City & County of Honolulu

Climate Adaptation
DESIGN PRINCIPLES FOR URBAN DEVELOPMENT

PICHTR Webinar

November 18, 2020

TOD HONOLULU Transit-Oriented Development

CITY AND COUNTY OF HONOLULU STATE OF HAWAII

RESILIENT O'AHU

SSFM International

ARUP

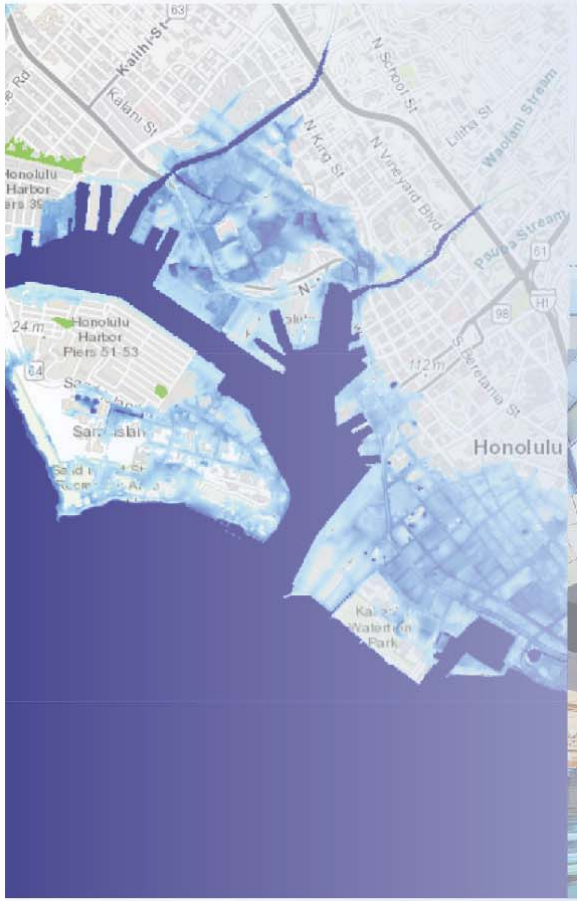
AGENDA

01 **Project Purpose**
Harrison Rue, DPP-TOD

02 **Resilient Design Principles**
Melissa May, SSFM

03 **Resilient Building & Site Design**
Andrew Tang, DPP-TOD

04 **Next Steps**



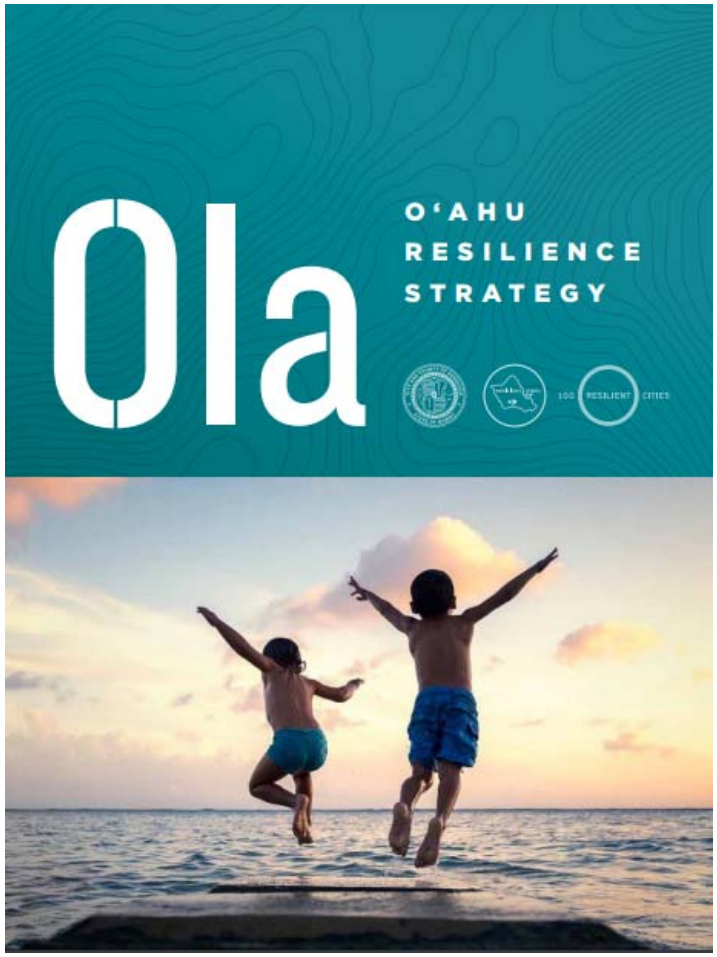
PROJECT PURPOSE

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

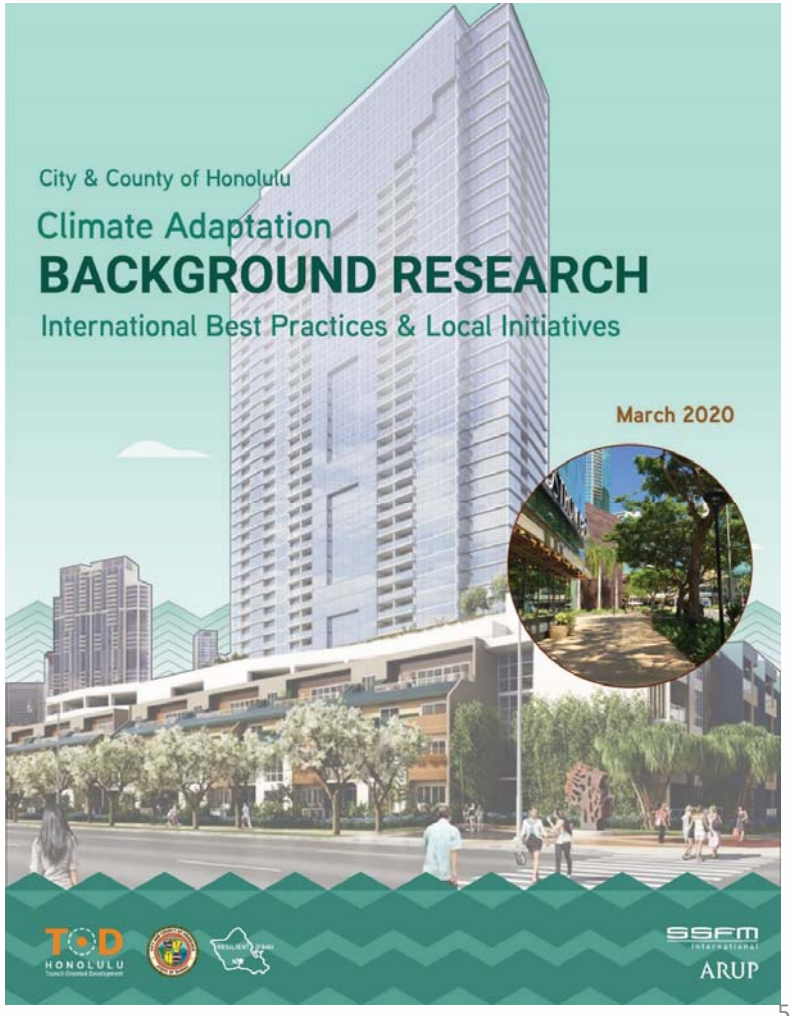
Mayor's Directive on Climate Change
Waikīkī Special District Design Guidelines
TOD Plans & Zoning
PUC Development Plan



