Climate Adaptation Design Principles

- Background
- International Examples & Research
- Design Principles Overview
- Building Typologies & Treatments
- Next Steps
Resilience Strategy Action 14: Establish Future Conditions Climate Resilience Design Guidelines

Forward-looking Design Parameters for:
• Heat, Wind
• Flooding, Sea Level Rise
• Materials and Reuse

Mayor’s Directive on Climate Change
Waikīkī Special District Design Guidelines
TOD Plans & Zoning
PUC Development Plan
Climate Adaptation Background Research

• Coordinated with City agencies and stakeholders
• Local & international research to identify best practices and obtain information on City initiatives at the local level
• Best practices for stormwater management, SLR and flood protection, transitions between buildings and streets, and mitigation for extreme heat
Outlines key design principles:

- For City agencies updating policies and regulations
- Focused on urban areas vulnerable to sea level rise (SLR) and other climate hazards
- Includes approaches to consider in designing building sites and structures
- To increase resilience to SLR, flooding, extreme heat, and groundwater inundation
INTERNATIONAL PRECEDENTS RESEARCH
SEA LEVEL RISE ADAPTATION AND STORM RESILIENCE

AMERICAS
- Vancouver
- San Francisco
- San Rafael
- New Orleans
- Miami
- Fort Lauderdale
- Georgetown
- Annapolis
- Norfolk
- Bridgeport
- New York
- Hoboken
- Staten Island
- Boston
- Toronto
- Calgary
- Toronto

EUROPE / AFRICA
- Copenhagen
- Rotterdam
- Nijmegen
- Hull
- Hamburg
- Venice
- Lagos

ASIA / AUSTRALIA
- Hong Kong
- Singapore
- Shanghai
- Tokyo
- Jakarta
- New Zealand
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<td>Rebuild by Design - Hurricane Sandy Design Competition</td>
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<td>Climate Ready Boston</td>
<td>Climate Ready Boston</td>
<td><a href="https://www.boston.gov/departments/environment/climate-ready-boston">https://www.boston.gov/departments/environment/climate-ready-boston</a></td>
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| 3         | Annapolis Resilient Design Guidelines for the City of Annapolis | Annapolis Resilient Design Guidelines for the City of Annapolis | https://www.annapolis.gov/DocumentCenter/View/2187/Resilient-Design-Guidelines-for-the-City-of-Annapolis-

**National**

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<td>Norfolk Resilience 2100</td>
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<td><a href="https://www.norfolk.gov/2100/docs/Final-2100-CRSP.pdf">https://www.norfolk.gov/2100/docs/Final-2100-CRSP.pdf</a></td>
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SINGAPORE

Minimum Platform Level (new developments)
- +0.6 m above adjacent road/ground

Minimum Crest Level (entrances, exits, basements)
- +0.3 m above platform level

New roads and open public spaces on terraces more than 8m above normal high tide.

All new buildings stand on artificial bases 8m above sea level for storm surge and SLR

Floodproofing of lower floors required for all new buildings

HAMBURG
Multi-family and commercial buildings require 100-year + 12”

Critical facilities require 100-year + 24” + (6” to 36”) depends on lifecycle

Non-critical facilities require 100-year + 12” + (6” to 36”) depends on lifecycle

Climate projections are recommended for design and data is provided for:

- Sea level rise and storm surge
- Extreme precipitation
- Extreme heat

Example: 100-year, 24-hr design storm rainfall shifts to 12” from 8” baseline for stormwater design with 2100 as end of useful life
“LIVING DOCUMENTS”

BOSTON
Coastal Resilience
Design Guidelines

NEW YORK
Climate Resiliency
Design Guidelines

SINGAPORE
ABC Waters Design
Guidelines

HAMBURG
HafenCity Buildings
Design Guidelines
<table>
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<tr>
<th>RESILIENT DESIGN PRINCIPLES</th>
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<tr>
<td><strong>UNDERSTANDING APPLICABLE HAZARDS</strong></td>
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<tr>
<td>Determine what hazards may affect the property or building site to inform siting and design.</td>
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<tr>
<td><strong>MANAGING STORMWATER</strong></td>
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<tr>
<td>Incorporate features to slow, detain, and retain stormwater on-site.</td>
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<tr>
<td><strong>DESIGN FOR FLOODING AND SEA LEVEL RISE</strong></td>
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<tr>
<td>Incorporate future flooding and sea level rise projections into site planning and building design.</td>
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<tr>
<td><strong>MITIGATING EXTREME HEAT</strong></td>
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<tr>
<td>Include design features for cooling, shade, and relief from warming temperatures.</td>
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Understanding Applicable Hazards

Current information on climate science and hazards should be used to determine what hazards may affect the property or building site. This can inform design of sites and structures to minimize risks and enhance safety.
The Climate Ready Oahu Web Explorer combines data from the City, State, and federal governments.

