City & County of Honolulu

Climate Adaptation
DESIGN PRINCIPLES FOR URBAN DEVELOPMENT

State TOD Council

April 16, 2021

TOD HONOLULU Transit-Oriented Development

CITY AND COUNTY OF HONOLULU STATE OF HAWAII

RESILIENT O'AHU

SSFM International

ARUP

Climate Adaptation Design Principles

- Background
- International Examples & Research
- Design Principles Overview
- Building Typologies & Treatments
- Next Steps

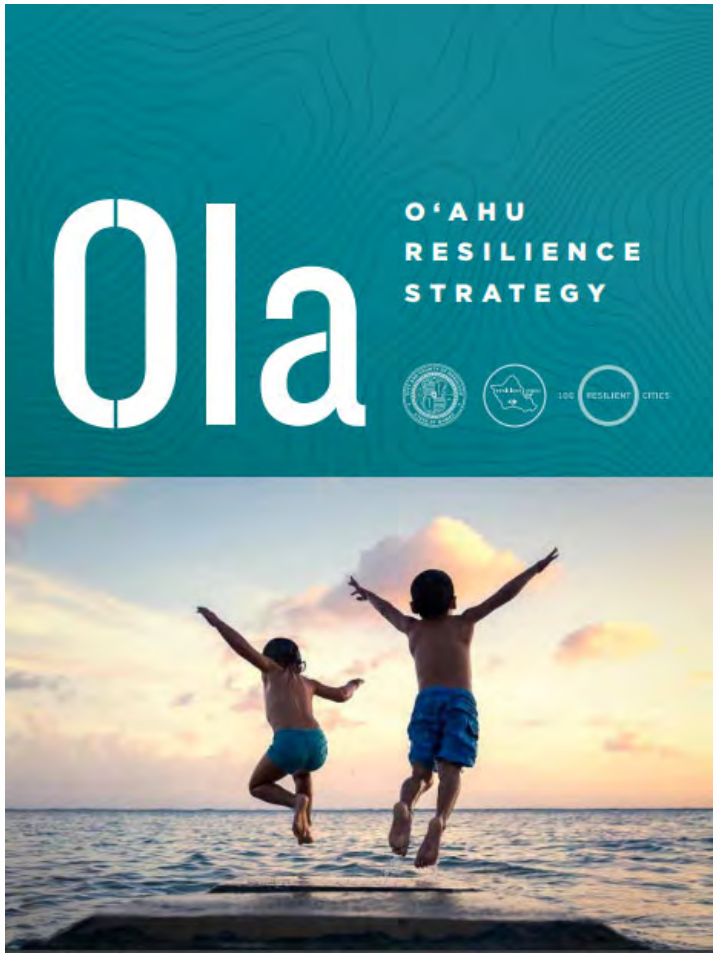
PROJECT PURPOSE

<u>Resilience Strategy Action 14:</u>
Establish Future Conditions Climate Resilience Design Guidelines

Forward-looking Design Parameters for:

- Heat, Wind
- Flooding, Sea Level Rise
- Materials and Reuse

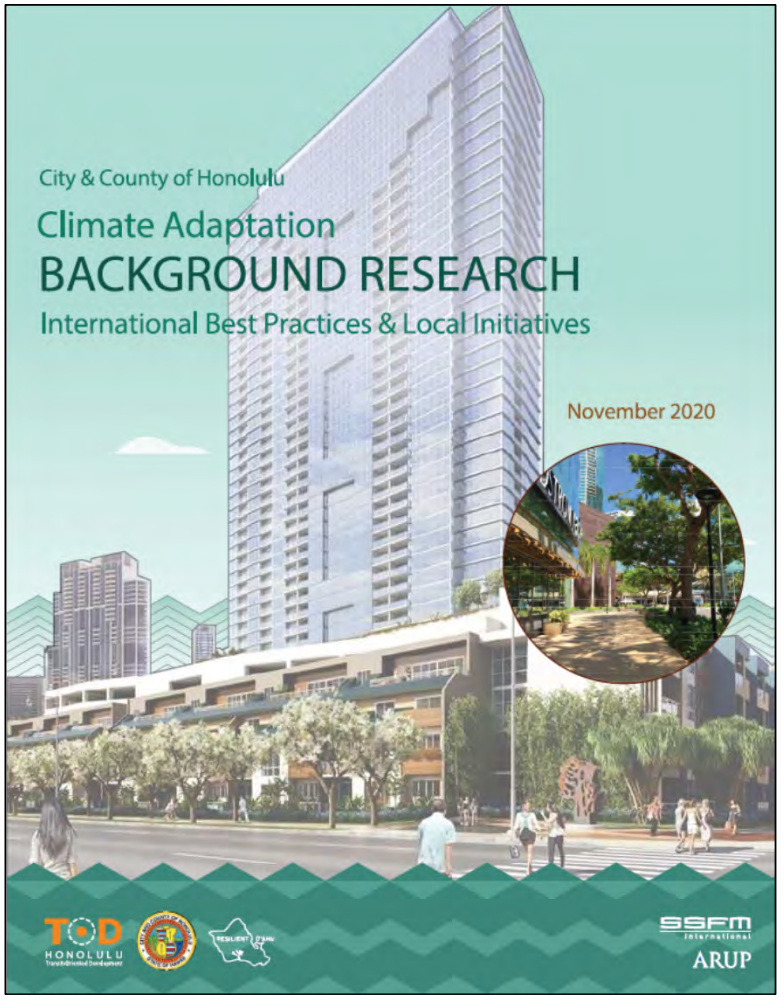
Mayor's Directive on Climate Change
Waikīkī Special District Design Guidelines
TOD Plans & Zoning
PUC Development Plan



BACKGROUND RESEARCH

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



LOCAL POLICY & REGULATIONS

GREENING IWILEI AND KAPALAMA

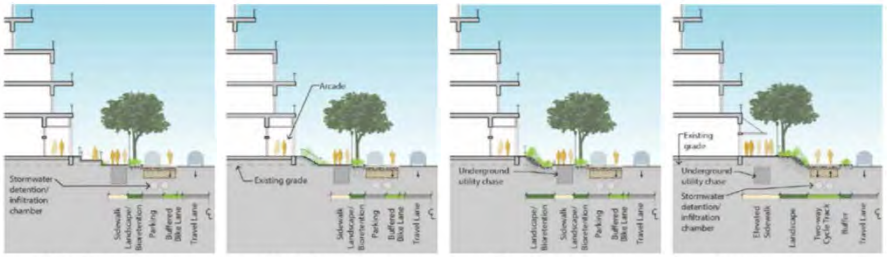


Figure 28A. Building relation to street option, section A- at Ramp

Figure 28B. Building relation to street option, section B- at Stairs

Figure 28C. Building relation to street option, section C- at Bioretention

Figure 28D. Building relation to street option, section D- through alternative with elevated sidewalk and no on-street parking

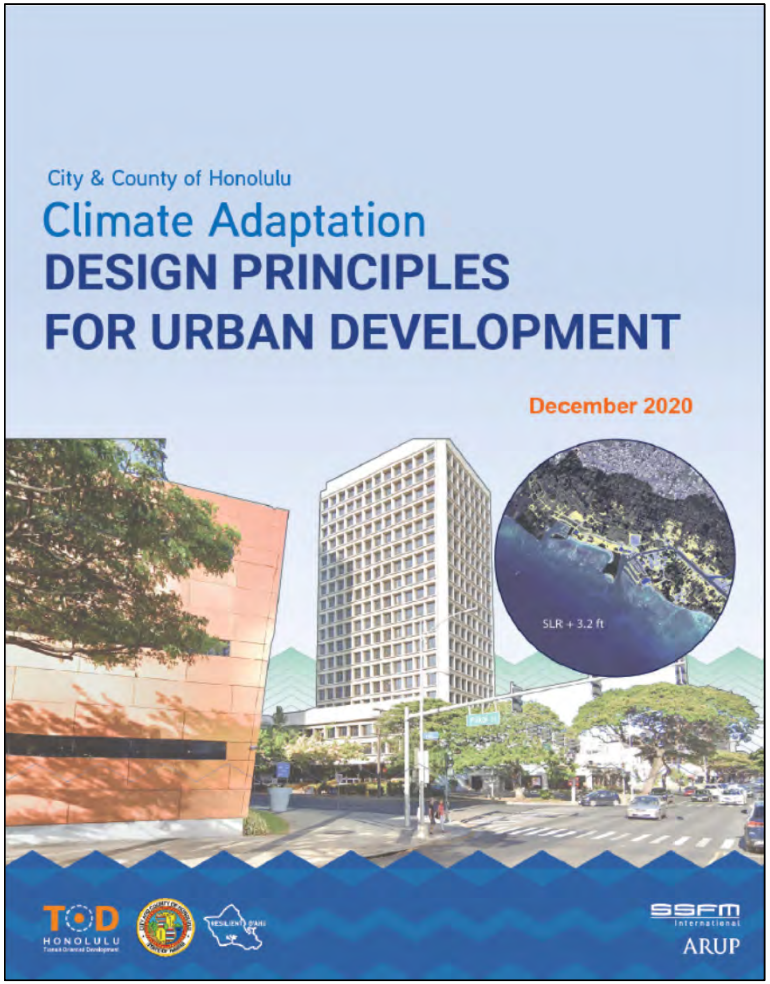
NEIGHBORHOOD TOD PLANS

- *Mayor's Directive on Climate Change* (18-02)
- *Mayor's Directive on Street Trees* (20-14)
- *O'ahu Resilience Strategy*
- *Climate 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*