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

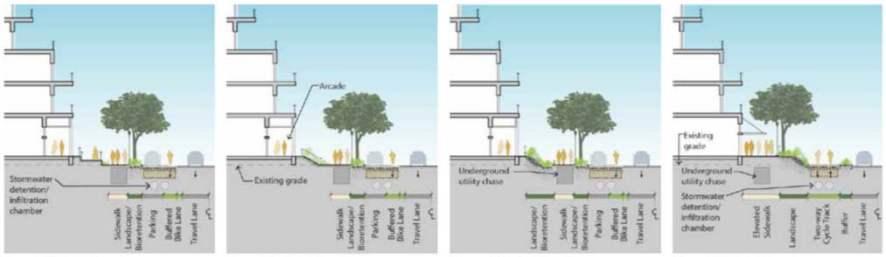


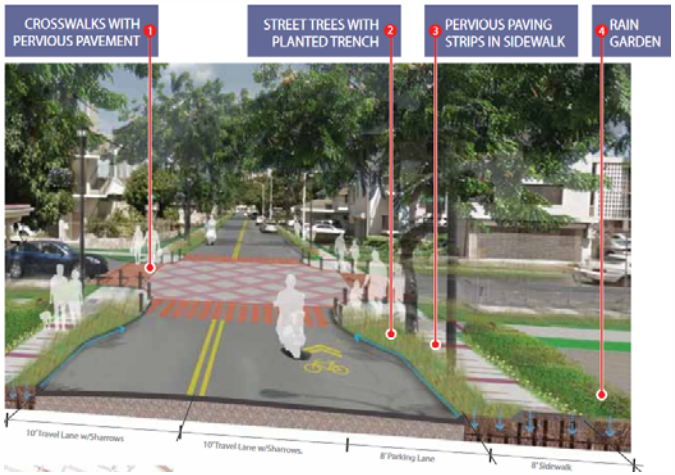
Figure 28A. Building relation to street option, section A- at Ramp

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



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- *Mayor's Directive on Street Trees* (20-14)
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  - *Building, Plumbing, Electrical Codes*
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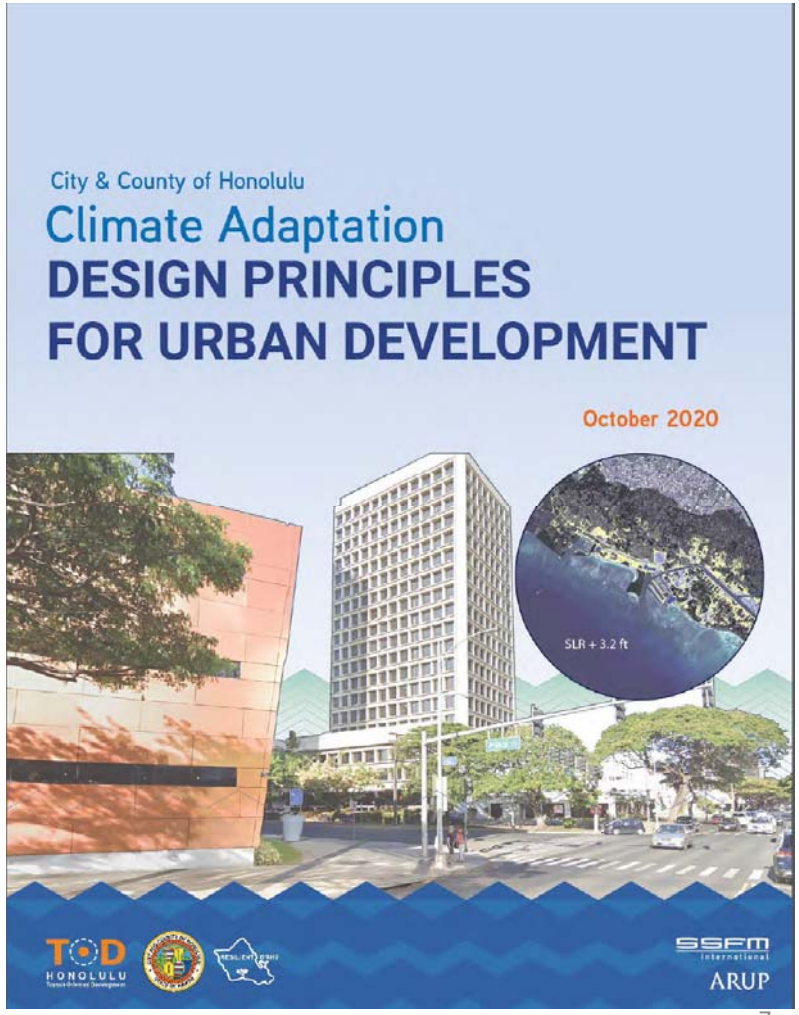
  - *Land Use Ordinance (Draft Update)*
  - *Plan Review Use Permit Guidelines*
  - *Planned Development Permit Guidelines*
  - *Special District Design Guidelines*
  - *Special Management Area*
  - *Shoreline Setback Ordinance*
  - *Subdivision Permit Requirements*
  - *Site Development Division Submittal*
  - *Neighborhood TOD Plans & TOD Zoning*

CLIMATE ADAPTATION DESIGN PRINCIPLES

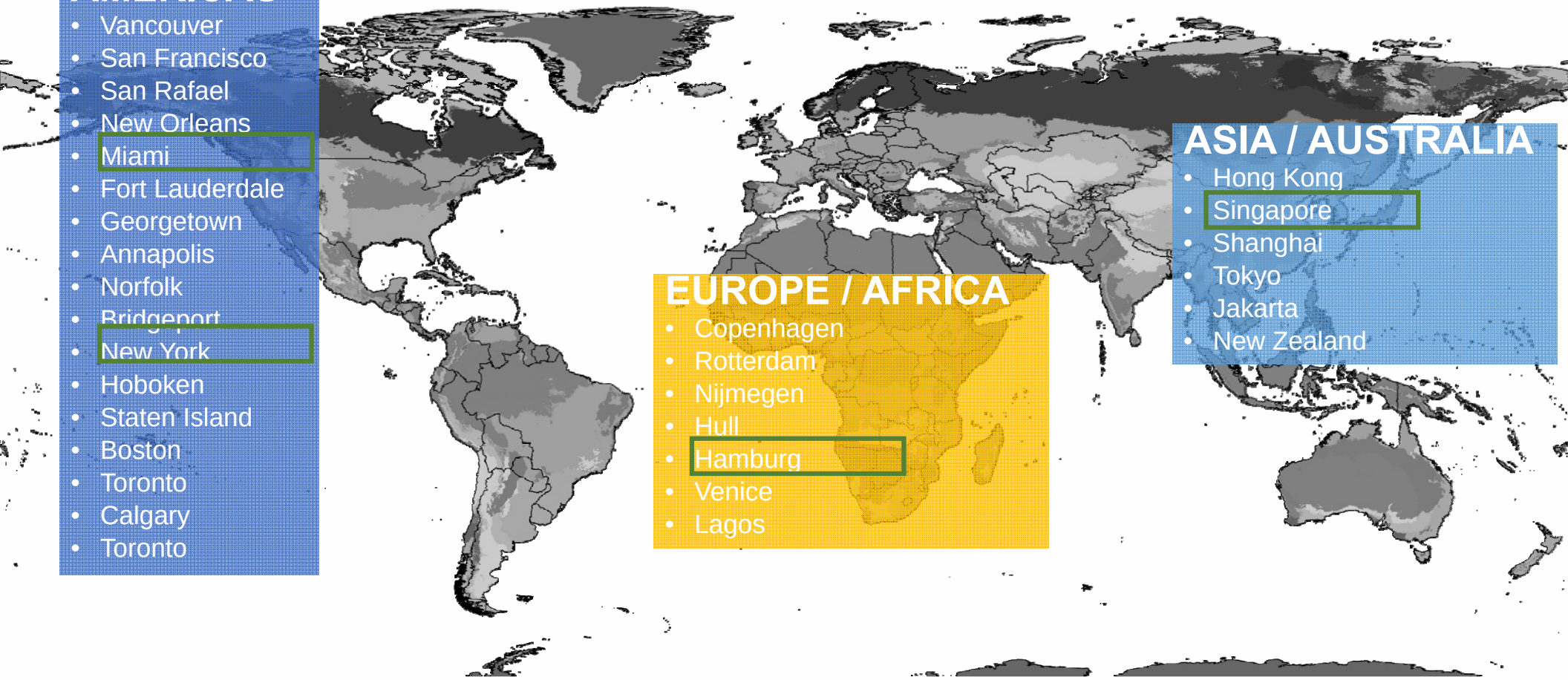
Outlines key design principles:

