example from septic systems. The possible release of chemical contaminants also needs to be considered along with containment plans. Cities should be able to anticipate some of this damage and plan for remediation or regeneration beforehand.

#	Question	Guidance
	the aftermath of a **coastal disaster event**? (See also E5)	**Validation** • Evidence of consideration for likely environmental damage from worst case **coastal disaster scenario** in E2 and a strategy for remediation (e.g., re-seeding/planting, decontamination) • Remediation should not reintroduce flood or landslide hazard (see Appendix C)
10.6	**Learning Loops**	
10.6.1	To what extent is a process predefined for post-event learning in the aftermath of a **coastal disaster event**?	Responding to any **coastal disaster** will inevitably illuminate things that work well and those that work less well. Assessing this experience can provide valuable learnings for future planning, implementation and event response. Where applicable, cities need to learn from **coastal disaster events** that they experience - what worked, what did not, and what changes need to be made in adaptation and mitigation elements across all ten Essentials. Learning should also apply to future approvals for building and rebuilding (i.e., codes, zoning) to avoid recreating the same vulnerabilities as existed before. **Validation** • Evidence of post-event review process (where applicable) and changes made because of it • If no **coastal disaster** has yet been experienced: demonstration of learning process in post-event planning such as through policy development in building and rebuilding codes and zoning

APPENDIX A: GLOSSARY

TERM	WORKING DEFINITION
Coastal Resilience Partnership	A partnership initiated between ARISE US and Waterfront Alliance, Inc. to build capacity for cities and other non-party stakeholders in coastal resilience.
Coastal Resilience Scorecard	Phase 1 of the partnership's efforts – to create a global identification & assessment tool for coastal disaster risk reduction and coastal resilience to allow cities to self-score readiness levels against universal coastal disaster risks – natural and human-induced.
Coastal Resilience Toolkit	Phase 2 of the partnership's efforts – to create a localized marketplace for buyers and sellers of coastal resilience products and services alongside pilot cities completing the Scorecard.
Coastal Disaster (Event)	A coastal disaster (aka coastal disaster event) is a defined occurrence of natural or human-induced catastrophe or extreme adversity in a pre-specified coastal domain, such as a city, site, or asset location.
Acute Coastal Disaster (or Hazard)	An acute coastal disaster is an event that originates, materializes, and ends with catastrophic impacts in a pre-specified coastal domain. Such events may involve rapid intensification of storms, while others may be catalyzed by other singular hydrological events or a linear/cascading sequence of changing coastal conditions.
Chronic Coastal Stress Condition	As opposed to an acute coastal disaster, a chronic coastal stress condition is one that impacts a pre-specified coastal domain over a longer period of time and involves a degree of incrementality/sequencing. For example, sea level rise is not a singular event but a longer-term, slower-moving change that is challenging coastal physical conditions (i.e., shoreline health indicators).
Natural Coastal Conditions	Coastal conditions are measurements of the health of pre-specified coastal domains at any time – they may include natural environment indicators such as soil and sand structure or average surface water levels, for example.
Coastal Zones	Coastal zones refer to the pre-specified domain immediately interfacing with the sea (or inlets of the sea such as estuaries where tides meet the streams, harbors, and ports). Coastal zones are used as a pre-specified coastal domain in the spatial and temporal analysis of coastal resilience for a city – for example, its baseline condition versus its target state (with resilience features fully invested and ready to activate in a disaster).

Hinterland Coastal Zone	The pre-specified domain situated behind the coastal zone stretching as much as 100 miles (or more) back from the sea itself and reaching into the floodplains/watersheds.
Coastal Setting	For the Scorecard, the coastal zone + the hinterland coastal zone make up a coastal setting given the functional relevance from 'ridge to reef' and in particular the relationship of freshwater systems with marine aquatic environments.
Coastal Resilience	**Note:** Adapted from IPCC definition[vii]. The capacity for interconnected social, economic, and ecological coastal systems to cope with a hazardous event, trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure.
Resilience Dividends	Also known as co-benefits; these refer to the financial and non-financial (i.e., environmental, socio-economic, operational) benefits materialized from investing with purpose into resilient outcomes. The means by which the dividends are funded and executed are essentially boundless.
Climate Change Mitigation	An action-centric strategy in which climate actors invest in removing and avoiding anthropogenic greenhouse gas emissions.
Climate Change Adaptation	An action-centric strategy in which climate actors invest in adapting measures, activities, and assets to climate-induced, dynamic natural hazards and conditions.
Coastal Disaster Risk Reduction	Similar to traditional disaster risk reduction – the understanding, prevention, mitigation, response, and recovery aspects of defending people and the planet against disasters however defined in coastal settings. Coastal disaster risk is broadly defined by the Scorecard to include singular events as well as chronic stresses or conditions.
Prevention Period	The prevention period is the time available before a disaster strikes – most resilience investments can and should be made during this period. For that reason, 8 of the 10 Essentials focus on prevention as the ultimate mitigant of harm.
Response Period	The response period is the time immediately during a disaster – how humans and systems respond to an imminent and existential threat. The key priorities are human health and safety during a disaster or period of prolonged stress.
Recovery Period	The recovery period begins when the coastal disaster or chronic coastal stress condition has subsided – it's typically a time of devastated systems that require prioritization and preventive planning to maximize recovery efforts. Great care should be taken to focus on enablement a speedy, efficient and resilience-building recovery.