The data represents the best available science for a variety of climate change stressors and other regulatory layers.

Landowners and developers can use this tool to assess what climate change-related hazards may impact their site to inform design decisions.

The web explorer incorporates SLR data from the Hawaii SLR Viewer and the National Oceanic and Atmospheric Administration’s SLR Viewer.

Bit.ly/climatereadyoahumap
How to Use the Map

• Explore the map by zooming around or searching by address or TMK
• Investigate which areas of the island are projected to be at risk of **flooding** (due to SLR/rainfall); **extreme heat** (due to rising temperatures and the urban heat island effect).
• Different layers can be turned on or off in the Layers tab
• Additional map resources, information, and metadata are available on the Details tab (information “i” icon).
Data Available

- Shoreline Change Rates (ft/yr), historical & future
- Erosion Zone (3.2 feet SLR)
- SLR-XA (3.2 feet) (State) - passive flooding, annual high wave flooding, & coastal erosion
- Flooded Highways in the SLR-XA (3.2 feet) (State)
- SLR (6 feet) (NOAA)
- FEMA Flood Insurance Rate Map flood zones
- Heat Index (afternoon)
- Tree Canopy - Land Cover (2010)
Managing Stormwater

Climate change is expected to increase the frequency and intensity of storms, making stormwater management a key concern for resilient site design.
STRATEGIES FOR MANAGING STORMWATER

- Minimize impervious surfaces
- Infiltrate, evaporate, and reuse rainwater
- LID and green infrastructure
- Increase detention and manage the rate of stormwater flow
- Install stormwater infiltration, detention, and storage

The City is exploring the formation of a stormwater utility that would impose fees for impervious surfaces and further incentivize the use of green infrastructure, LID, and water conservation in new development and redevelopment.
The City Storm Water BMP Guide for New and Redevelopment (2017) provides details on post-construction measures that can be integrated into building design.

An appendix to the BMP Guide is under development and will provide specifications and guidelines for LID features, including infiltration basins and trenches, vegetated bioretention basins, permeable pavement and pavers, vegetated swales, biofilters, and buffer strips.

www.honolulu.gov/rep/site/dfm/Post_Construction_WQR_July_2019_booklet.pdf
Design for Flooding and Sea Level Rise

Mayor’s Directive 18-02 requires all City agencies, departments, and consultants to City projects to consider sea level rise of 3.2 to 6 feet by the end of this century.
Design Flood Elevations (DFE) require building for greater inundation as a result of SLR and/or more extreme rainfall events.

Anything below DFE/BFE should be floodproofed and designed to withstand loads from projected flooding. Sensitive uses and equipment, such as power systems and residential units, should be elevated.

The City has adopted the 2012 International Building Code (IBC) and International Residential Code (IRC). The code requires new construction to be designed with one foot freeboard above current Base Flood Elevation (BFE) in hazardous flood zones.
For larger flooding events, site design can include features that provide both function and flood retention, such as floodable parking structures and plazas, or areas that can accommodate greater flows.

Tanner Springs Park, Portland OR
On-site rainwater harvesting can be used for the dual benefit of flood mitigation and water conservation.

The City is proposing updates to the Plumbing Code (Revised Ordinances of Honolulu (ROH) Chapter 19) that would allow more applications for on-site water reuse for residential and commercial properties.
Mitigating Extreme Heat

As the atmosphere warms, Hawai‘i can expect more record high temperatures and heat waves, bringing associated threats to human and environmental health.
Providing shade through trees, awnings, or canopies

Using high solar reflectance building materials and colors for windows, pavements, and coatings (within acceptable local ordinances)

Landscaping on rooftops and around buildings for cooling

Designing common outdoor areas with shade, seating, shelters at bus stops, and other amenities
Mayor’s Directive 20-14 (2020) requires City departments to consider climate change mitigation and environmental benefits of a healthy urban tree canopy in decisions that affect city trees.

This policy requires the protection of trees that pose no threat to safety, do not undermine an essential government function, and planting more trees to expand urban canopy.

DPP is developing Street Tree Plans for all TOD areas.
RESILIENT BUILDINGS & SITE DESIGNS

Three Common Urban Typologies

- Mid-Rise Building
- Tower & Podium
- Low-Rise Walk-up
Resilient Streetscape Transition Zone

• Creates an accessible slope up to a building’s required BFE or DFE.