- 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



RESILIENT DESIGN PRINCIPLES

INTERNATIONAL & NATIONAL EXAMPLES



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

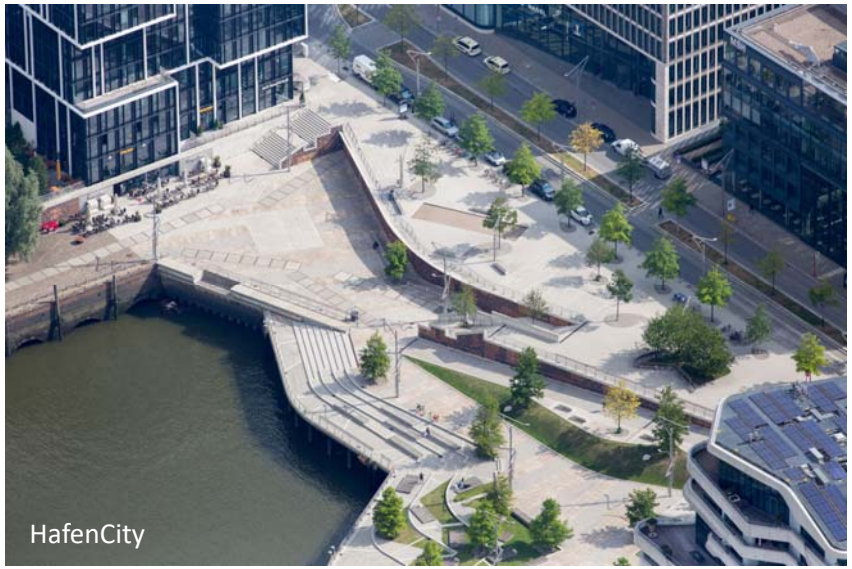
ASIA / AUSTRALIA

- Hong Kong
- Singapore
- Shanghai
- Tokyo
- Jakarta
- New Zealand

INTERNATIONAL & NATIONAL EXAMPLES

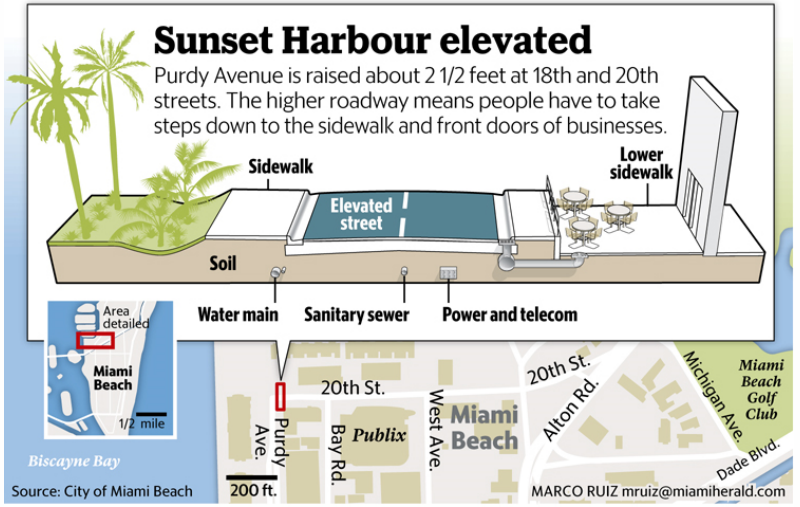
SINGAPORE:
RAISED BUILDING PLATFORMS

New developments are required to build +0.6 m above adjacent road/ground or above highest recorded flood level.



HAMBURG:
ELEVATED PROMENADES

The city built the roads and open public spaces on terraces more than 25 feet above normal high tide.



https://www.miamiherald.com/news/local/community/miami-dade/miami-beach/article115264938.html

MIAMI BEACH:
STREET & BUILDING RAISING

Working on resilient building design guidelines and updates to zoning code to allow for raising of buildings.

LOCAL POLICY & REGULATIONS

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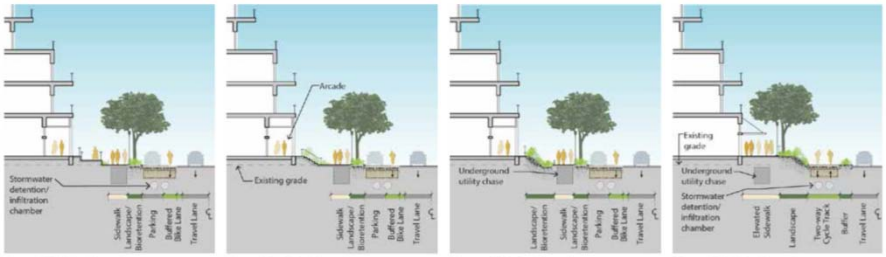

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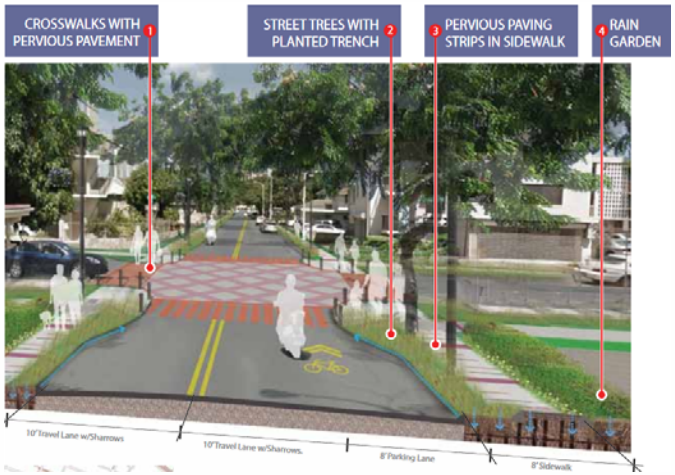