Coastal Disaster Scenario	A coastal disaster scenario is a modeled acute event, chronic coastal stress condition, or other harmful coastal condition, which requires a forecasting (look-forward) tool that builds plausible future states that should be evaluated with the best information possible.
Coastal Hazard	A coastal hazard is generally a naturally occurring event with some cases where human activity (i.e., design) is responsible for a vector of harm on a spatial domain such as an asset.
Coastal Exposure	A coastal exposure can refer to people, properties, plants & equipment that are generally stationary in a coastal setting and exposed to a hazard.
Coastal Vulnerability	A coastal vulnerability is the sensitivity or responsiveness of a coastal exposure to a coastal hazard given internal and external factors.
Coastal Disaster Risk Profile	A coastal disaster scenario will yield a baseline coastal disaster risk profile and allow for the setting of target states (i.e., a resilient profile).
Coastal Ecosystem Services	Like ecosystem services, coastal ecosystem services are the values that the natural environment provides to the human-built environment – it can be physical resources, protection, and intangible value such as health and well-being.
Coastal Nature-based Solutions	Also known as nature-based approaches or nature-based methods; when humans restore nature's valuable qualities and quantities or use nature's design in the built environment. Often halting and reversing nature's destruction can be very cost-effective and revenue-accretive even in shorter-term periods.

APPENDIX B: COASTAL DISASTER RISK & RESILIENCE PHYSICAL DETERMINANTS

Coastal Hazards ("What might happen?")

Geohazard

- Coastal Erosion
- Compressible & Expansive Soils
- Earthquake (Shockwave, Landslides)
- Landslide (non-seismic)
- Liquefaction
- Sand Encroachment
- Subsidence & Uplift

Hydrological

Flooding

- Natural Forms of Flooding incl. Coastal Flooding
- Urban Flooding

Marine Aquatic

- Extreme Wave Event (e.g., Tsunami)
- Marine Ecosystem Degradation
- Marine Pollution (non-point source)
- Marine Pollution (point source)
- Sea-level Rise (SLR)
- Secondary Salinity (incl. Saltwater Intrusion damaging freshwater reserves and structural integrity of buildings)

Meteorological

Extreme Weather

- Extreme Coastal Event (Convective, Low-pressure, Wind)
- Extreme Temperature Event (Cold Spell, Marine Heatwave, Ocean Rise via Warming)

Coastal Exposures ("What is in harm's way?")

- **Human** - Health & Safety, Quality of Life & Economic Livelihoods
- **Built Environment** – Housing, Manufacturing/Warehousing, Workplaces, Life Sciences, Commerce, Education, Tourism & Leisure, etc.
- **Built Environment** - Critical Infrastructure, Energy, Food & Water Systems, and Health Services
- **Natural Environment** – Land, Ecosystem Services, Biodiversity, Public Access to Waterfronts and Coastlines

Coastal Vulnerability ("What and how will the actual impact be?")

Impact Areas

- Casualties / Injuries/ Health & Quality of Life
- Damage to Physical Assets (e.g., Infrastructure, Housing, Utilities)
- Loss of Service or Functions from Disrupted and Damaged Physical Assets (including Cascading Failures due to Interdependence)
- Loss of Economic Activity (Physical and Financial losses, Loss of Employment, Loss of Inbound Investment)
- Loss of Economic Vitality or Livelihoods
- Damage to Ecosystem Services
- City Vitality and Cohesion

Factors

- Design of built and natural environments
- Composition of built and natural environments
- Human intention and activities for built and natural environments

APPENDIX C: UNIVERSAL COASTAL HAZARDS FOR COASTAL DISASTER SCENARIO TOOLS

Geohazard

- **Coastal Erosion**
- **Compressible & Expansive Soil**
- **Earthquake** (Shockwave, Landslides)
- **Landslide** (non-seismic)
- **Liquefaction**
- **Sand Encroachment**
- **Subsidence & Uplift**

Hydrological

- **Extreme Wave Event** (e.g., Tsunami)
- **Marine Ecosystem Degradation**
- **Marine Pollution** (non-point source)
- **Marine Pollution** (point source)
- **Sea-level Rise** (SLR)
- **Secondary Salinity (incl. saltwater intrusion)**
- **Urban Flooding**
- **Natural Flooding** (incl. coastal flooding)

Meteorological

- **Extreme Coastal Event** (Convective, Low-Pressure, Wind Storms - i.e., Hurricane, Typhoon, etc.)
- **Extreme Temperature Event** (Marine Cold Spell, Marine Heatwave, Ocean Rise via Warming)

APPENDIX D: FREQUENTLY ASKED QUESTIONS

What are Waterfront Edge Design Guidelines (WEDG)? How is it connected and/or different from the Scorecard?