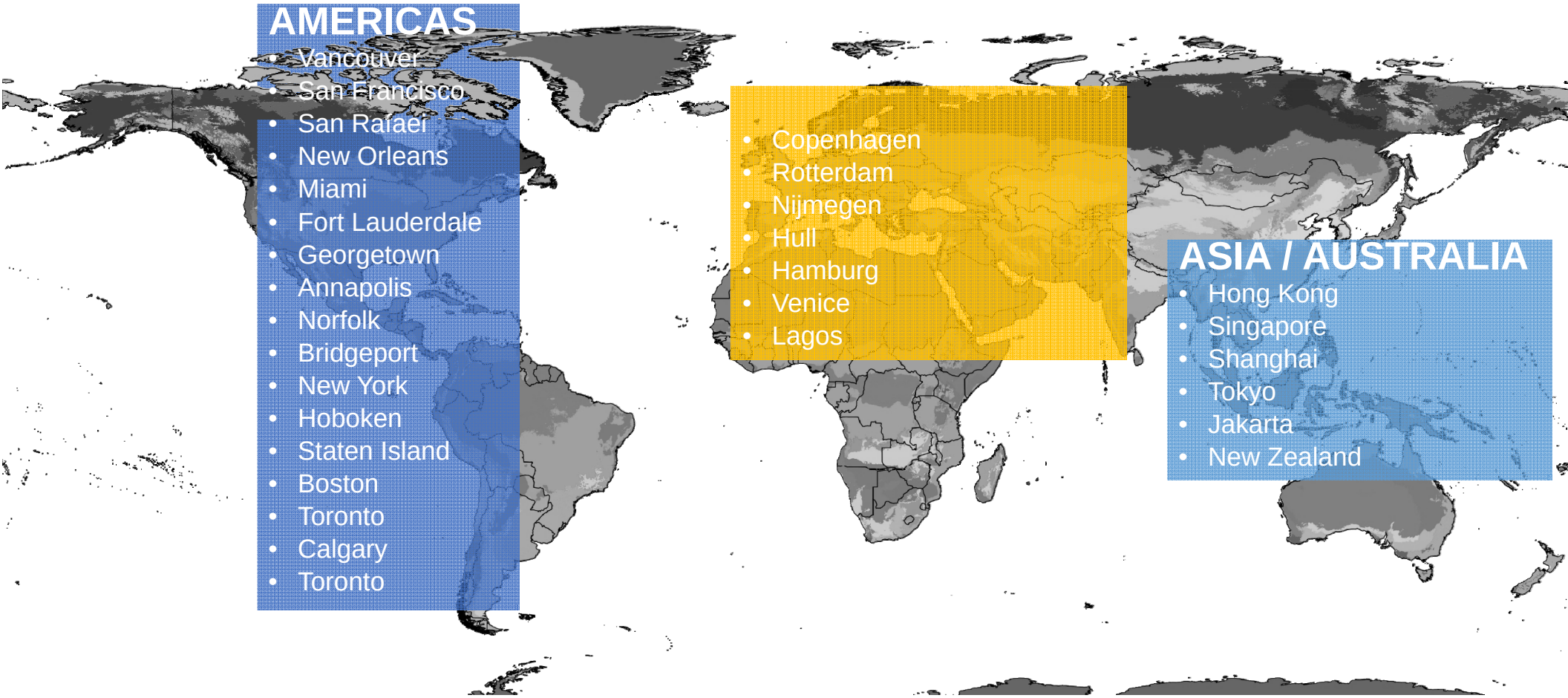
CLIMATE ADAPTATION DESIGN PRINCIPLES

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



	Relevance (1-5)	Location	Title	Link
National	4	Various	FEMA Coastal Construction Manual	https://www.fema.gov/media-library-data/20130726-1510-20490-2899/fema55_voli_combined.pdf
	2		RELi Rating System (USGBC)	https://www.usgbc.org/articles/reli-rating-system-improves-project-resiliency
	4	New York	Retrofitting Buildings for Flood Risk	https://www1.nyc.gov/assets/planning/download/pdf/plans-studies/retrofitting-buildings/retrofitting_complete.pdf
	1		Shaping the Sidewalk Experience	https://www1.nyc.gov/site/planning/plans/active-design-sidewalk/active-design-sidewalk.page
	3		Urban Waterfront Adaptive Strategies	https://www1.nyc.gov/assets/planning/download/pdf/plans-studies/sustainable-communities/climate-resilience/urban_waterfront.pdf
	3		NYC Street Design Manual	https://www1.nyc.gov/html/dot/downloads/pdf/nycdot-streetdesignmanual-interior-02-geometry.pdf
	5		NYC Climate Resiliency Design Guidelines	https://www1.nyc.gov/assets/orr/pdf/NYC_Climate_Resiliency_Design_Guidelines_v3-0.pdf
	3		Rebuild by Design - Hurricane Sandy Design Competition	http://www.rebuildbydesign.org/our-work/sandy-projects
	4		Climate Resilience Design Guidelines - Port Authority of NY & N	https://www.panynj.gov/business-opportunities/pdf/discipline-guidelines/climate-resilience.pdf
	4		Initiatives for Increasing Resiliency in NYC Buildings	https://www1.nyc.gov/assets/sirr/downloads/pdf/Ch4_Buildings_FINAL_singles.pdf
	3	Boston	Climate Ready Boston	https://www.boston.gov/departments/environment/climate-ready-boston
	2		Coastal Resilience Solutions for East Boston and Charlestown	https://www.boston.gov/departments/environment/climate-ready-east-boston
	2		Coastal Resilience Solutions for South Boston	https://www.boston.gov/departments/environment/climate-ready-boston/climate-ready-south-boston
	5		Coastal Flood Resilience Design Guidelines	http://www.bostonplans.org/getattachment/d1114318-1b95-487c-bc36-682f8594e8b2
	5		Retrofitting Boston Buildings for Flooding: Potential Strategies	https://www.boston.gov/sites/default/files/imce-uploads/2017-01/retrofitting_report_10.7.2016.pdf
	5		Climate Resilient Design Standards and Guidelines	https://www.boston.gov/sites/default/files/imce-uploads/2018-10/climate_resilient_design_standards_and_guidelines_for_protection_of_public_rights-of-way_no_appendices.pdf
	4		Resilient, Historic Buildings Design Guideline	https://www.boston.gov/sites/default/files/imce-uploads/2018-10/resilient_historic_design_guide_updated.pdf
	4		Voluntary Resilience Standards	https://www.abettercity.org/assets/images/Voluntary_Resilience_Standards.pdf
	5		Building Resilience in Boston: "Best Practices" for Climate Chan	https://www.greenribboncommission.org/archive/downloads/Building_Resilience_in_Boston_SML.pdf
	4	Hoboken	Resilient Building Design Guidelines	https://betterwaterfront.org/wp-content/uploads/2016/05/Resilient-Buildings-Design-Guidelines.pdf
	3	Annapolis	Flood Mitigation Strategies for the City of Annapolis	https://dnr.maryland.gov/ccs/Publication/Annapolis_FIMS_eastport.pdf
	3		Revising Floodplain Regulations for the Increased Protection of H	https://www.annapolis.gov/DocumentCenter/View/2187/Revising-Floodplain-Regulations-for-the-Increased-Protection-of-Historic-District-PDF
	3	Miami	Climate Ready Miami	https://www.miamigov.com/Government/ClimateReadyMiami/Buildings-and-Land-Use
	3		Miami Forever Resilience Projects	https://www.miamigov.com/Government/Departments-Organizations/Office-of-Capital-Improvements-OCI/Miami-Forever-Bond
	3		Miami Beach Street Design Guidelines	https://www.miamibeachfl.gov/wp-content/uploads/2017/12/Street-Design-Guidlines-(FINAL).pdf
	3		Sea Level Rise and the Public Realm	https://carta.fiu.edu/mbus/event/fiuupenn-sea-level-rise-and-the-public-realm/
	3		South Florida and Sea Level: The Case of Miami Beach	http://www.mbrisingabove.com/wp-content/uploads/2017/08/South-Florida-and-Sea-Level-The-Case-of-Miami-Beach.pdf
	4		Miami Beach Street & Building Raising	https://www.miamiherald.com/news/local/community/miami-dade/miami-beach/article115264938.html
	3	Stonington	Community Coastal Resiliency Plan	http://www.stonington-ct.gov/sites/stoningtonct/files/file/file/coastal_resiliency_plan_presentation.pdf
	3	Norfolk	Coastal Resilience Strategy	https://www.norfolk.gov/DocumentCenter/View/16292/Coastal-Resilience-Strategy-Report-to-Residents-?bidId=
	3		Norfolk Vision 2100	https://www.norfolk.gov/DocumentCenter/View/27768/Vision-2100---FINAL?bidId=
	3	New Orleans	Greater New Orleans Urban Water Plan - Vision	https://livingwithwater.com/blog/urban_water_plan/reports/
	3		Greater New Orleans Urban Water Plan - Urban Design	https://livingwithwater.com/blog/urban_water_plan/reports/
	3		Greater New Orleans Urban Water Plan - Implementation	https://livingwithwater.com/blog/urban_water_plan/reports/
	3		Greater New Orleans Urban Water Plan - Roadway Retrofits	https://livingwithwater.com/blog/urban_water_plan/reports/
	3	Oakland	Resilient East Bay 2050	https://www.design.upenn.edu/city-regional-planning/graduate/work/resilient-east-bay-2050
	1	San Francisco	Islais Hyper Creek - Resilience by Design	http://www.resilientbayarea.org/islais-hyper-creek
	1		Resilient South City - Resilience by Design	http://www.resilientbayarea.org/resilient-south-city
	4		Treasure Island Sea Level Rise Adaptaion Strategy	https://bcdc.ca.gov/cm/2016/0915TreasureIslandpp.pdf
	3		The Estuary Commons - Resiliency by Design	http://www.resilientbayarea.org/estuary-commons/
	3		Resilience by Design Bay Area	http://www.resilientbayarea.org/
International	3	Hong Kong	Climate Action Plan 2030+	https://www.enb.gov.hk/sites/default/files/pdf/ClimateActionPlanEng.pdf
	3		Sponge City: Adapting to Climate Change	https://www.dsd.gov.hk/Documents/SustainabilityReports/1617/en/sponge_city.html
	3	Rotterdam	Rotterdam Climate Proof Adaptation Programme	https://sdr.gdos.gov.pl/Documents/Wizyty/Belgia%20i%20Holandia/Program%20adaptacji%20do%20zmian%20klimatu%20w%20Rotterdamie.pdf
	3		Benthemplein Water Plaza	https://www.c40.org/case_studies/benthemplein-water-square-an-innovative-way-to-prevent-urban-flooding-in-rotterdam
	3	Shanghai	Case Studies of the Sponge City Program in China	https://www.researchgate.net/publication/303362681_Case_Studies_of_the_Sponge_City_Program_in_China
	5	Singapore	Code of Practice on Surface Water Drainage	https://www.pub.gov.sg/Documents/COP_Final.pdf
	4		On-site Stormwater Detention Tank Systems Technical Guide	https://www.pub.gov.sg/Documents/detentionTank.pdf
	4		Managing Urban Runoff	https://www.pub.gov.sg/Documents/managingUrbanRunoff.pdf
	4		ABC Waters Design Guidelines	https://www.pub.gov.sg/Documents/ABC_Waters_Design_Guidelines.pdf
	5	Hamburg	HafenCity	https://www.hafencity.com/upload/files/artikel/180215_HC_Bauherrenbooklet_2018_engl_FREI.pdf
	4	Copenhagen	Cloudburst Management Plan	https://en.klimatilpasning.dk/media/665626/cph_-_cloudburst_management_plan.pdf
	3	Bangkok	Resilient Bangkok	https://www.100resilientcities.org/wp-content/uploads/2017/07/Bangkok_-_Resilience_Strategy.pdf
	3	Byblos	Resilient Byblos	http://www.resilientbyblos.org/
	3	Lagos	A Vision of floating cities	https://news.harvard.edu/gazette/story/2013/03/a-vision-of-floating-cities/
	3	Venice	Rising Sea Levels and Flood Water Management	https://urpl590resilience.wordpress.com/2016/05/02/venice-italy-rising-sea-levels-and-flood-water-management-and-mitigation-practices/
	3	New Zealand	Preparing New Zealand for Rising Seas	https://www.pce.parliament.nz/media/1390/preparing-nz-for-rising-seas-web-small.pdf

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

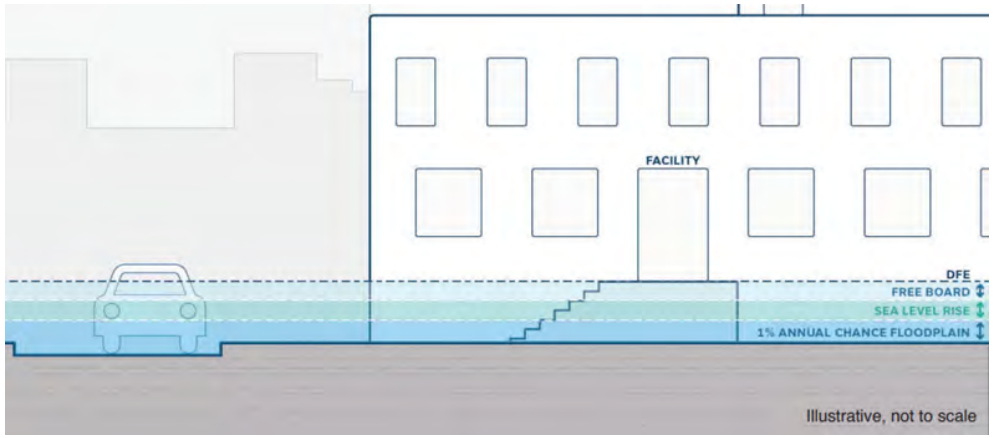
HAMBURG

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

NEW YORK

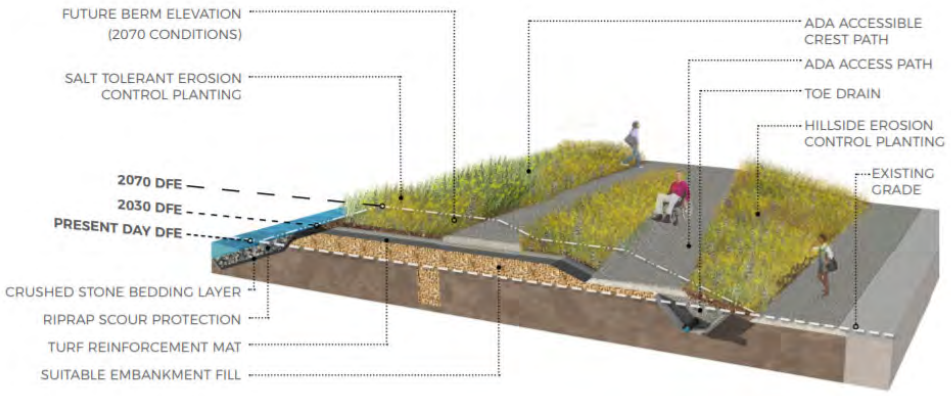


Multi-family and commercial buildings require
100-year + 12”

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

BOSTON



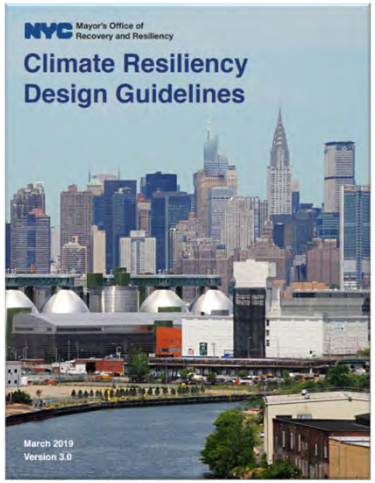
Climate projections are recommended for design and data is provided for:

- 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

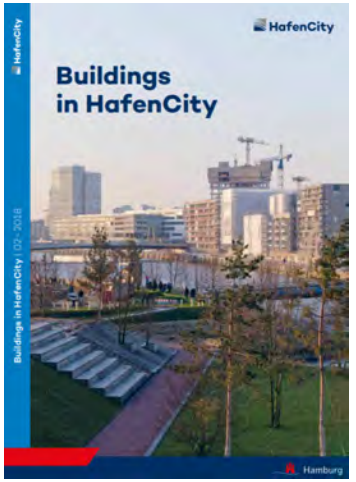
“LIVING DOCUMENTS”

BOSTON
Coastal Resilience
Design Guidelines



NEW YORK
Climate Resiliency
Design Guidelines

SINGAPORE
ABC Waters Design
Guidelines



HAMBURG
HafenCity Buildings
Design Guidelines

RESILIENT DESIGN PRINCIPLES

RESILIENT DESIGN PRINCIPLES

UNDERSTANDING APPLICABLE HAZARDS

Determine what hazards may affect the property or building site to inform siting and design.

MANAGING STORMWATER

Incorporate features to slow, detain, and retain stormwater on-site.