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RESILIENT DESIGN PRINCIPLES

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

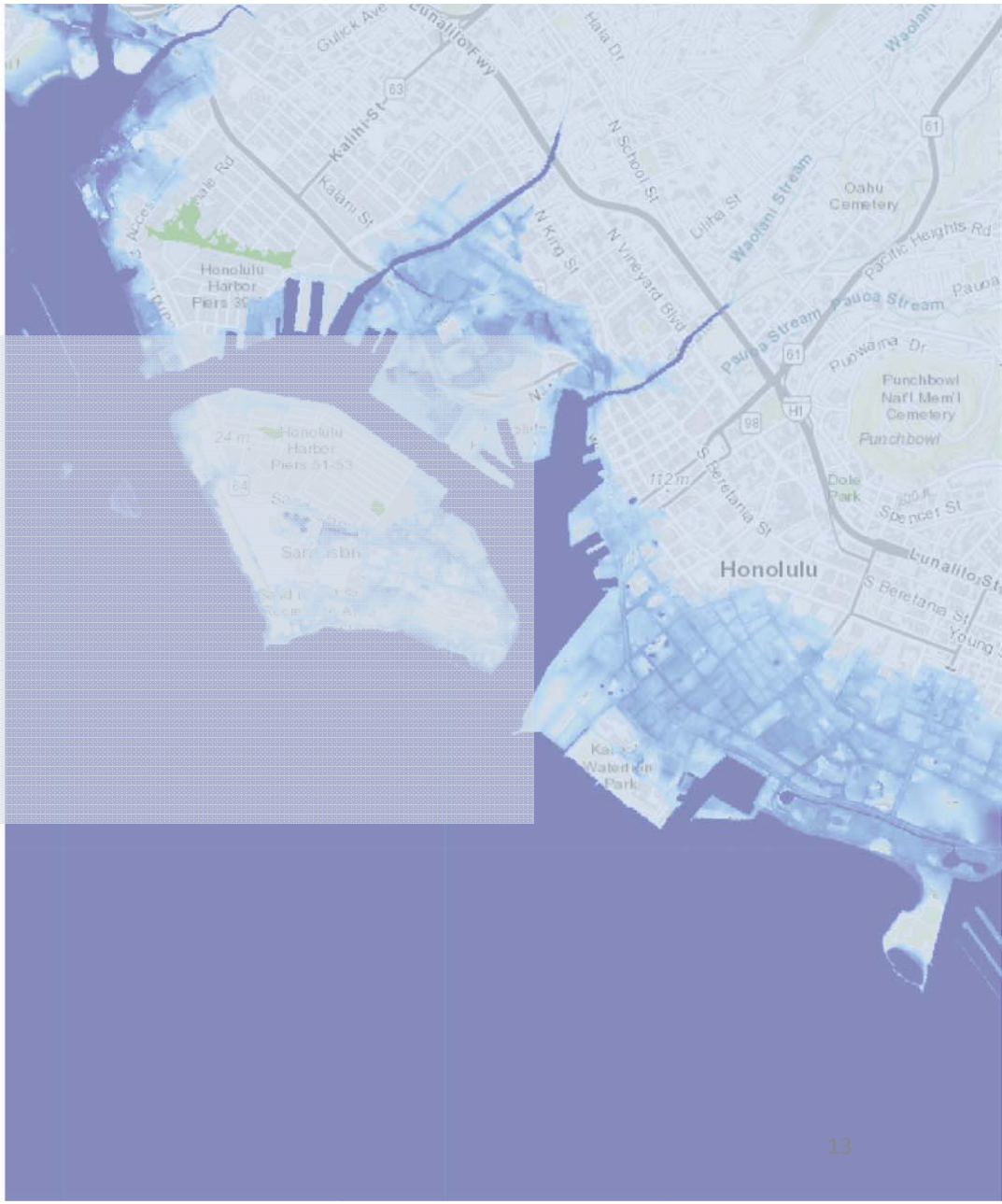
Incorporate future flooding and sea level rise projections into site planning and building design.

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.



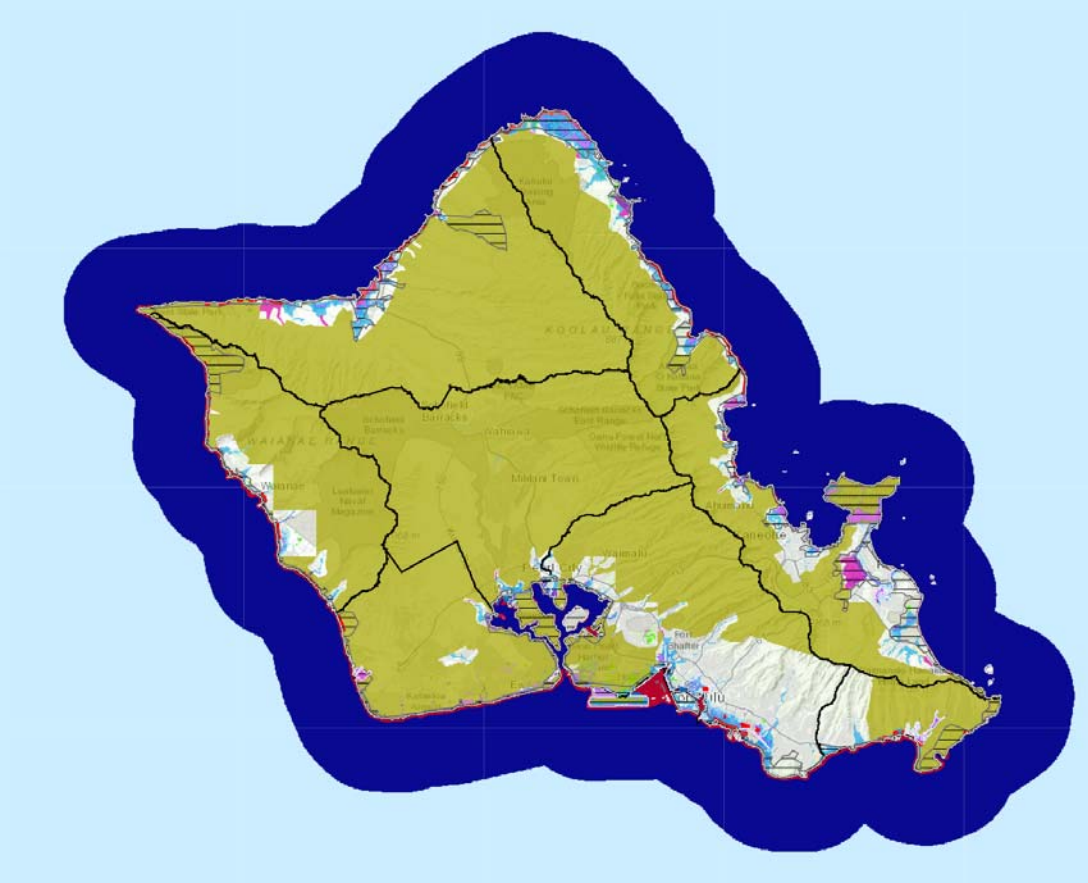
CLIMATE READY O‘AHU WEB EXPLORER

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.