The Waterfront Alliance brings deep expertise in resilient waterfront design, codified in WEDG – the gold standard for waterfront sites. WEDG is a national rating system adopted by projects across the U.S. and supported by over 750 accredited practitioners on three continents. WEDG credits are awarded to waterfront projects that incorporate best practices in climate resilience, ecology, and community access and can yield a passing score for verification of an entire site.

Note: completing the Scorecard does not automatically qualify a city or any of its assets for WEDG certification – instead, single sites must be submitted for preliminary review (free) and full accreditation (cost).

Waterfronts are high-value city spaces that support recreation, commerce, and ecological health. However, designing them requires balancing environmental integrity, equitable access, and long-term resilience. Estuarine and riparian habitats are sensitive and have suffered significant loss and damage over the last century due to human activities. Flooding and sea level rise threaten homes and livelihoods, resulting in billions (USD) annually across the globe. As environmental justice concerns intersect with real estate pressures, strong leadership and practical guidance are needed at every scale—local, regional, and national.

How does the Scorecard relate to other coastal disaster risk reduction tools?

We are aware that there are other scorecards and assessment frameworks for assessing coastal risk and responses to it. However, so far as we are aware none of these will be as holistic and comprehensive as this Scorecard. If your city has already used one of the other tools, we suggest you bring the data and answers from that over to this tool and then fill in around it where gaps remain. The Scorecard is not a standard or a taxonomy – it works alongside such credentials and this first version is influenced by WEDG (a site-specific residential) envisioned to a city scale.

What are the terms on which the Scorecard is offered?

The Scorecard is available free of charge to anyone who wishes to use it thanks to the generosity of our partners. Any person or organization that wishes to use it to create for-profit derivatives such as software or consulting services is also at liberty to do this, provided that they do not charge for the Scorecard itself.

While it is thorough, and systematic and while it has been peer-reviewed as set out below, *no warranty is offered as to the Scorecard's completeness or suitability for use in any specific set of circumstances. Users are* ***strongly*** *encouraged to satisfy themselves that the Scorecard is suitable for the purpose at hand and that it contains no erroneous suggestions or omissions when applied to their specific circumstances.*

If you have suggestions for improving the Scorecard, whether just editorial or more substantive, or whether you are a coastal planning and vulnerability expert or perhaps just someone who lives in a coastal zone, we welcome your contributions.

Are Cities' Scorecard data kept confidential if they participate in pilots with ARISE US?

Yes. We do not publish scores or carry out benchmarking that identifies individual cities, because we do not wish to discourage them from using the scorecard if they think they may do poorly. Cities are however at liberty to publish or benchmark their own data if they so choose. In addition, we may publish commentaries or analyses on trends revealed as cities use the scorecard (for example, which Essentials or questions seem to be attracting the highest and lowest scores) without identifying cities either directly or indirectly.

CITATIONS | END NOTES

[i] **Nature**: "Accelerating growth of human coastal populations at the global and continent levels," 2000-2018, Web, accessible on November 5th, 2025.
[ii] **World Economic Forum**: "Sea level rise: everything you need to know," March 25th, 2025, Web, accessible on November 6th 2025.
[iii] **S&P Global**: "Understanding sea-level rise and risks for coastal flooding," December 8th, 2023, Web, accessible on November 5th, 2025.
[iv] **Visual adapted from MCR 2030**: "The Ten Essentials for Making Cities Resilient," Web, accessible on November 5th, 2025.
[v] Cardona, O.D., M.K. van Aalst, J. Birkmann, M. Fordham, G. McGregor, R. Perez, R.S. Pulwarty, E.L.F. Schipper, and B.T. Sinh, 2012: **Determinants of risk: exposure and vulnerability. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation** [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 65-108., Web, accessible on November 5th, 2025.
[vi] **IPCC**: "Sixth Assessment Report, Impacts, Adaptation & Vulnerability: "Annex II: Glossary," Web, accessible on November 5th, 2025.
[vii] **IPCC:** Sixth Assessment Report (AR6), "Annex II: Glossary," Web, accessible on November 5th, 2025.