DESIGN FOR FLOODING AND SEA LEVEL RISE

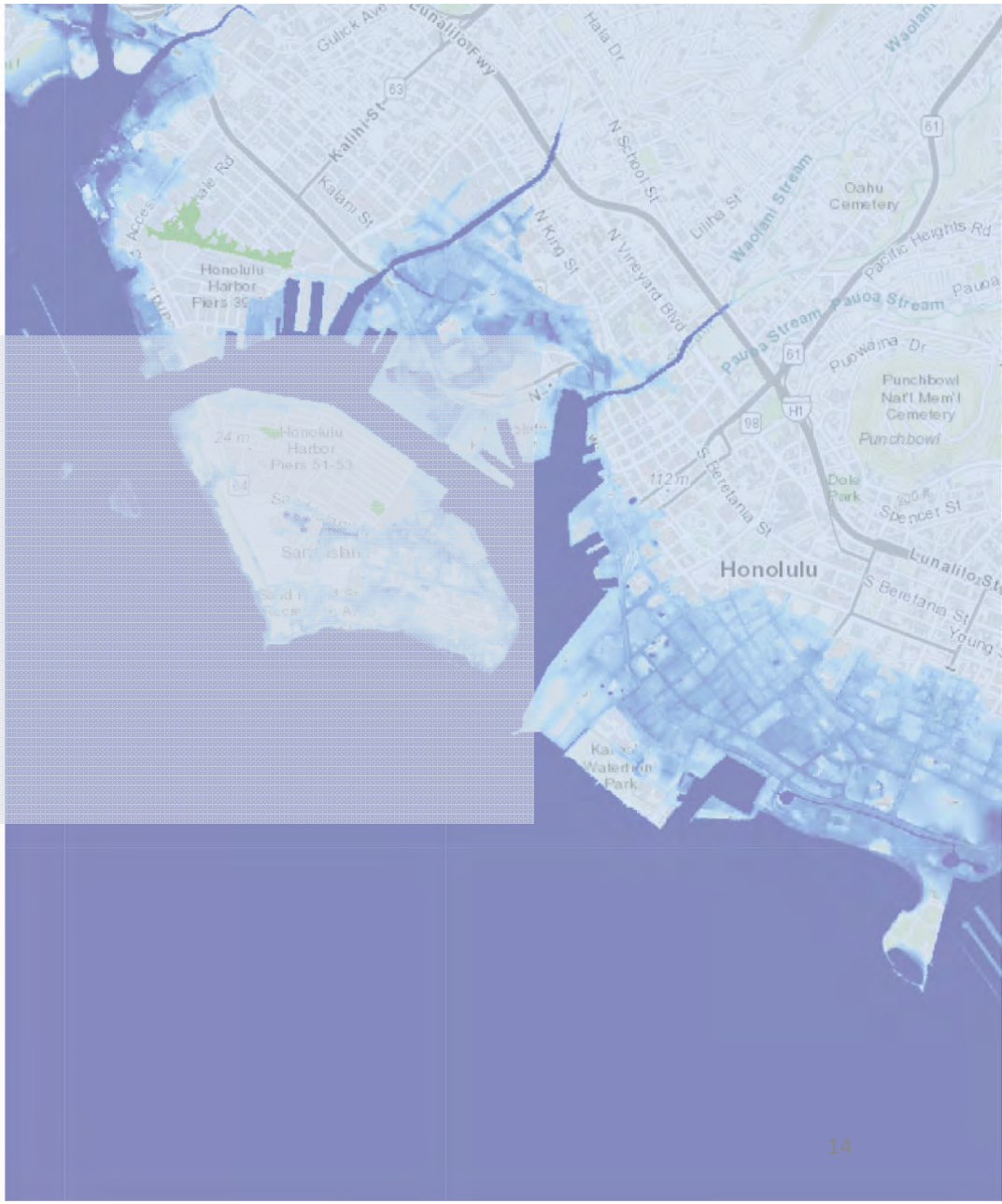
Incorporate future flooding and sea level rise projections into site planning and building design.

MITIGATING EXTREME HEAT

Include design features for cooling, shade, and relief from warming temperatures.

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.



CLIMATE READY O‘AHU WEB EXPLORER

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.

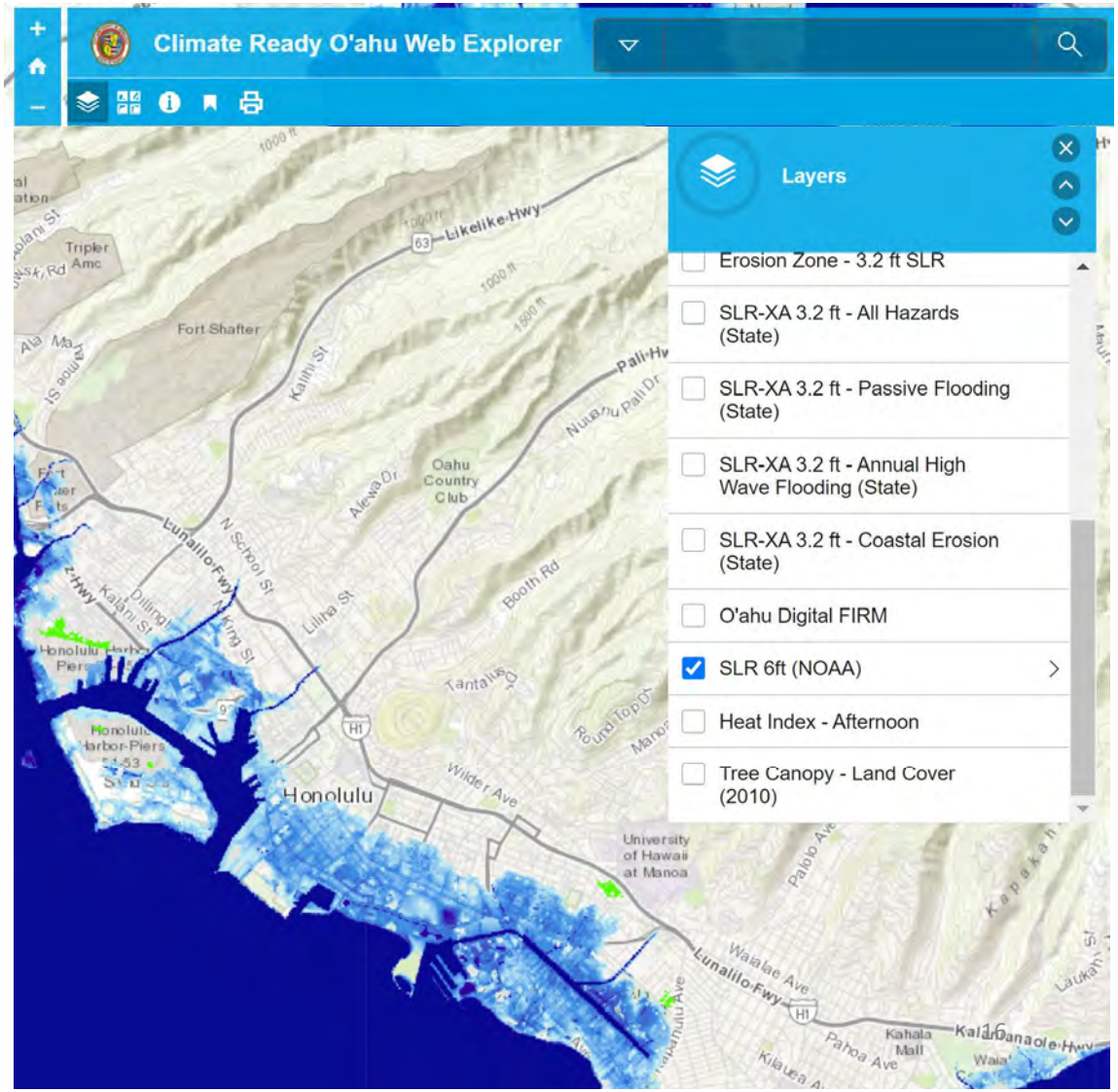
Landowners and developers can use this tool to assess what climate change-related hazards may impact their site to inform design decisions.

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

Bit.ly/climatereadyoahumap

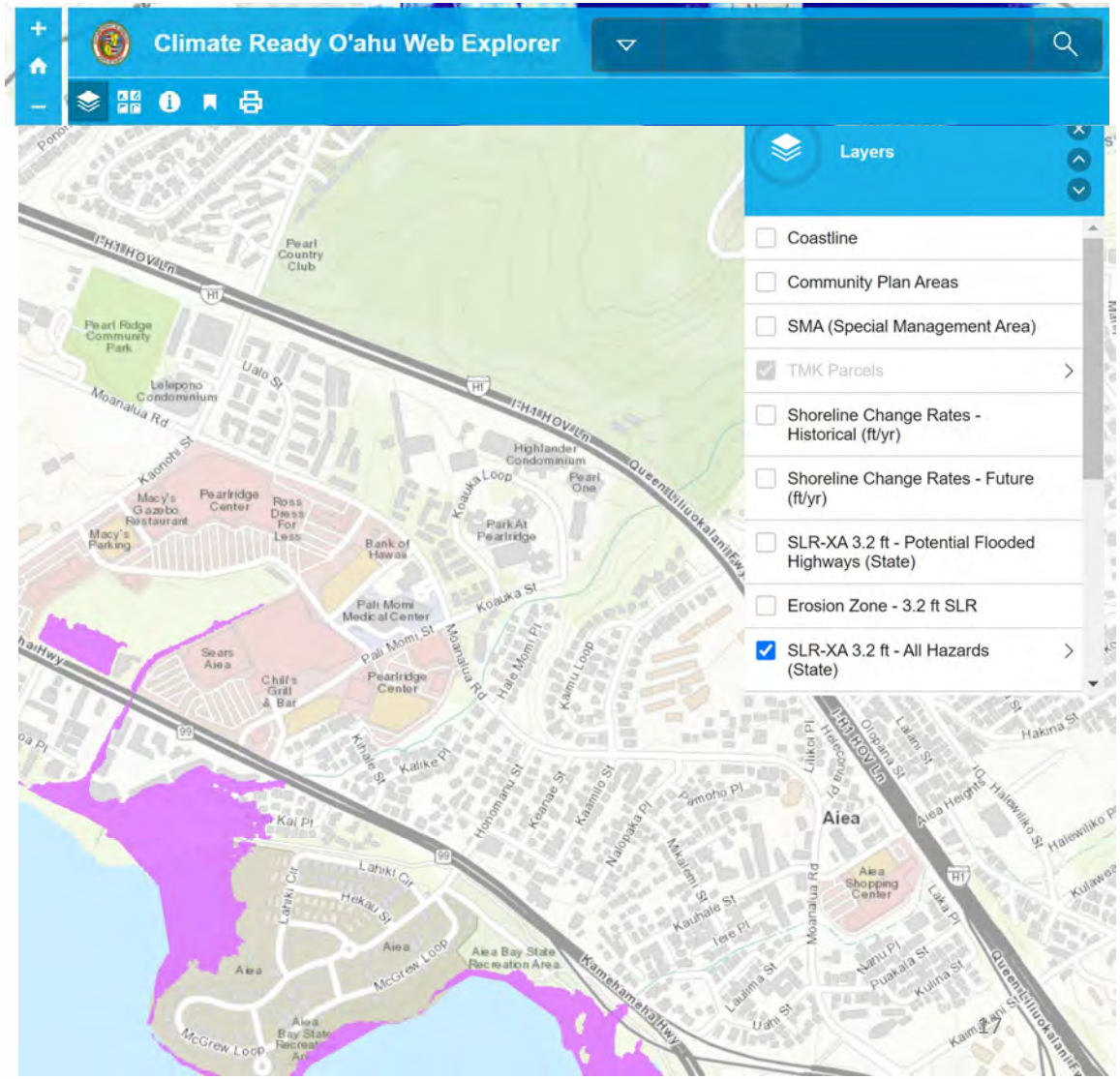
How to Use the Map

- 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.

Green Roofs

Capture and filter stormwater
Source: Hans van Heeswijk Architecten. "Rooftop Garden". Amsterdam, Netherlands.

Blue Roofs

Temporarily store rainwater in any of a number of types of detention systems
Source: Flickr.com. "Green Infrastructure Pilot Projects in NY". New York.

Living/Green Walls

Help to filter stormwater before it enters the storm drain
Source: Hawaiilife.com. "Living Walls are Becoming Popular in Honolulu". Ala Moana Center.

Rain Gardens

Store and collect rainwater as well as filter overflow
Source: Behance.net. "Rain Garden Display Panel". Kailua.

Detention tanks

Store rainwater that can be reused for irrigation and indoor non-potable uses following plumbing codes
Source: Artspace.org. "Olas Kailima Artspace Lofts". Honolulu.

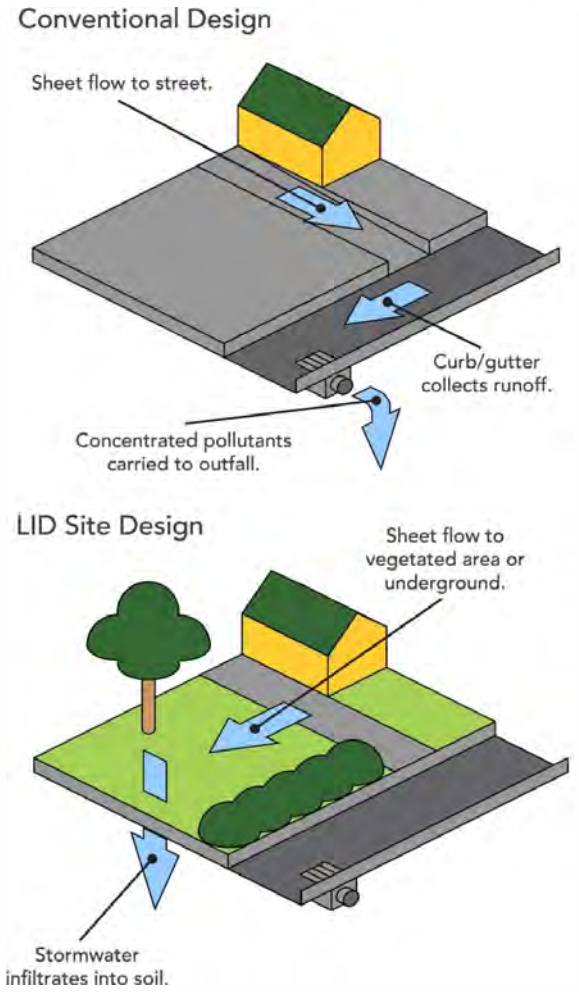
Permeable Pavements

Capture water in place while filtering it and potentially replenishing aquifers
Source: Google Maps. "Street View Kapiolani Park". Honolulu.