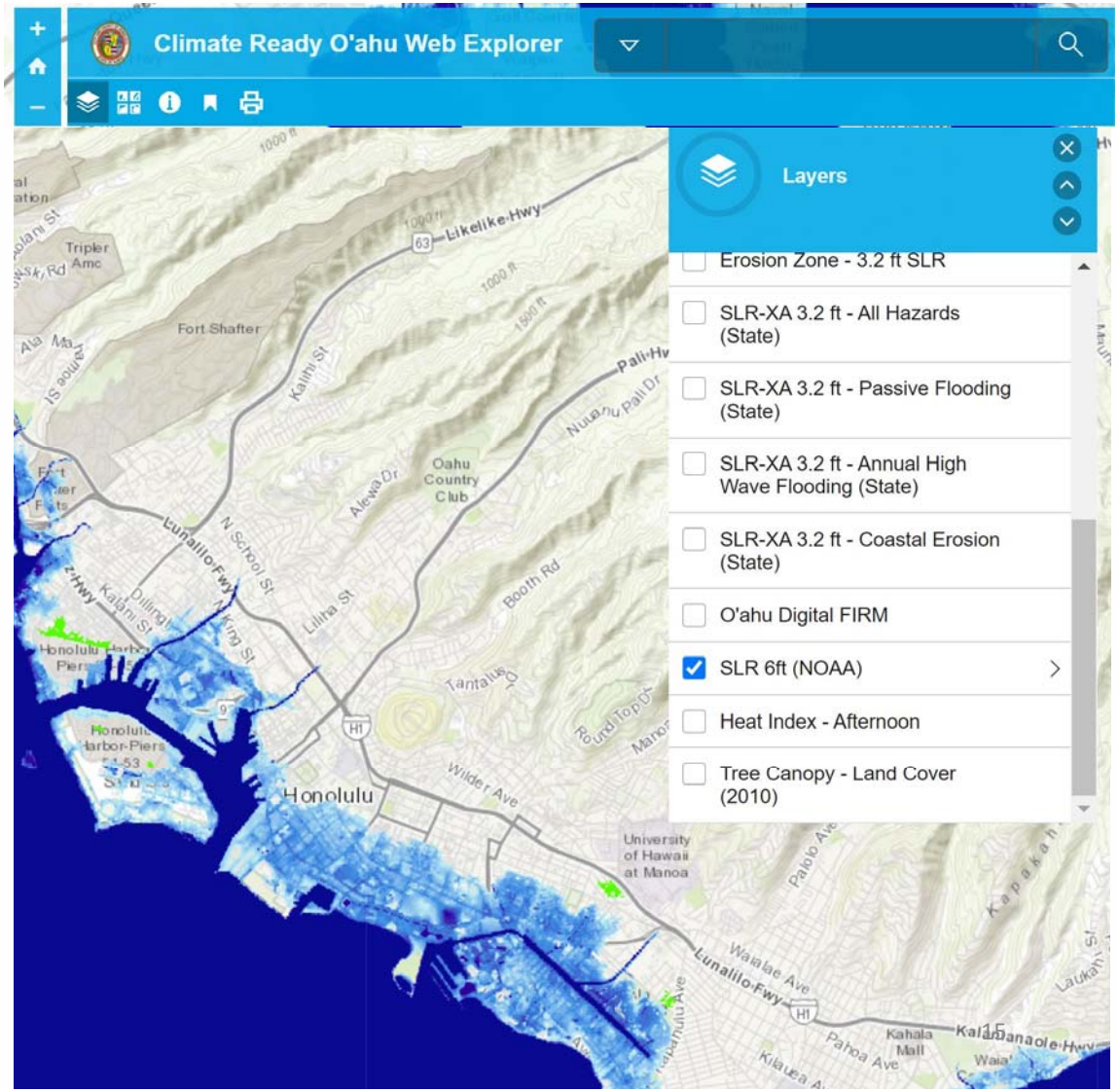
The web explorer incorporates SLR data from the Hawaii SLR Viewer and the National Oceanic and Atmospheric Administration’s SLR Viewer.



Bit.ly/climatereadyoahumap

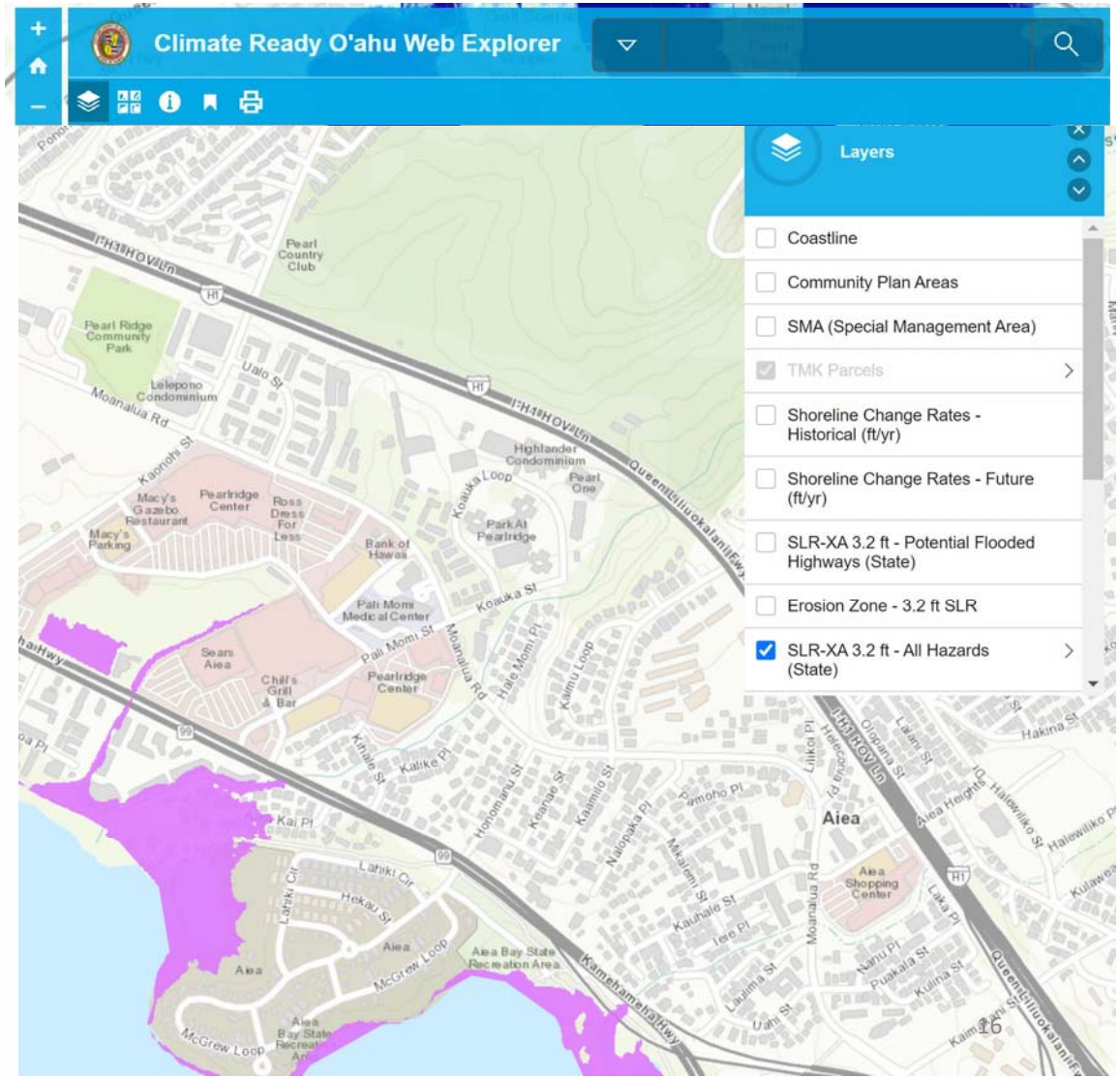
How to Use the Map

- 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 Kaïlima Artspace Lofts". Honolulu.