• Includes amenities: flood-resistant plantings, walking paths, seating, trees, awnings, and other placemaking elements.

• Complies with applicable standards and regulations for drainage, as well as Americans with Disabilities Act (ADA) Accessibility Guidelines.
Tower & Podium

- Multi-level (8 – 40 or more), mixed-use tower/podium structure
- Residential and/or Commercial uses
- retail, residential, or a combination lining in front of at 3-7 stories parking podium base
Tower & Podium

- Locate critical systems above the BFE or DFE
- Provide sustainable roof systems
- Podium is designed to be Pedestrian scale with high ground floor transparency
- Typically located along a high-volume “complete street”
Resilient Streetscape Transition Zone

- Flood-resistant/saltwater tolerant landscaping
- Pedestrian amenities
- Shade structures
- Paths
Mid-Rise Building

- Four to seven-story building contains apartment flats
- Residential use
- Off-street parking, active ground floor retail space
Mid-Rise Building

- Provide sustainable roof systems
- Provide systems for onsite water reuse
- Typically located along “complete street”
- Locate critical systems above the BFE or DFE
- Typical U-shaped, L-shaped layouts with internal courtyards and green roofs.
Resilient Streetscape Transition Zone

- Flood-resistant/saltwater tolerant landscaping
- Green infrastructure

Mid-Rise Apartment Building

Design Flood Elevation

Standard Design Elevation

- Permeable pavement
- Bike lane
- Transitional landscape
- Parking entrance
- Barrier-free ADA ramp up to sidewalk from intersection
- Supporting infrastructure
- Planters with seating
- Active ground floor use

All Resilient Transition Zones must be ADA compliant
Low Rise Walk-up

- Two to five-story multi-family residential building
- First floor built above the BFE or DFE
- Shallow setback from street edge
- Off-street parking provided at out of view of the public ROW.
Low Rise Walk-up

- Typically built along a local street with relatively low traffic volumes

- Site critical mechanical and electrical systems on the roof

- Provide wet floodproofed basement or storage area below BFE or DFE.
Resilient Streetscape Transition Zone

- Flood-resistant/saltwater tolerant landscaping
- Green infrastructure
- Street trees and other green elements to soften or screen parking from public view
Kapalama Canal Catalytic Project
Overall Character: Central Street Section

- (2075) WS
- (2017) HHW
- Mean Sea Level
- (E) Sediment
- (P) B.O. Channel

Shared Street Zone:
- Sidewalk: 10' - 0"
- Street: 22' - 0"
- Biofilter: 6' - 0"
- Permeable Path: 15' - 0"
- Lawn: 8' - 0"
- Rip-Rap Bank: Varies

Stabilized Bank: 70' - 0"
Overall Character: Central Street Section
Overall Character: Central Street Section
Central Canal: Section D, typ. (SLR +3.2')

NOTES
1. POSITION, SPECIES, & ROOT CONTAINMENT OF NEW TREES TO BE DETERMINED AS FLOODWALL DESIGN DEVELOPS SUCH THAT TREES DO NOT MINIMIZE INTEGRITY & FUNCTIONALITY OF EMBANKMENT SYSTEM.
Key Structural Design Outcomes

- Inform Cost
  - Wall design height
  - Required embedment
  - Preliminary sizing
- Confirm Feasibility
  - Stability
  - Constructability
- Advise on detailing constraints

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<th>Relative Structural Geometry for Representative Sections</th>
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<tr>
<td>Wall Design Height:</td>
<td>H = 10 ft</td>
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<tr>
<td>Cantilever T-Wall Option</td>
<td>Total Height of wall</td>
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<tr>
<td>Sheet Pile E-Wall Option</td>
<td>Foundation Footing Width</td>
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<tr>
<td>Total Height of wall</td>
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<tr>
<td>Min Sheet Pile Embedment Depth</td>
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1. Required height is small because sheet pile wall is to be located behind existing CRM wall which is expected to retain the sheet pile wall tip elevation is governed by embedment into competent soil (see Section 3)
2. Elevation of bottom of T-wall footing is governed by preexisting topography for location of competent soil
State TOD Planning & Implementation for O'ahu
Appendix I: Flexible Adaptation Pathways
An Approach for Sea Level Rise and Flood Infrastructure
Focus on Iwilei-Kapalama
April 2020
NEXT STEPS
PURPOSE OF THE DOCUMENT

- Help designers and developers to understand potential climate change impacts/problems
- Consider adaptation solutions early in project planning
- Identify conflicts and updates needed to city policies and regulations across departments