CITY STORMWATER BMP GUIDE

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

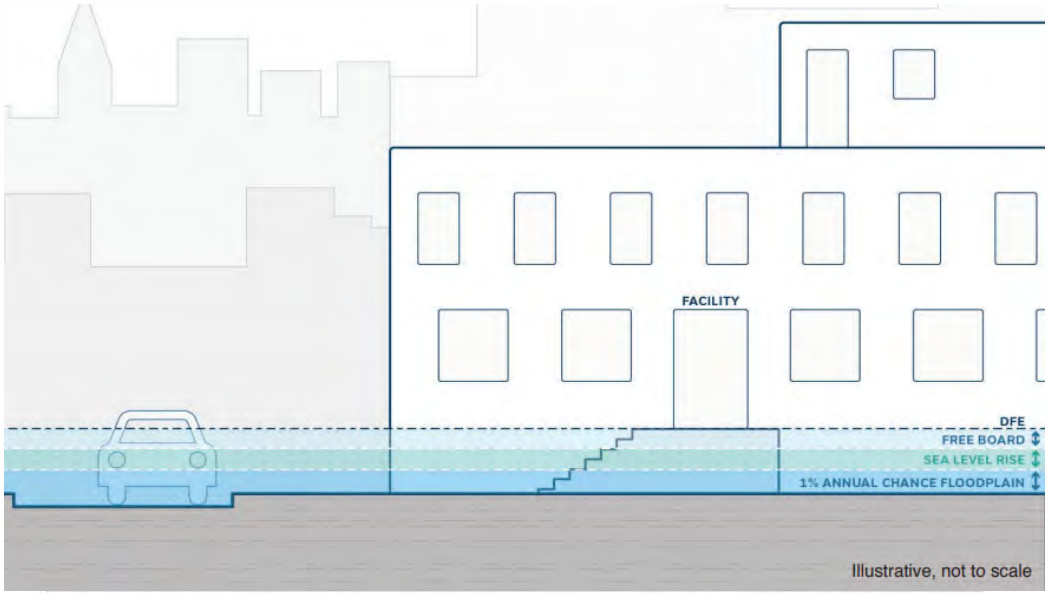
Mayor's Directive 18-02 requires all City agencies, departments, and consultants to City projects to consider sea level rise of 3.2 to 6 feet by the end of this century.

DESIGN / BASE FLOOD ELEVATIONS

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.



Source: NYC Mayor's Office of Recovery and Resiliency. "Climate Resiliency Design Guidelines"

FLOOD RETENTION FEATURES

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

RAINWATER HARVESTING & REUSE

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.

DESIGN STRATEGIES FOR EXTREME HEAT

- 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

Source: City and County of Honolulu. "Design Guidelines: Transit-Oriented Development". Honolulu.

Source: City and County of Honolulu. "Design Guidelines: Transit-Oriented Development". Honolulu.

Source: Coolroofstore.net. "The Cool Roof Store Hawai'i". Honolulu.

MAYOR'S DIRECTIVE ON STREET TREES

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 DESIGN APPLICATIONS

Building Typologies

Tower & Podium

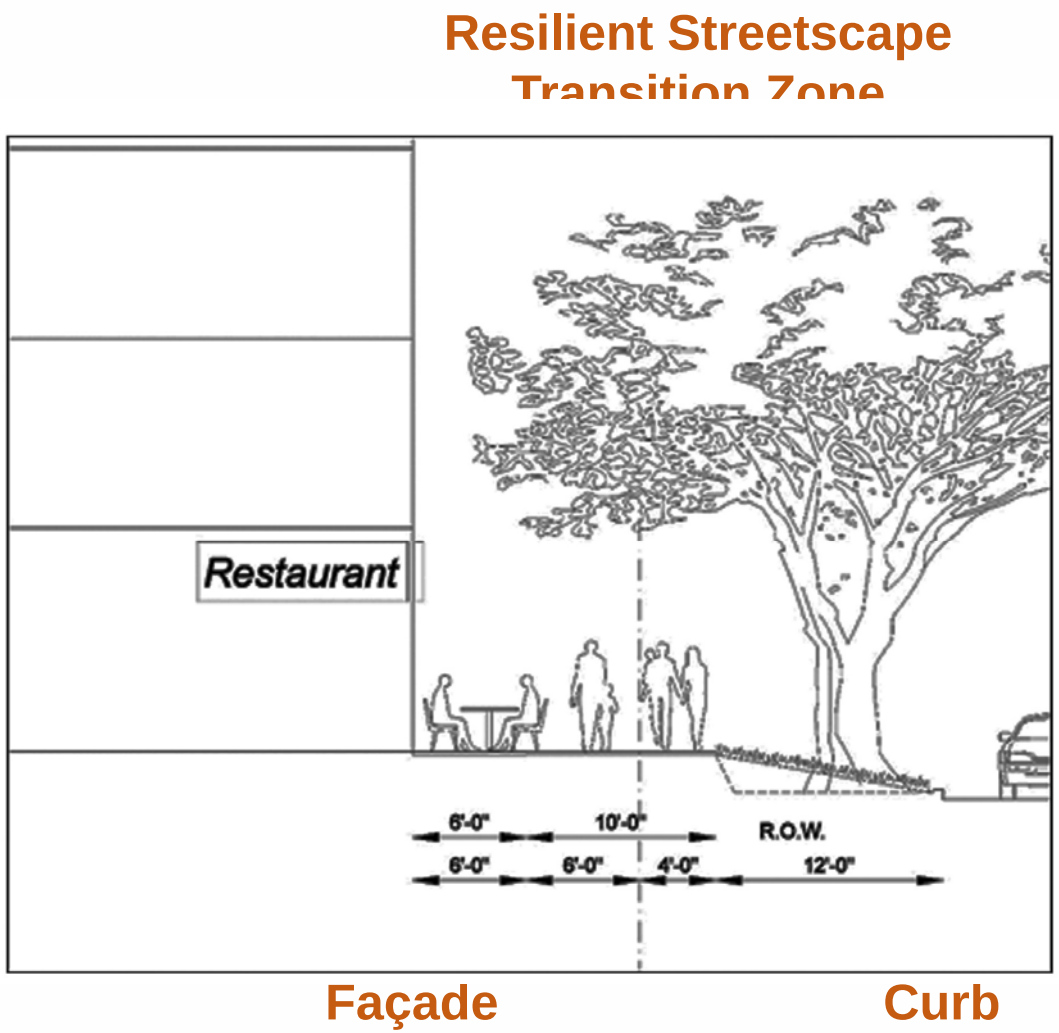
Mid-Rise Building

Low-Rise Walk-up

Three Common Urban Typologies

RESILIENT BUILDINGS & SITE DESIGNS

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.


NORDSTROM


sanrik


sanrik

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

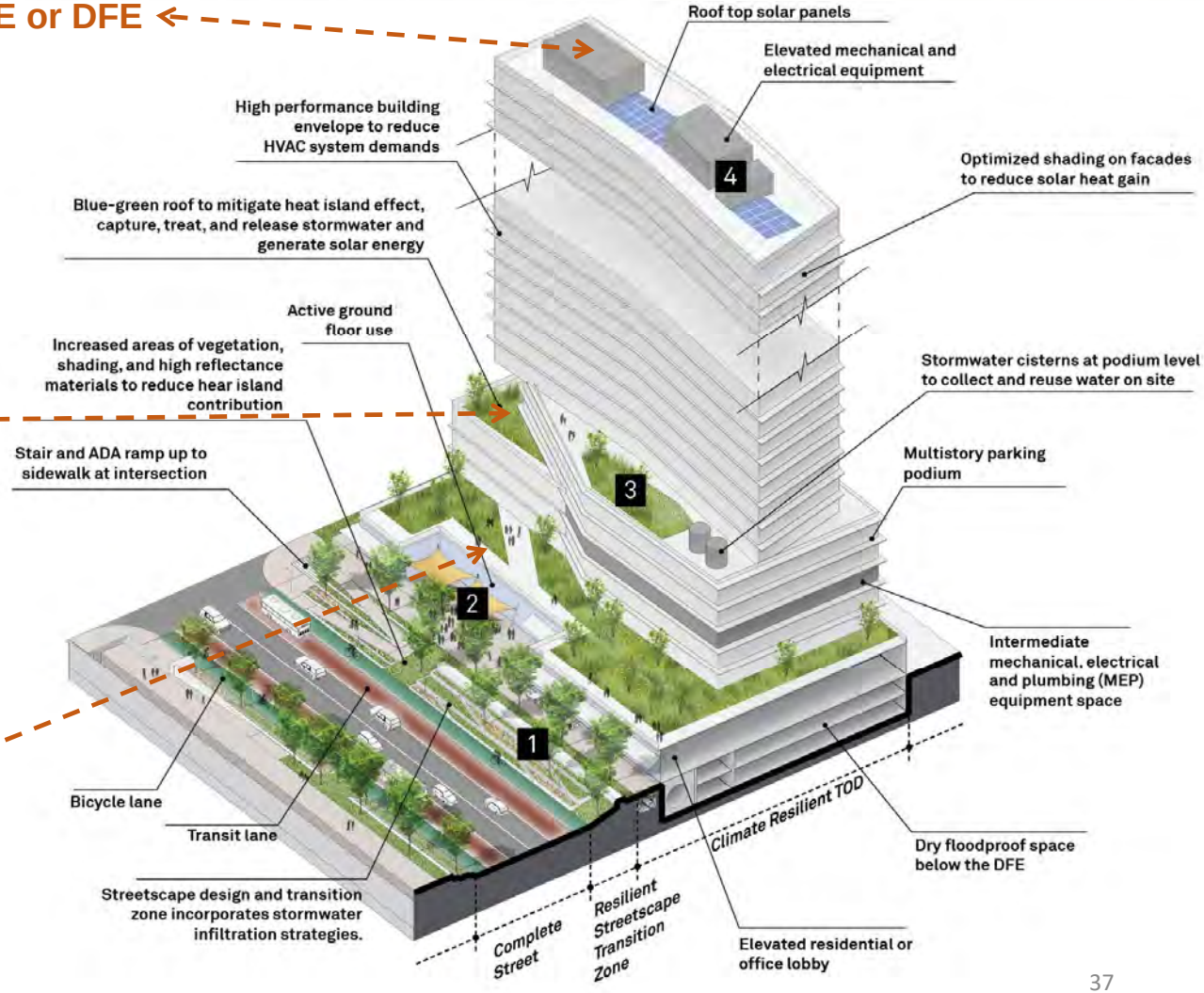
Tower & Podium

- **Locate critical systems above the BFE or DFE**

- **Provide sustainable roof systems**

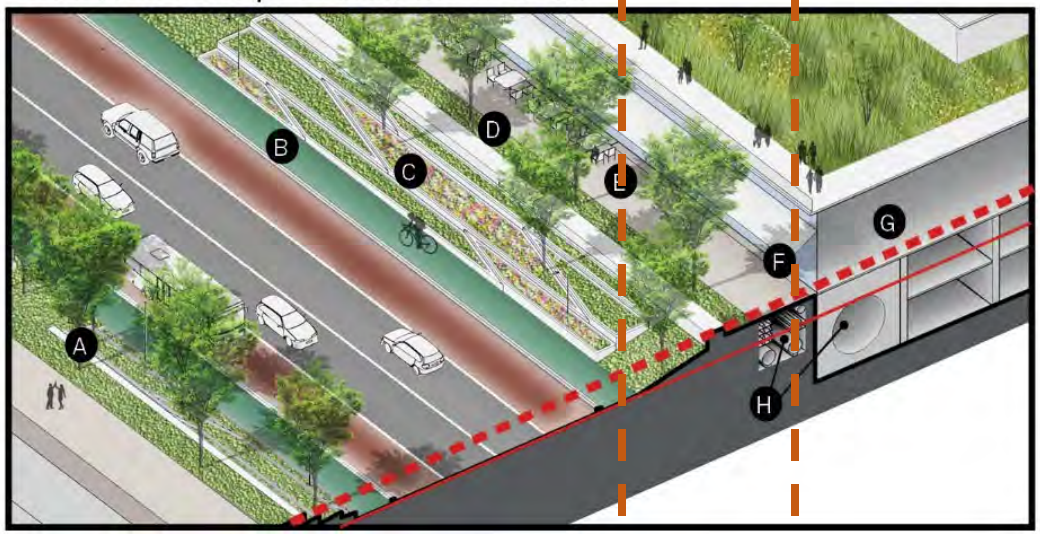
- **Podium is designed to be Pedestrian scale with high ground floor transparency**

- **Typically located along a high-volume “complete street”**



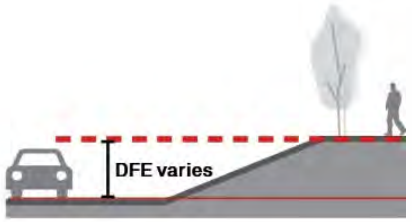
Resilient Streetscape Transition Zone

Resilient Streetscape Transition Zone Detail



Design Flood Elevation

Standard Design Elevation



- A Public green space
- B Bike Lane
- C Transitional planters
- D Tree lawn
- E Street furniture
- F Active ground floor use
- G Raised ground floor
- H Supporting Infrastructure

All Resilient Transition Zones must be ADA compliant

Resilient Streetscape Transition Zone

- **Flood-resistant/saltwater tolerant landscaping**
- **Pedestrian amenities**
- **Shade structures**
- **Paths**