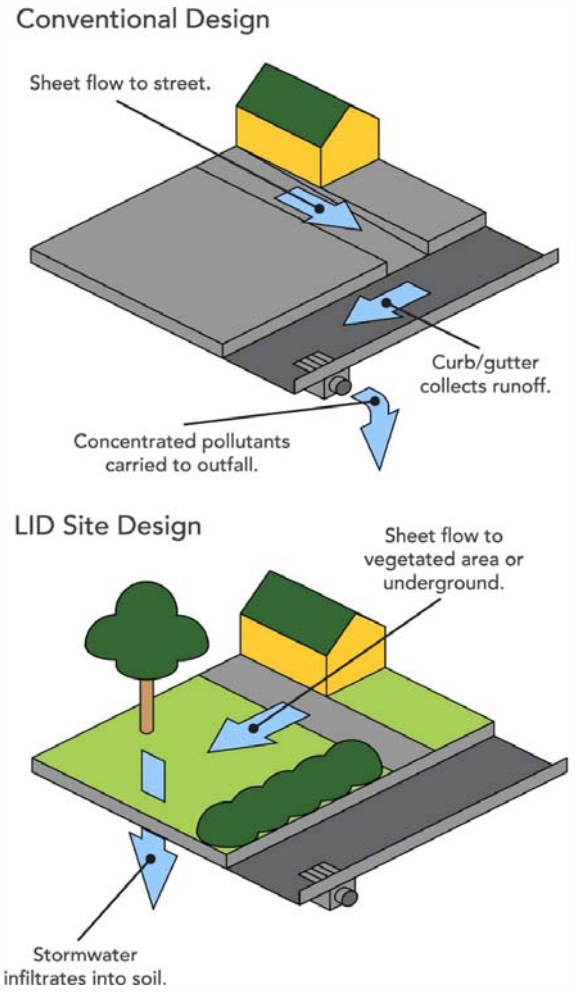
Permeable Pavements

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

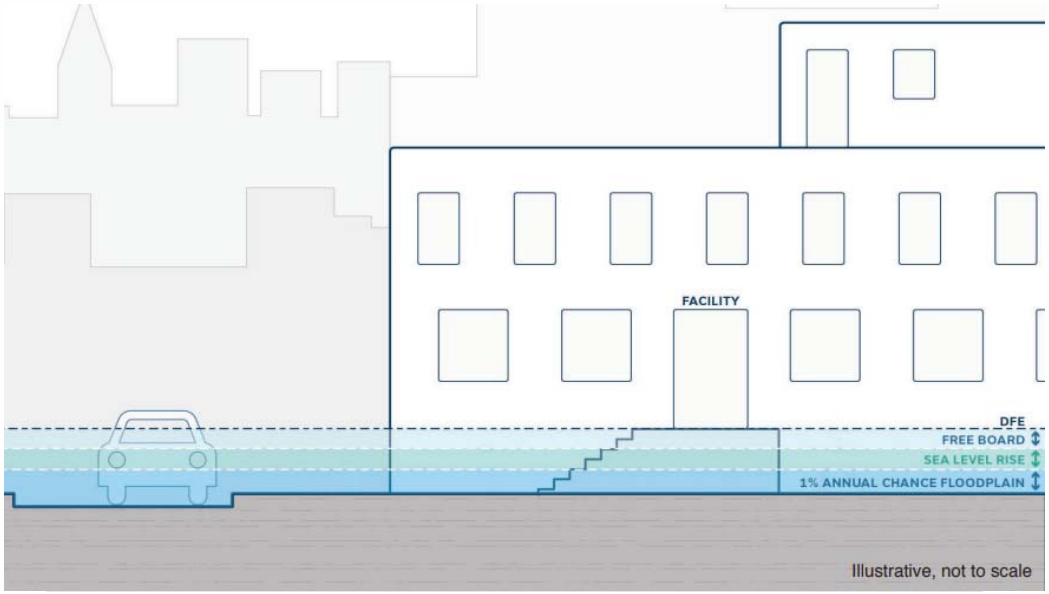
Mayor's Directive 18-02 requires all City agencies, departments, and consultants to City projects to consider sea level rise of 3.2 to 6 feet by the end of this century.

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.

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Source: Coolroofstore.net. "The Cool Roof Store Hawaii". 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