Download a copy at www.honolulu.gov/tod
**LOCAL POLICY & REGULATIONS**

**GREENING IWILEI AND KAPALAMA**

- Mayor’s Directive on Climate Change (18-02)
- Mayor’s Directive on Street Trees (20-14)
- O‘ahu Resilience Strategy
- City Climate Change Commission Guidance
- Hawai‘i SLR Vulnerability and Adaptation Report
- Department of Facilities Maintenance
  - Storm Water Management Plan
  - Rules Relating to Water Quality
  - Storm Water BMP Guide for New and Redevelopment
- Department of Transportation Services
  - Complete Streets Design Manual
- Department of Planning and Permitting
  - Building, Plumbing, Electrical Codes
  - Flood Ordinance
  - Land Use Ordinance (Draft Update)
  - Plan Review Use Permit Guidelines
  - Planned Development Permit Guidelines
  - Special District Design Guidelines
  - Special Management Area
  - Shoreline Setback Ordinance
  - Subdivision Permit Requirements
  - Site Development Division Submittal
- Neighborhood TOD Plans & TOD Zoning
IDENTIFIED NEEDS & GAPS

- Need for continued inter-agency, cross-sector coordination around climate adaptation and infrastructure planning (City/State/industry)
- Based on islandwide adaptation strategy, more focused studies needed to decide where to protect, where/how to accommodate, and where to retreat
  - Site-specific or neighborhood-level engineering and feasibility studies and cost-benefit analyses needed to vet different adaptation strategies
- Land use, zoning, flood zones and hazard areas need updating to incorporate future projections of SLR and other climate-related hazards
- Regulations and guidance needed for providing retention/detention to accommodate increased rainfall and flooding
- Requirements for trees, landscaping, and transition zones between the building and sidewalks need to be detailed/updated and reconciled with potentially conflicting codes
- *And plenty more*……
Key initiatives related to the adaptation design principles needing discussion, under way or planned

- **Climate Resilience Design Guidelines** DDC/CCSR are developing Design Guidelines to inform the design of city facilities and infrastructure (lead by example)
- **Updates to Special Management Area & Shoreline Setback Regulations** (DPP-LUPD) will incorporate sea level rise projections
- **Neighborhood TOD Plans and Zoning** (DPP-TOD) will include updated guidance for areas affected by SLR
- **DPW standard details** & stormwater utility (DFM)
3. Other City Plans, Policies, Regulations

Noted for awareness/coordination

- **Climate Adaptation Strategy** – [www.climatereadyoahu.org](http://www.climatereadyoahu.org) (CCSR)
- **Primary Urban Center Development Plan** (DPP-PD)
- **North Shore Sustainable Communities Plan Update** (DPP-PD)
- **OneWater planning** (Ordinance 20-47, multi-department)
- **FEMA Hazard Mitigation Grants** (CCSR)
- **Flood ordinance updates** (DPP)
- **Building code updates** (DPP)
- **Others??**
ClimateReadyOahu Adaptation Strategy

www.climatereadyoahu.org/participate

- Pearlridge Farmers Market on Saturday, July 10, from 8 a.m. - 12 p.m.
- Kailua Farmers Market on Thursday, July 15, from 4 p.m. - 7 p.m.
- Waimea Valley for Lā ‘Ohana Day on Sunday, July 18, from 10 a.m. - 2 p.m.
- Mililani Farmers Market on Sunday, July 25, from 8 a.m. - 11 a.m.
- Kaka‘ako Waterfront Park for the Youth Engagement Social on Saturday, July 31, at 4 p.m.
- Hawai‘i State Art Museum on Saturday, August 7, from 2 p.m. - 4 p.m.
- Bishop Museum for ‘Seas the Day’ on August 28

We will be set up with all the art supplies—all you need to bring is your creativity! Stay tuned for even more dates and locations throughout July and August.
Primary Urban Center Development Plan Update

The PUC DP Draft (Fall 2021):

- Includes broad policies on climate resilience and maps to help identify different coastal edge and backshore conditions in urban Honolulu.
- Promotes adopting the 3.2’ SLR-XA as a hazard overlay for current zoning and permitting decisions, and the 6’ SLR for critical infrastructure.
- Supports a One Water collaborative inter-agency process for resilience planning.
- Provides for an adaptable evidence-based regulatory framework and time-based monitoring.
- Supports both voluntary and regulatory adaptation actions and active hazard avoidance strategies.

www.pucdp.com
MAHALO!

To download the Design Principles & Background Research documents

www.honolulu.gov/tod