Mid-Rise Building

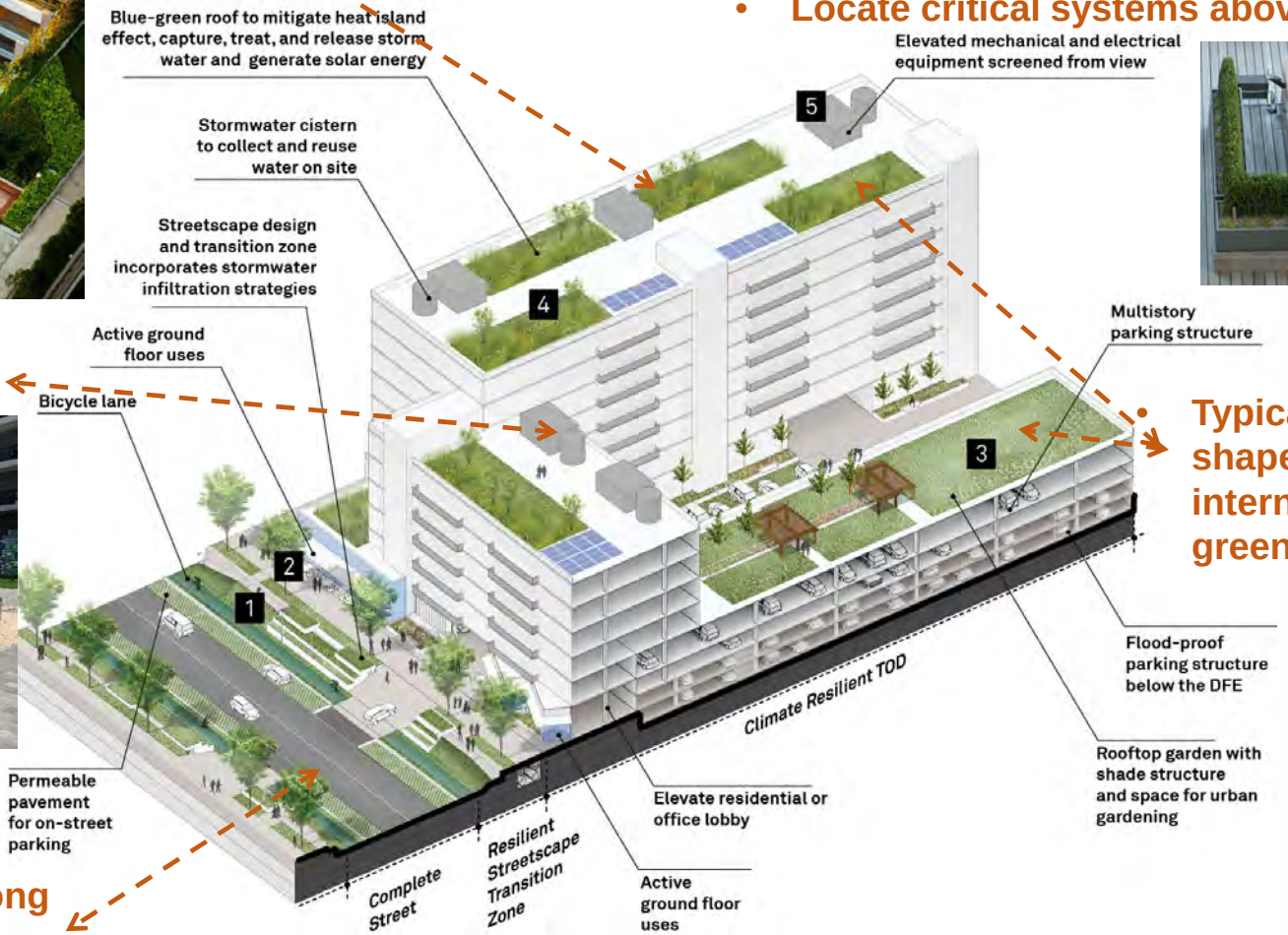
- Four to seven-story building contains apartment flats
- Residential use
- Off-street parking, active ground floor retail space

Mid-Rise Building

- **Provide sustainable roof systems**

- **Provide systems for onsite water reuse**

- **Typically located along "complete street"**

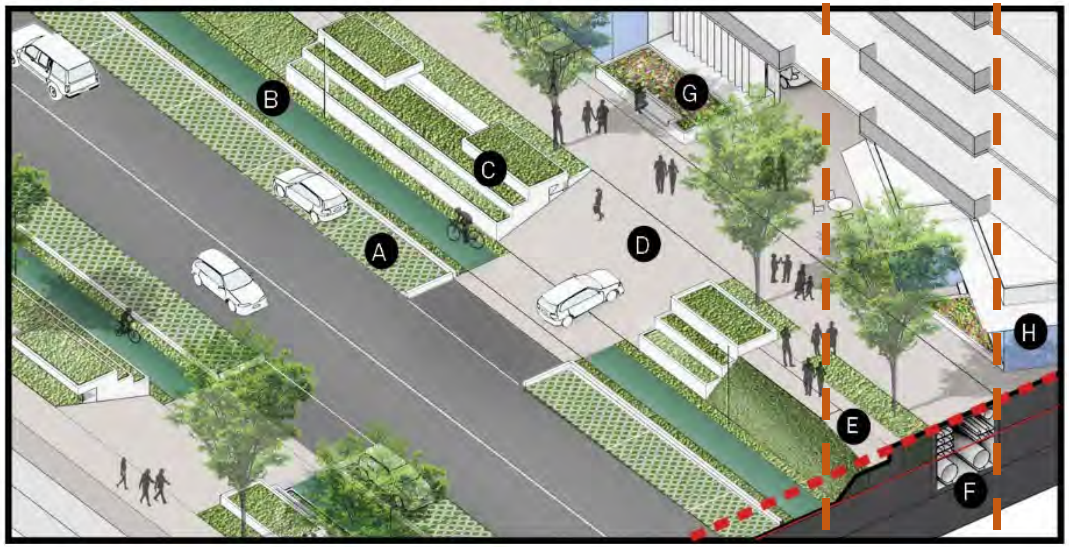


- **Locate critical systems above the BFE or DFE**

- **Typical U-shaped, L-shaped layouts with internal courtyards and green roofs.**

Mid-Rise Apartment Building

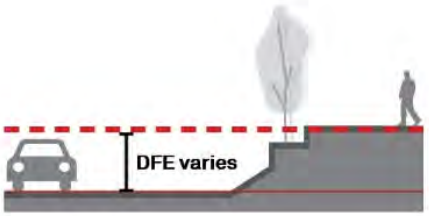
Resilient Streetscape Transition Zone Detail



All Resilient Transition Zones must be ADA compliant

Design Flood Elevation

Standard Design Elevation



- **A** Permeable pavement
- **B** Bike lane
- **C** Transitional landscape
- **D** Parking entrance
- **E** Barrier-free ADA ramp up to sidewalk from intersection
- **F** Supporting infrastructure
- **G** Planters with seating
- **H** Active ground floor use

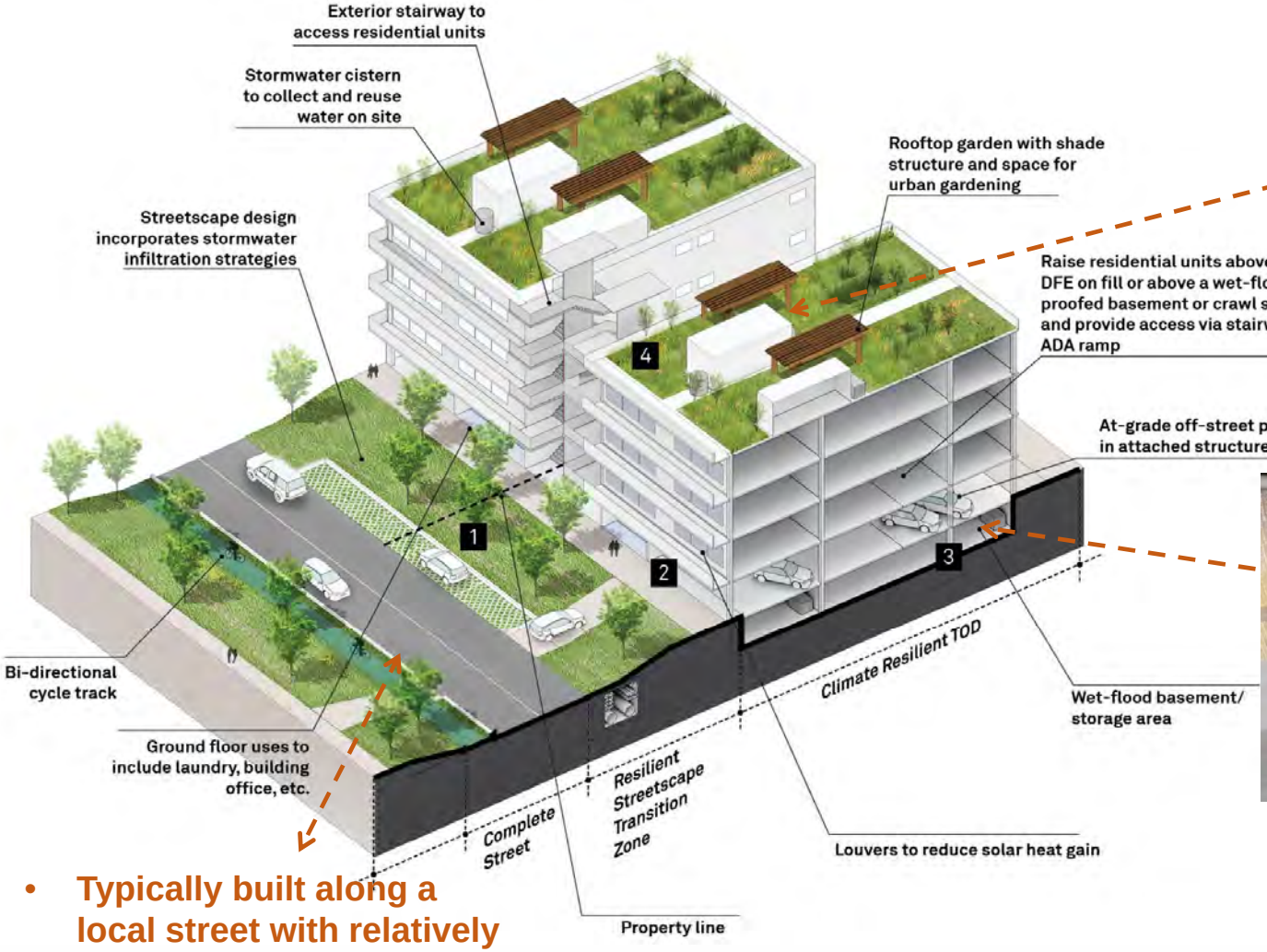
Resilient Streetscape Transition Zone

- **Flood-resistant/saltwater tolerant landscaping**
- **Green infrastructure**

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



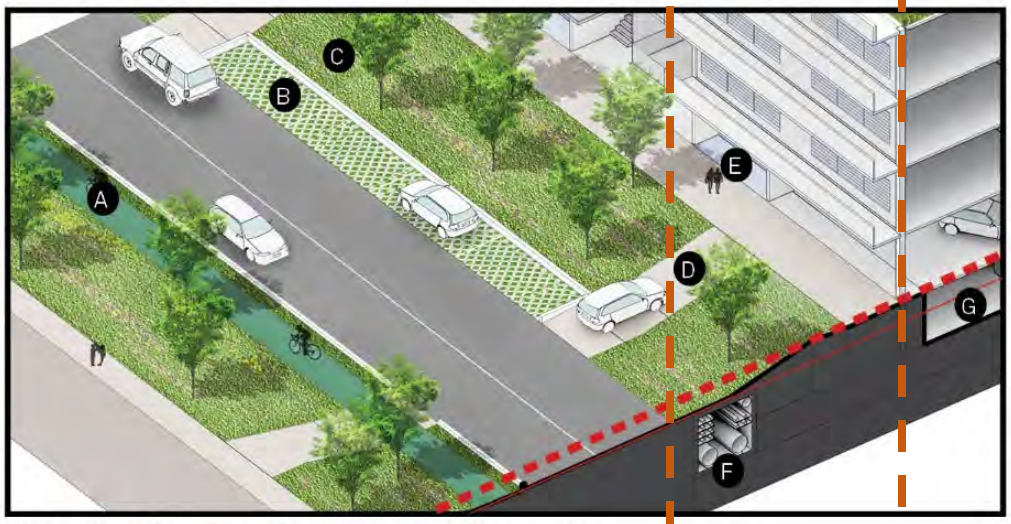
- **Typically built along a local street with relatively low traffic volumes**

- **Site critical mechanical and electrical systems on the roof**

- **Provide wet floodproofed basement or storage area below BFE or DFE.**

Low Rise Walk-up

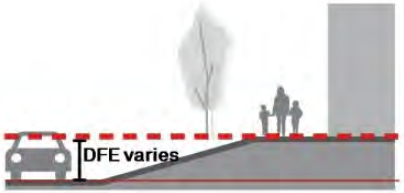
Resilient Streetscape Transition Zone Detail