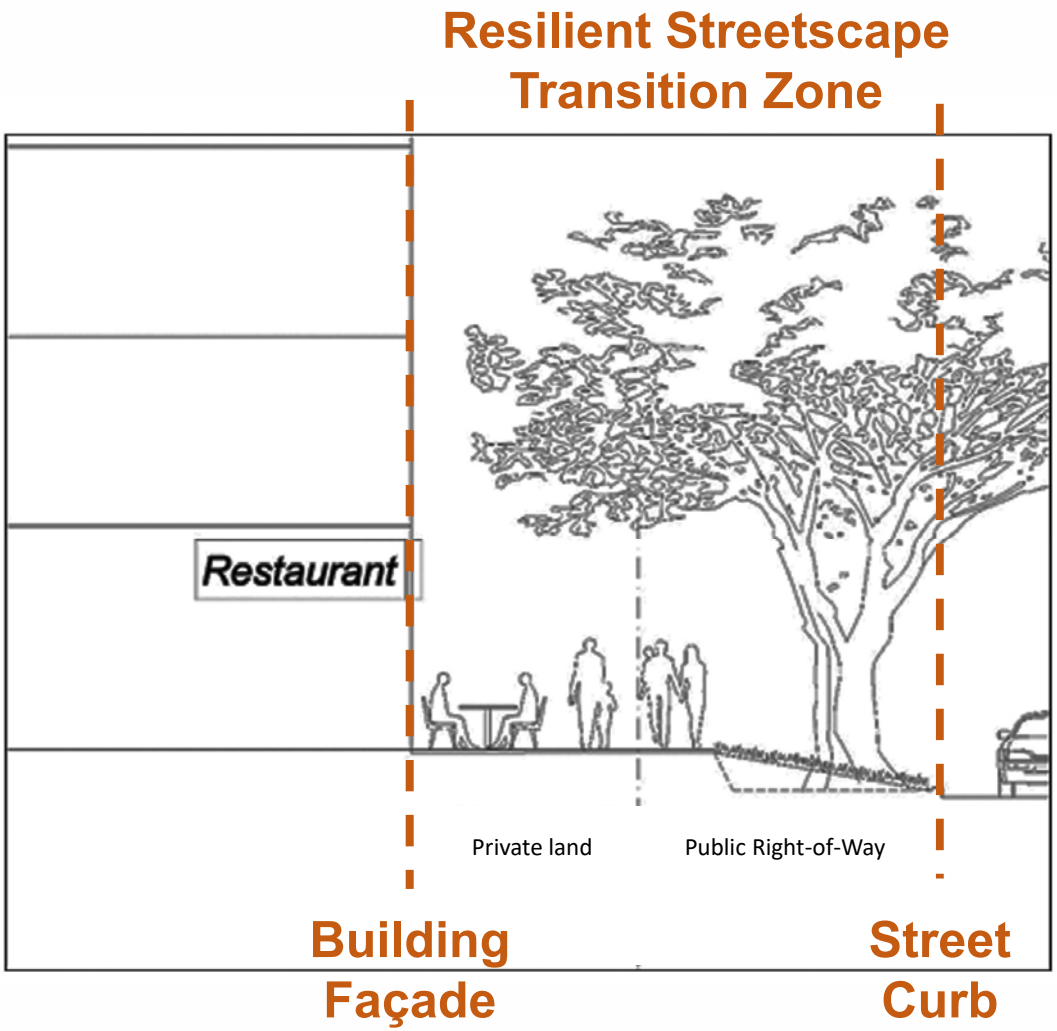
Mid-Rise Building

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.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OPEN

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

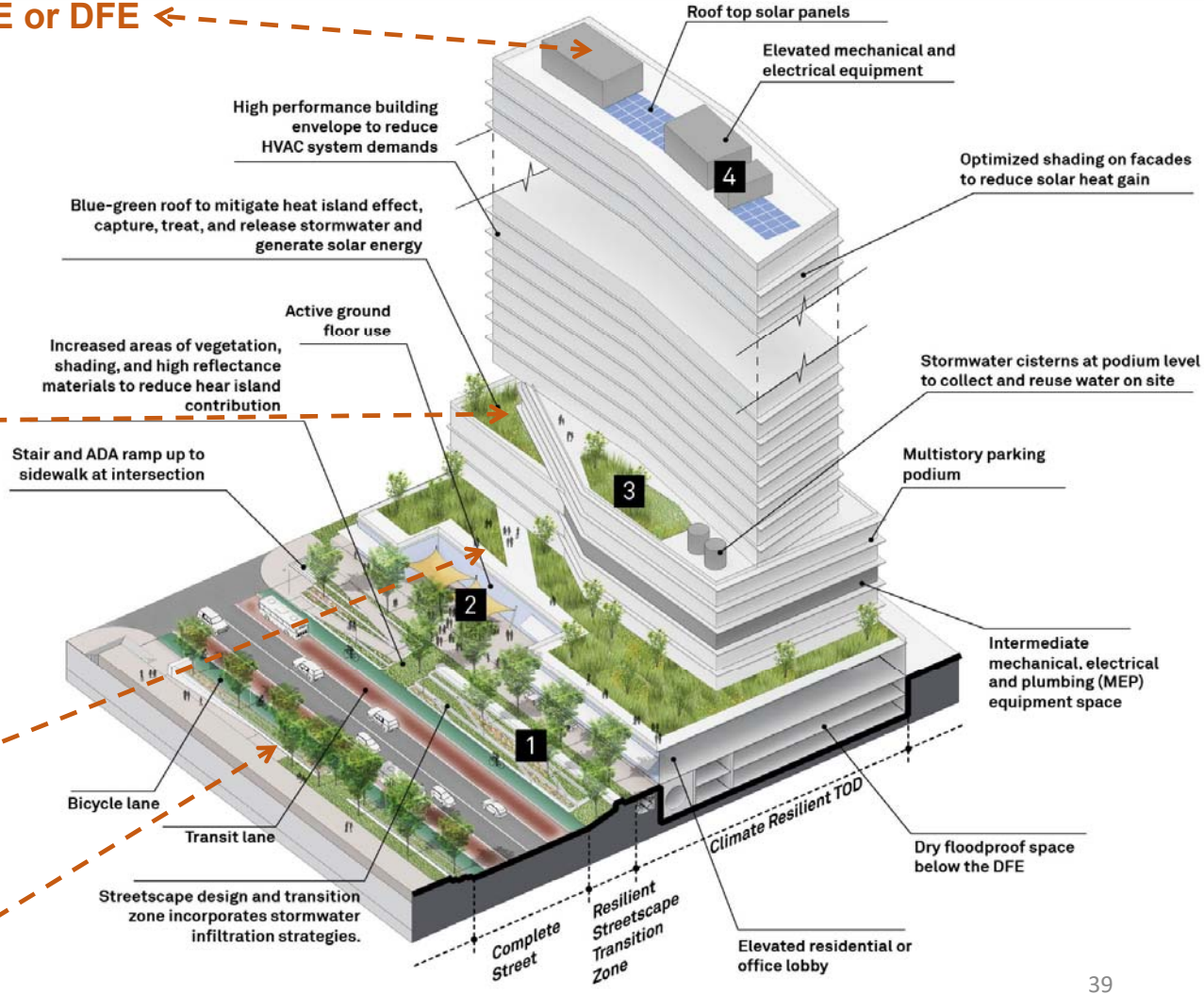
Tower & Podium

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

- **Provide sustainable roof systems**

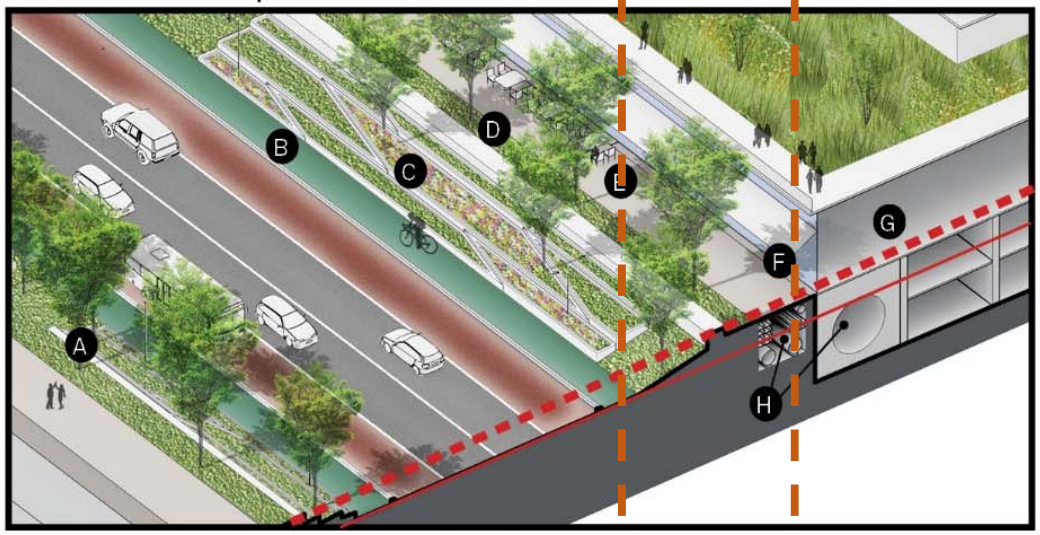
- **Podium is designed to be Pedestrian scale with high ground floor transparency**