All Resilient Transition Zones must be ADA compliant

Design Flood Elevation

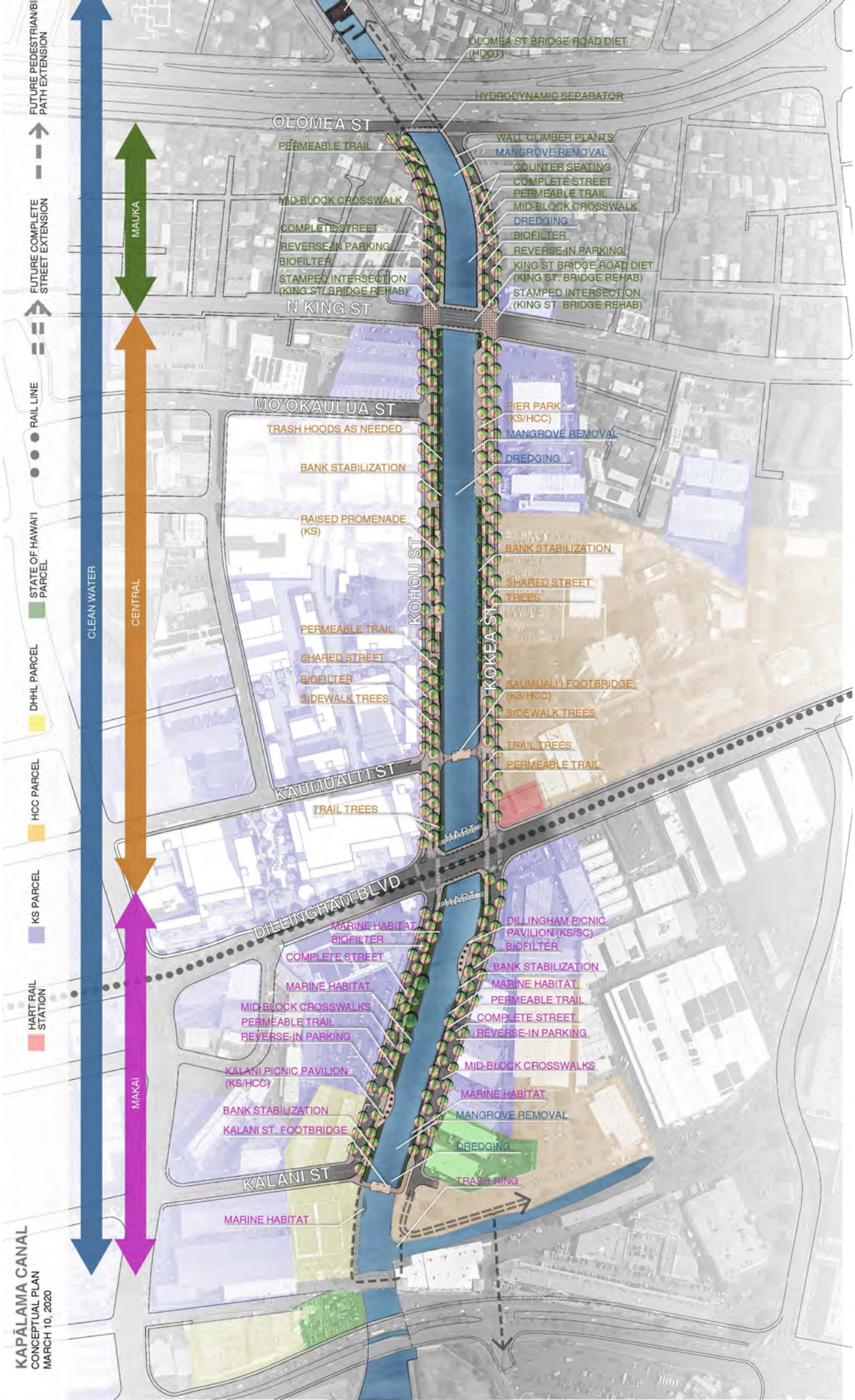
Standard Design Elevation



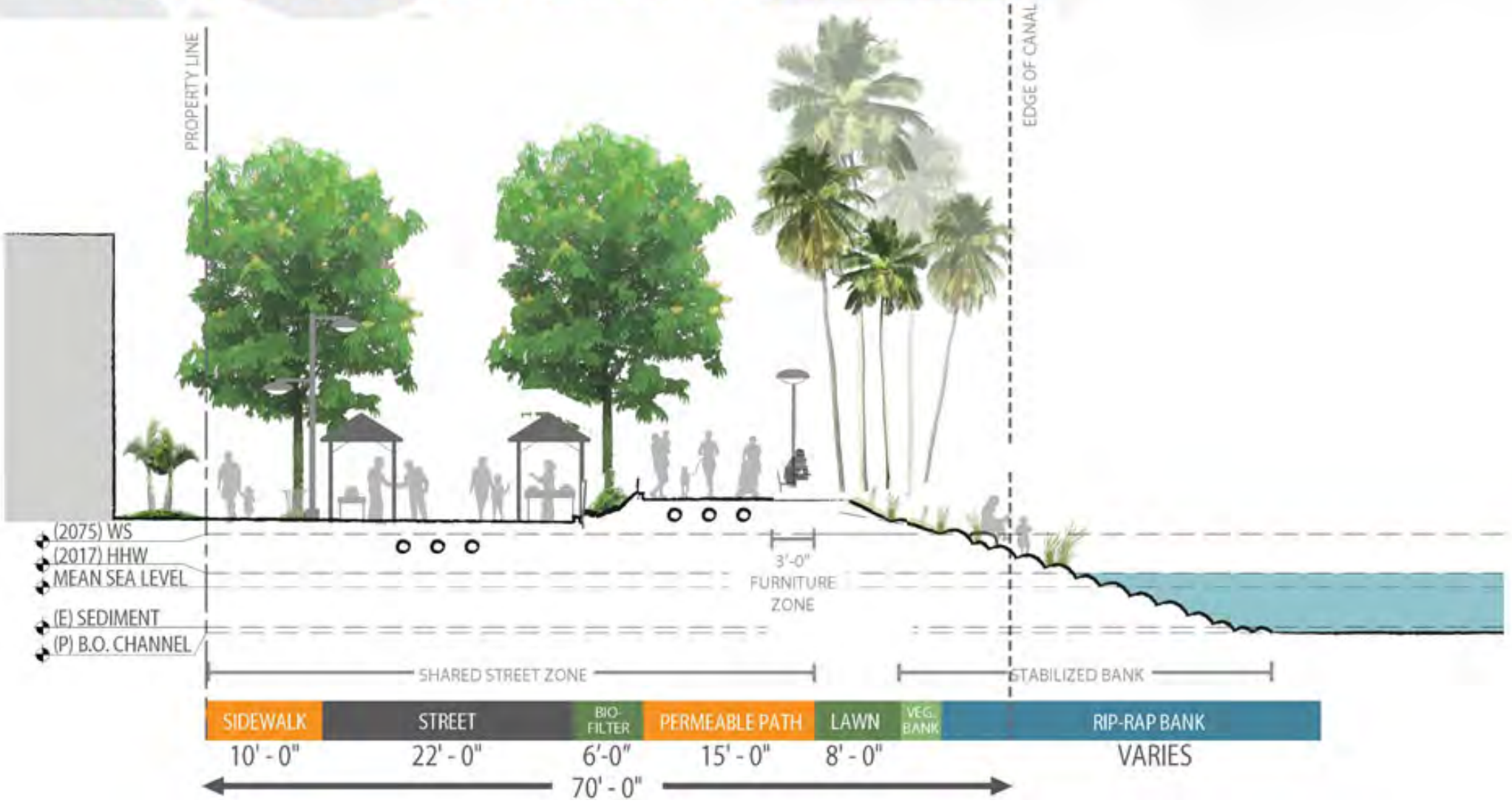
- **A** Cycle track
- **B** Permeable pavement
- **C** Transitional landscape
- **D** Parking entrance
- **E** Building lobby or office use to promote active frontage
- **F** Supporting infrastructure
- **G** Wetflood proofed storage space/basement

Resilient Streetscape Transition Zone

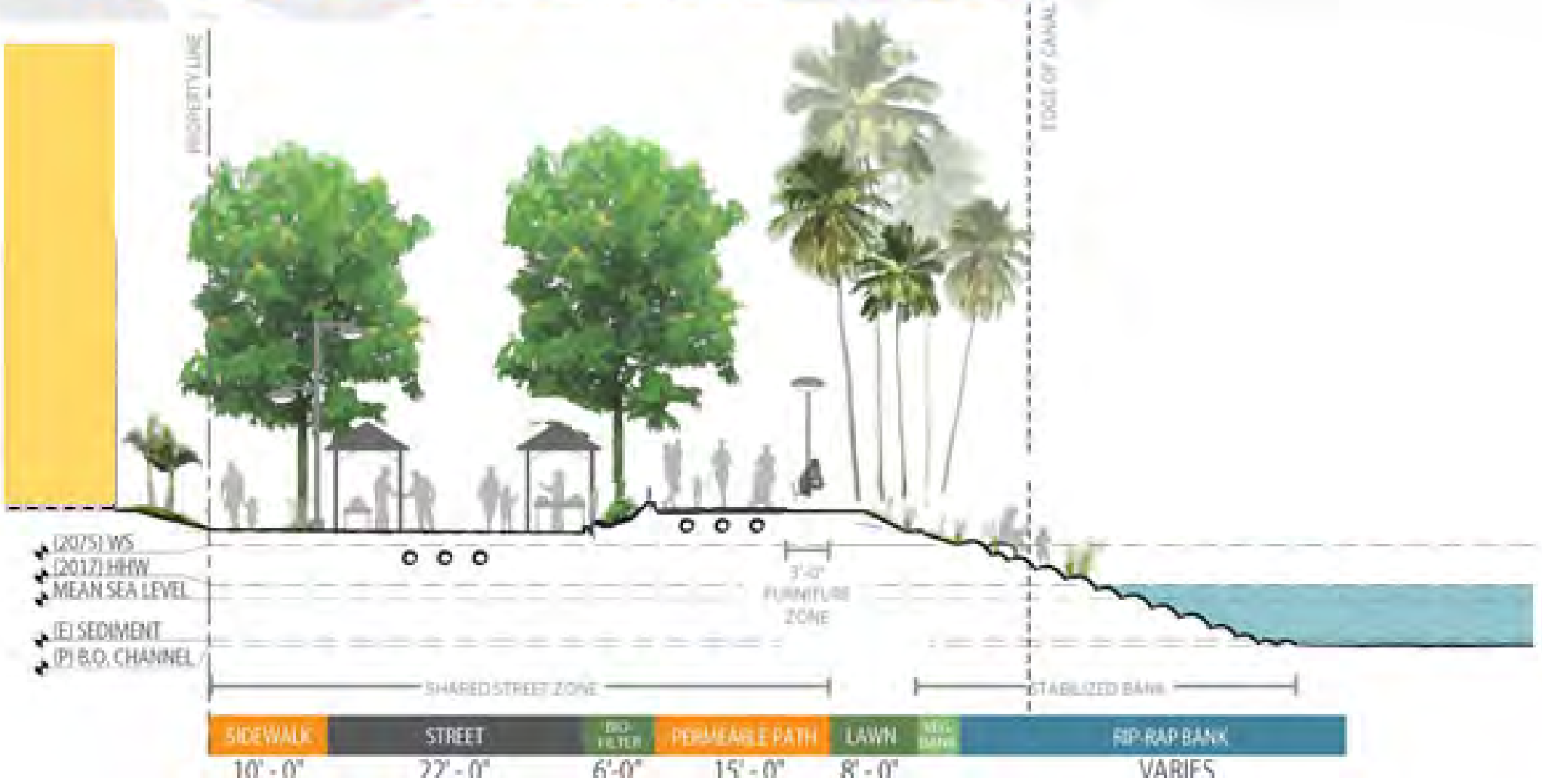
- **Flood-resistant/saltwater tolerant landscaping**
- **Green infrastructure**
- **Street trees and other green elements to soften or screen parking from public view**


FUTURE PEDESTRIAN/BI PATH EXTENSION
FUTURE COMPLETE STREET EXTENSION
RAIL LINE
STATE OF HAWAI'I PARCEL
DHHL PARCEL
HCC PARCEL
KS PARCEL
HART RAIL STATION
CLEAN WATER
MAUKA
CENTRAL
MAKAI
OLOMEA ST BRIDGE ROAD DIET (HDOT)
HYDRODYNAMIC SEPARATOR
OLOMEA ST
PERMEABLE TRAIL
MID-BLOCK CROSSWALK
COMPLETE STREET
REVERSE-IN PARKING
BIOFILTER
STAMPED INTERSECTION (KING ST. BRIDGE REHAB)
N KING ST
WALL CLIMBER PLANTS
MANGROVE REMOVAL
COUNTER SEATING
COMPLETE STREET
PERMEABLE TRAIL
MID-BLOCK CROSSWALK
DREDGING
BIOFILTER
REVERSE-IN PARKING
KING ST BRIDGE ROAD DIET (KING ST. BRIDGE REHAB)
STAMPED INTERSECTION (KING ST. BRIDGE REHAB)
MO'OKAULUA ST
TRASH HOODS AS NEEDED
BANK STABILIZATION
RAISED PROMENADE (KS)
PERMEABLE TRAIL
SHARED STREET
BIOFILTER
SIDEWALK TREES
KOHOU ST
KOKEA ST
PIER PARK (KS/HCC)
MANGROVE REMOVAL
DREDGING
BANK STABILIZATION
SHARED STREET TREES
KAUMUALI'I FOOTBRIDGE (KS/HCC)
SIDEWALK TREES
TRAIL TREES
PERMEABLE TRAIL
KAUMUALI'I ST
TRAIL TREES
HART
DILLINGHAM BLVD
HART
MARINE HABITAT
BIOFILTER
COMPLETE STREET
MARINE HABITAT
MID-BLOCK CROSSWALKS
PERMEABLE TRAIL
REVERSE-IN PARKING
KALANI PICNIC PAVILION (KS/HCC)
BANK STABILIZATION
KALANI ST. FOOTBRIDGE
KALANI ST
MARINE HABITAT
DILLINGHAM PICNIC PAVILION (KS/SC)
BIOFILTER
BANK STABILIZATION
MARINE HABITAT
PERMEABLE TRAIL
COMPLETE STREET
REVERSE-IN PARKING
MID-BLOCK CROSSWALKS
MARINE HABITAT
MANGROVE REMOVAL
DREDGING
TRASH RING
KAPĀLAMA CANAL
CONCEPTUAL PLAN
MARCH 10, 2020

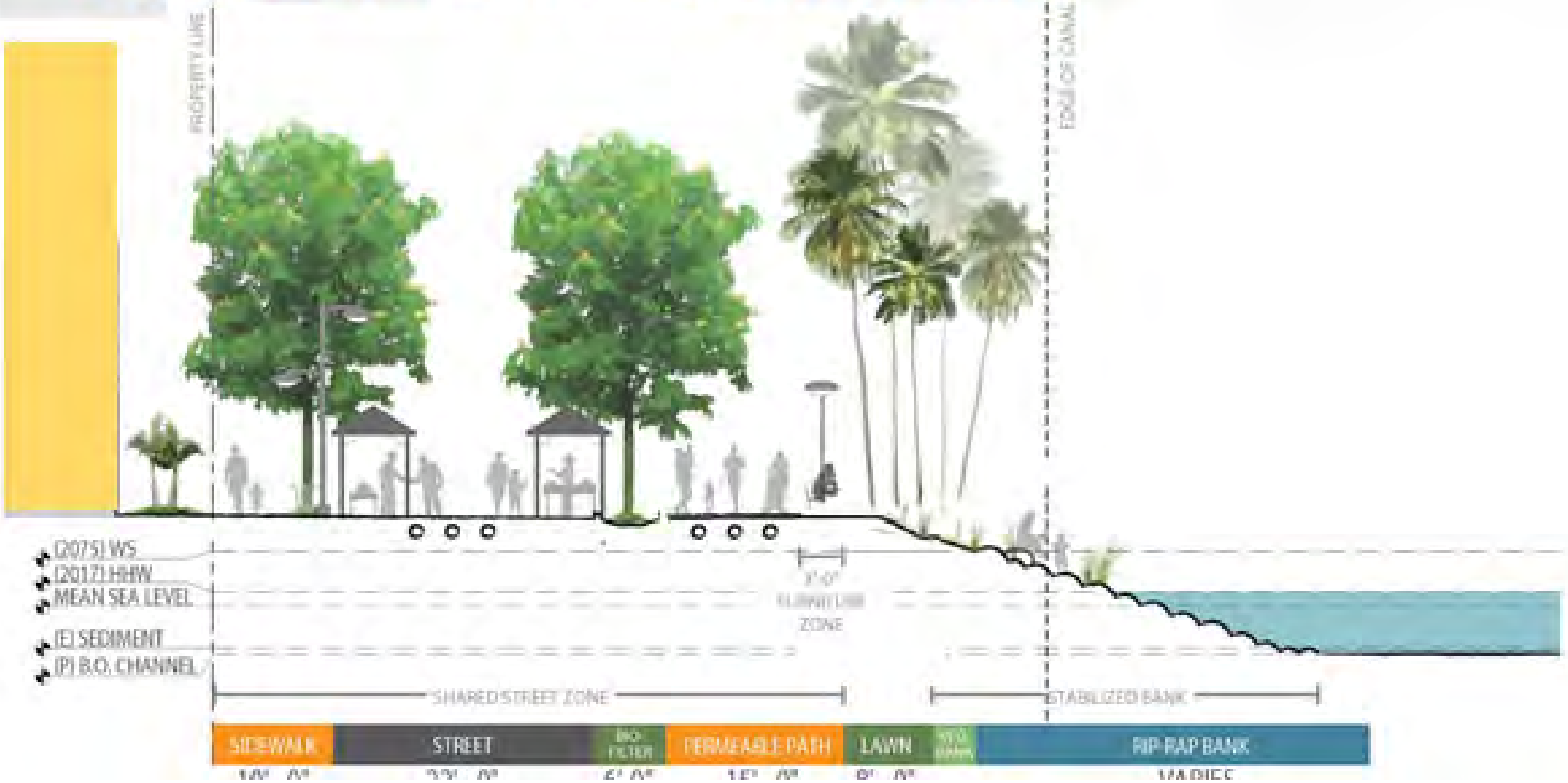
Overall Character: Central Street Section



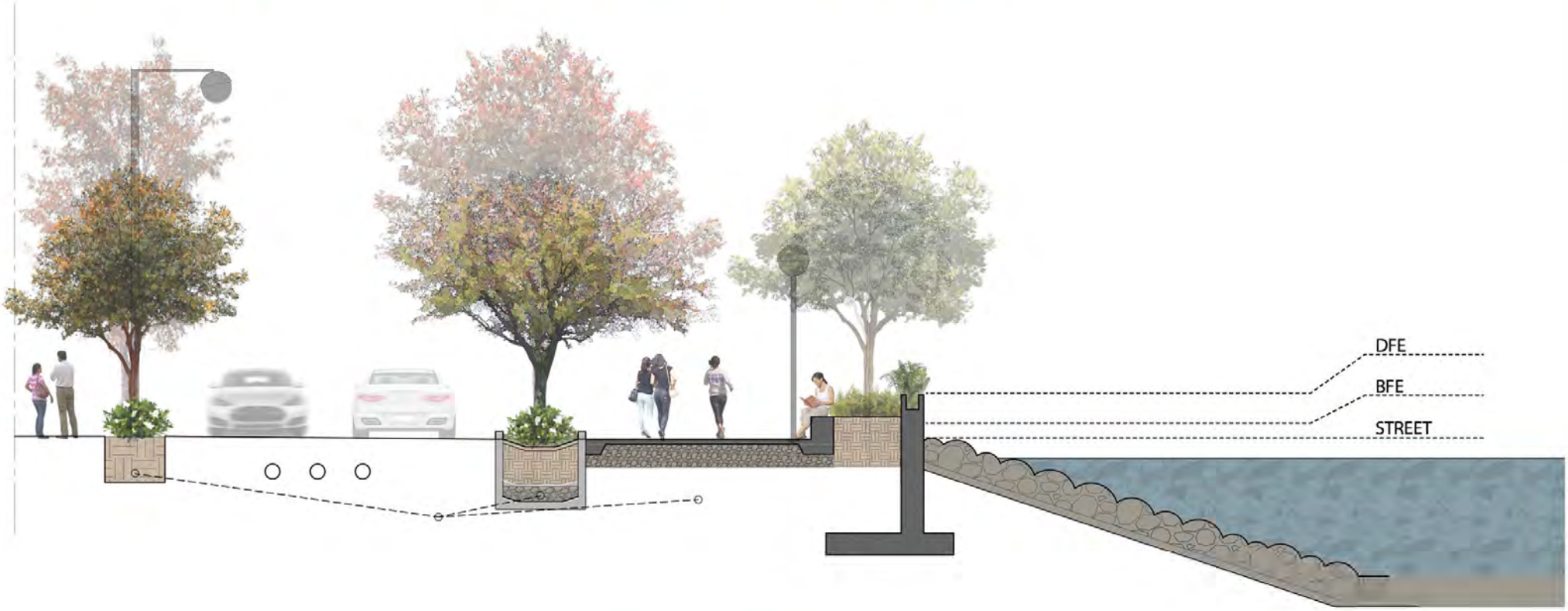
Overall Character: Central Street Section



Overall Character: Central Street Section



Central Canal: Section D, typ. (SLR +3.2')



SIDEWALK	STREET	BIO FILTER	PERMEABLE PATH	RAISED LAWN	FLOOD WALL	STABILIZED RIP-RAP
10'-0"	22'-0"	6'-0"	15'-0"	1'-6"		

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

Key Structural Design Outcomes

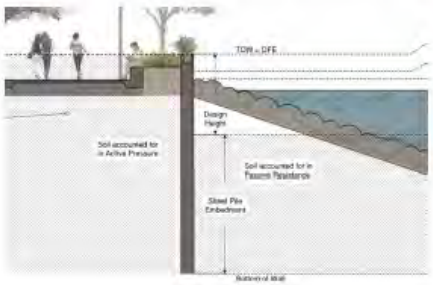
- Inform Cost
  - Wall design height
  - Required embedment
  - Preliminary sizing
- Confirm Feasibility
  - Stability
  - Constructability
- Advise on detailing constraints

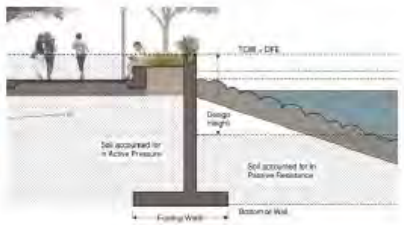
Table 7 Relative Structural Geometry for Representative Sections

		Makai	Central A	Central B	Mauka[1]
	Wall Design Height:	**H = 10ft**	**H = 9 ft**	**H = 10 ft**	**H = 4 ft**
Cantilever T-Wall Option	Total Height of wall[2]	22 ft	18 ft	28 ft	–
	Foundation Footing Width	23 ft	20 ft	30 ft	–
Sheet Pile I-Wall Option	Total Height of wall	37 ft	27 ft	37 ft	28 ft
	Min Sheet Pile Embedment Depth	27 ft	18 ft	27 ft	24 ft

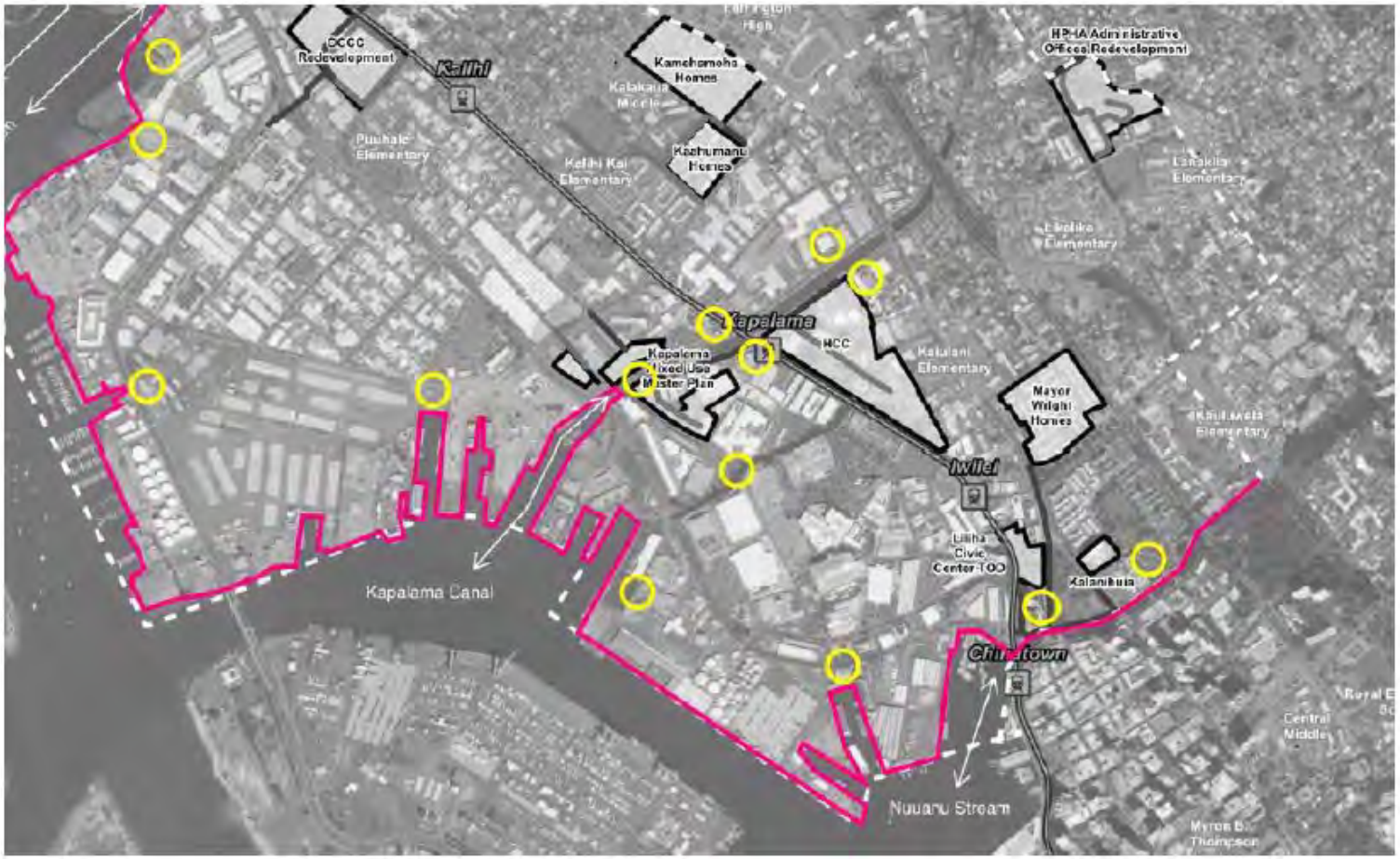
[1] Retained height is small because sheet pile wall it to be installed behind the existing CRM wall which is expected to retain: the sheet pile wall tip elevation is governed by embedment into competent soil (see Section 5)

[2] Elevation of bottom of T-wall footing is governed by geotechnical recommendation for location of competent soil





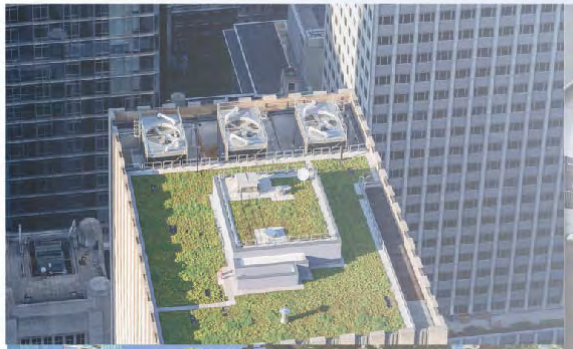
ARUP

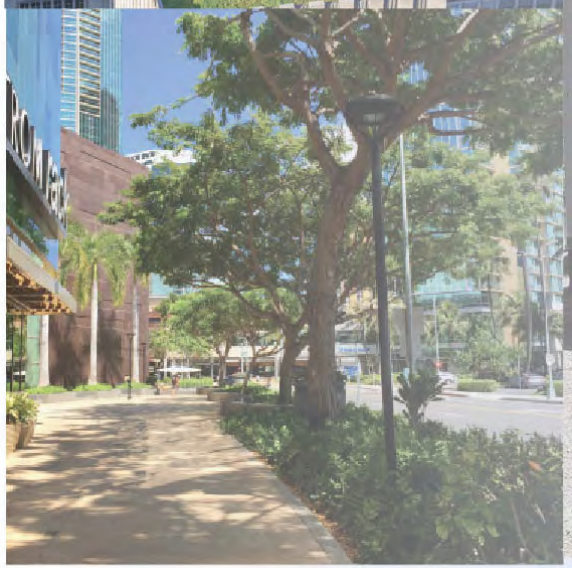


Long-Term Upgrades ???

Upgraded Seawall

Future Pump Stations

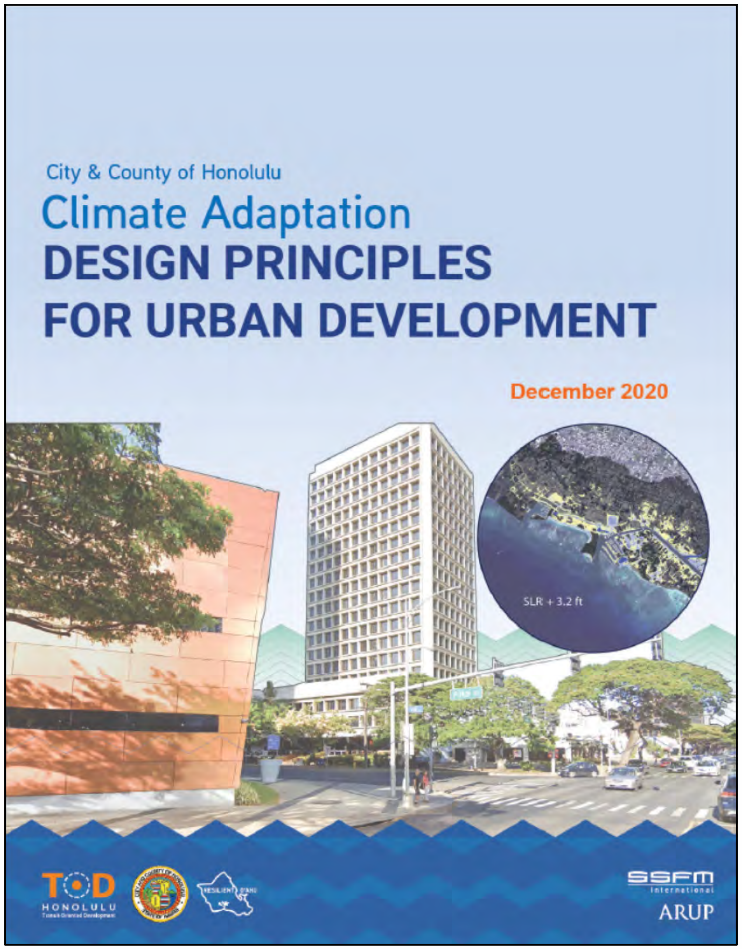




NEXT STEPS

HOW TO USE THIS DOCUMENT

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



Download a copy at
www.honolulu.gov/tod

LOCAL POLICY & REGULATIONS

GREENING IWILEI AND KAPALAMA

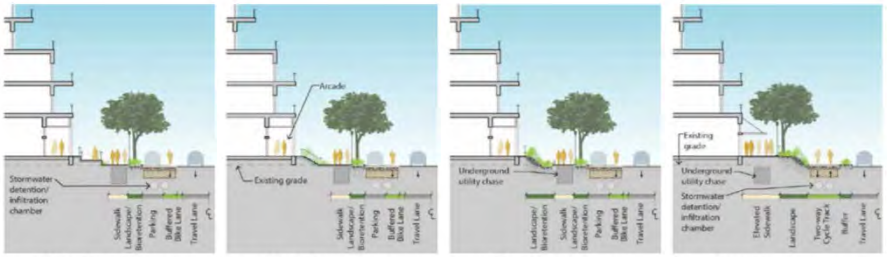


Figure 28A. Building relation to street option, section A- at Ramp

Figure 28B. Building relation to street option, section B- at Stairs

Figure 28C. Building relation to street option, section C- at Bioretention

Figure 28D. Building relation to street option, section D- through alternative with elevated sidewalk and no on-street parking

NEIGHBORHOOD TOD PLANS

- *Mayor's Directive on Climate Change* (18-02)
- *Mayor's Directive on Street Trees* (20-14)
- *O'ahu Resilience Strategy*
- *Climate 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
- 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……*

2. Related City Plans, Policies, Regulations

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 and private facilities and infrastructure
- **Updates to Special Management Area & Shoreline Setback Regulations** (DPP-LUPD) will incorporate sea level rise projections
- **Neighborhood TOD Plans and Zoning** (DPP-TOD)
- **DPW standard details** & stormwater utility (DFM)

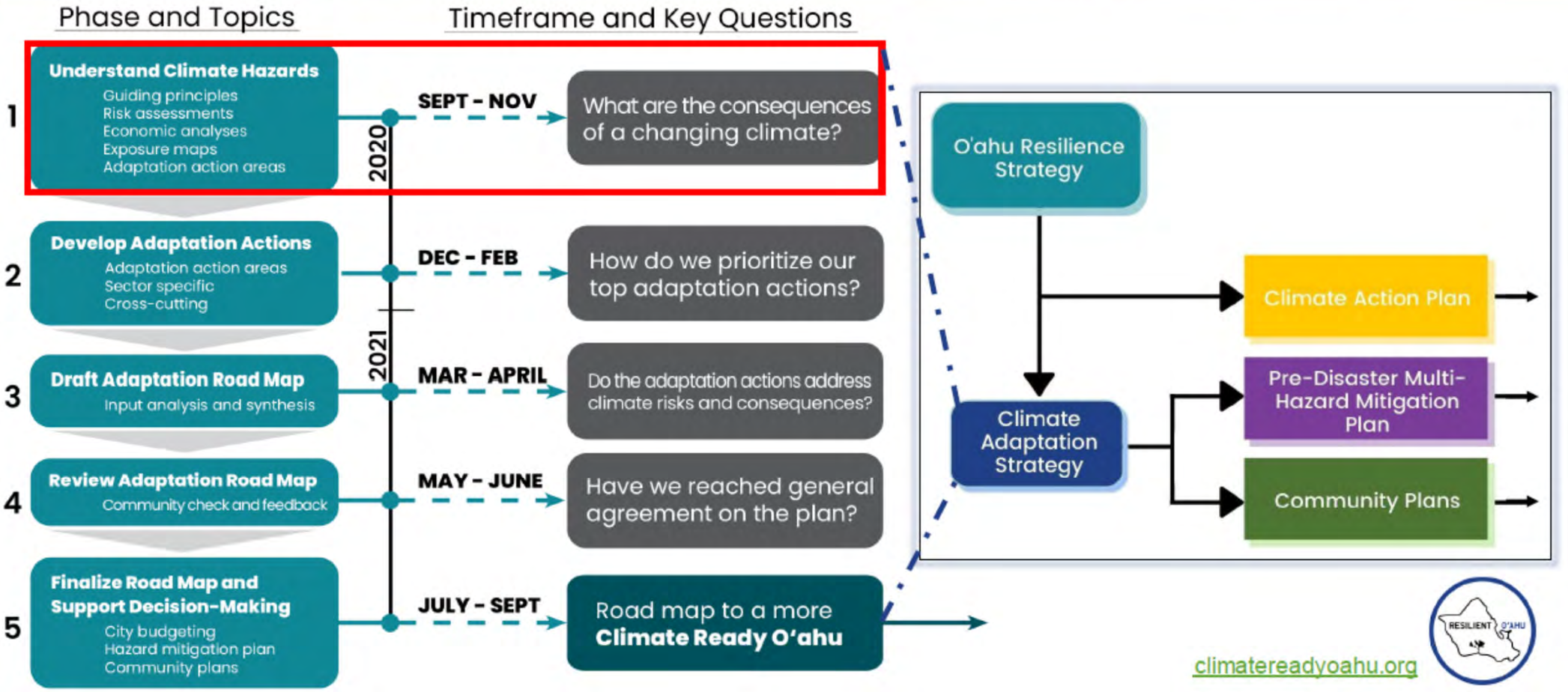
3. Other City Plans, Policies, Regulations

Noted for awareness/coordination; discuss further in next steps

- ❑ **Climate Adaptation Strategy -** climatereadyoahu (CCSR)
- ❑ **Primary Urban Center Development Plan** (DPP-PD)
- ❑ **OneWater planning** (BWS)
- ❑ **FEMA Hazard Mitigation Grants** (CCSR)
- ❑ **Flood ordinance updates** (DPP)
- ❑ **Building code updates** (DPP)
- ❑ **Others??**

Office of Climate Change, Sustainability and Resiliency

Climate Ready O'ahu Project Overview



climatereadyoahu.org

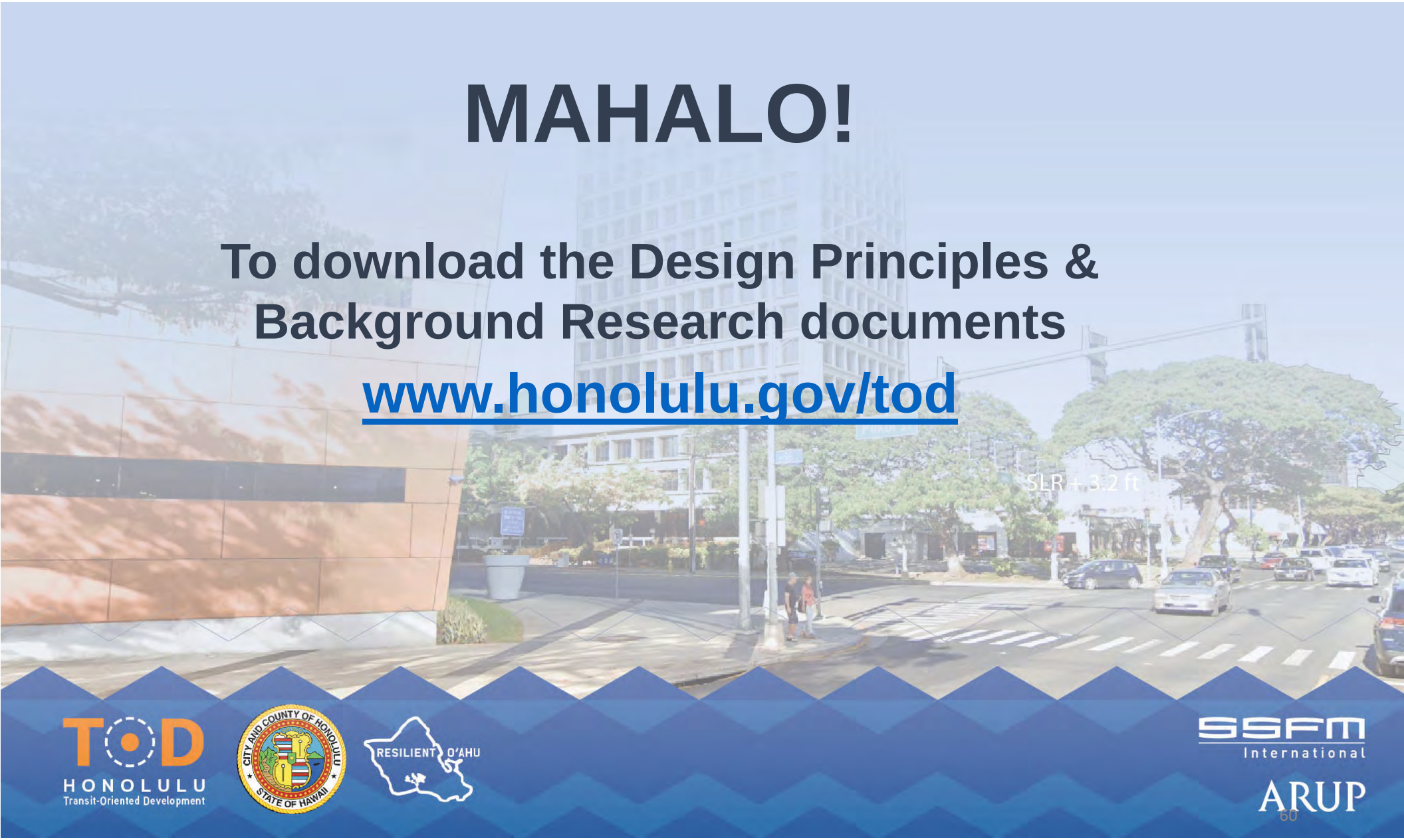
What's next for the PUC DP?

- The Public Review Draft for the PUC Development Plan is anticipated by this summer.
- The DP will include broad policies on climate resilience and maps to help clarify the different coastal edge and backshore conditions.
- In keeping with Directive 18-2 and Honolulu's Climate Guidance, the PUC DP policies promote adopting the 3.2' SLR-XA as a hazard overlay for zoning and permitting decisions.
- Adjusting to sea level rise will require unprecedented levels of agency coordination, difficult decisions about land uses, and trade-offs in public investment.
- While site-specific adaptation is important, it is just as important to plan on a regional basis for infrastructure adaptation and a phased approach to any needed hazard-based development restrictions.

MAHALO!

To download the Design Principles & Background Research documents

www.honolulu.gov/tod



TOD HONOLULU Transit-Oriented Development

CITY AND COUNTY OF HONOLULU STATE OF HAWAII

RESILIENT O'AHU

SSFM International

ARUP