- **Typically located along a high-volume "complete street"**



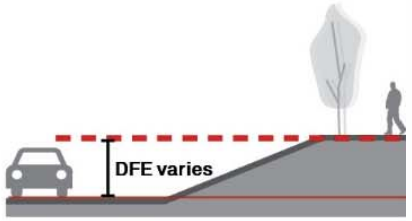
Resilient Streetscape Transition Zone

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

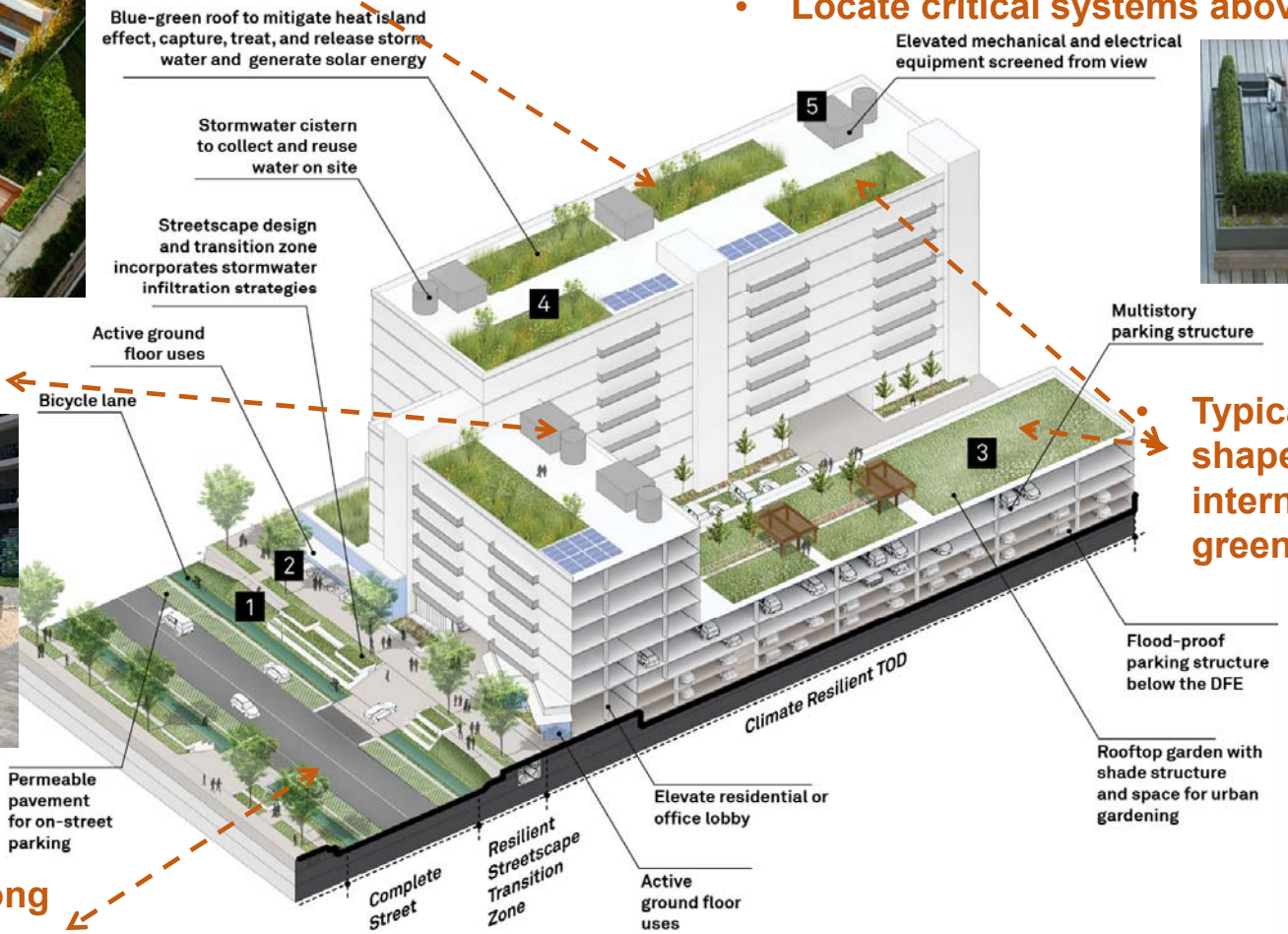
- ❑ Four to seven-story building contains apartment flats
- ❑ Residential use
- ❑ Off-street parking, active ground floor retail space

Mid-Rise Building

- **Provide sustainable roof systems**

- **Provide systems for onsite water reuse**

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

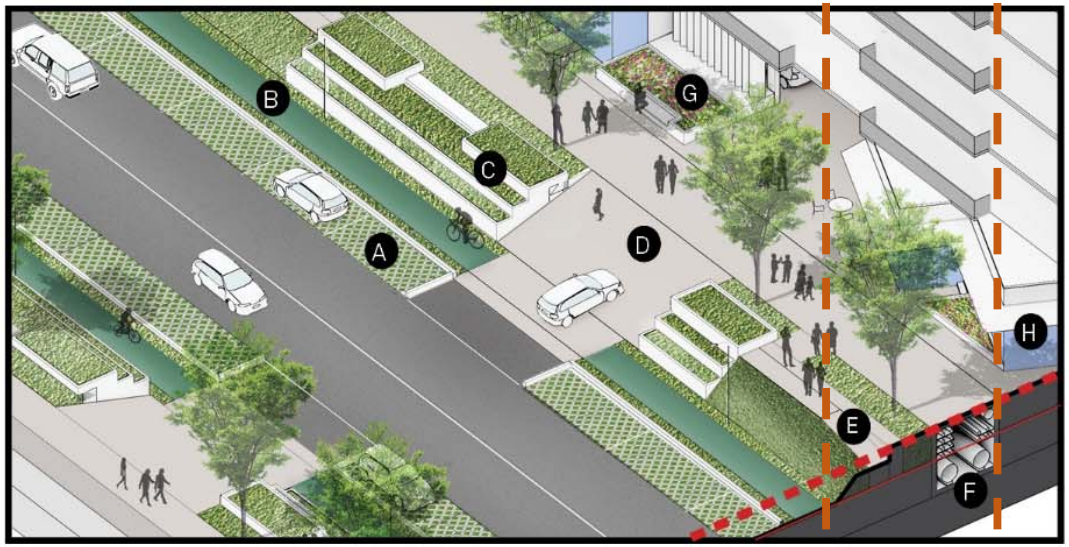


- **Locate critical systems above the BFE or DFE**

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

Mid-Rise Apartment Building

Resilient Streetscape Transition Zone Detail



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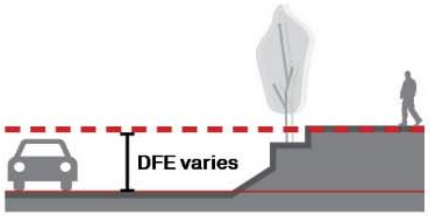


- **A** Permeable pavement
- **B** Bike lane
- **C** Transitional landscape
- **D** Parking entrance
- **E** Barrier-free ADA ramp up to sidewalk from intersection
- **F** Supporting infrastructure
- **G** Planters with seating
- **H** Active ground floor use

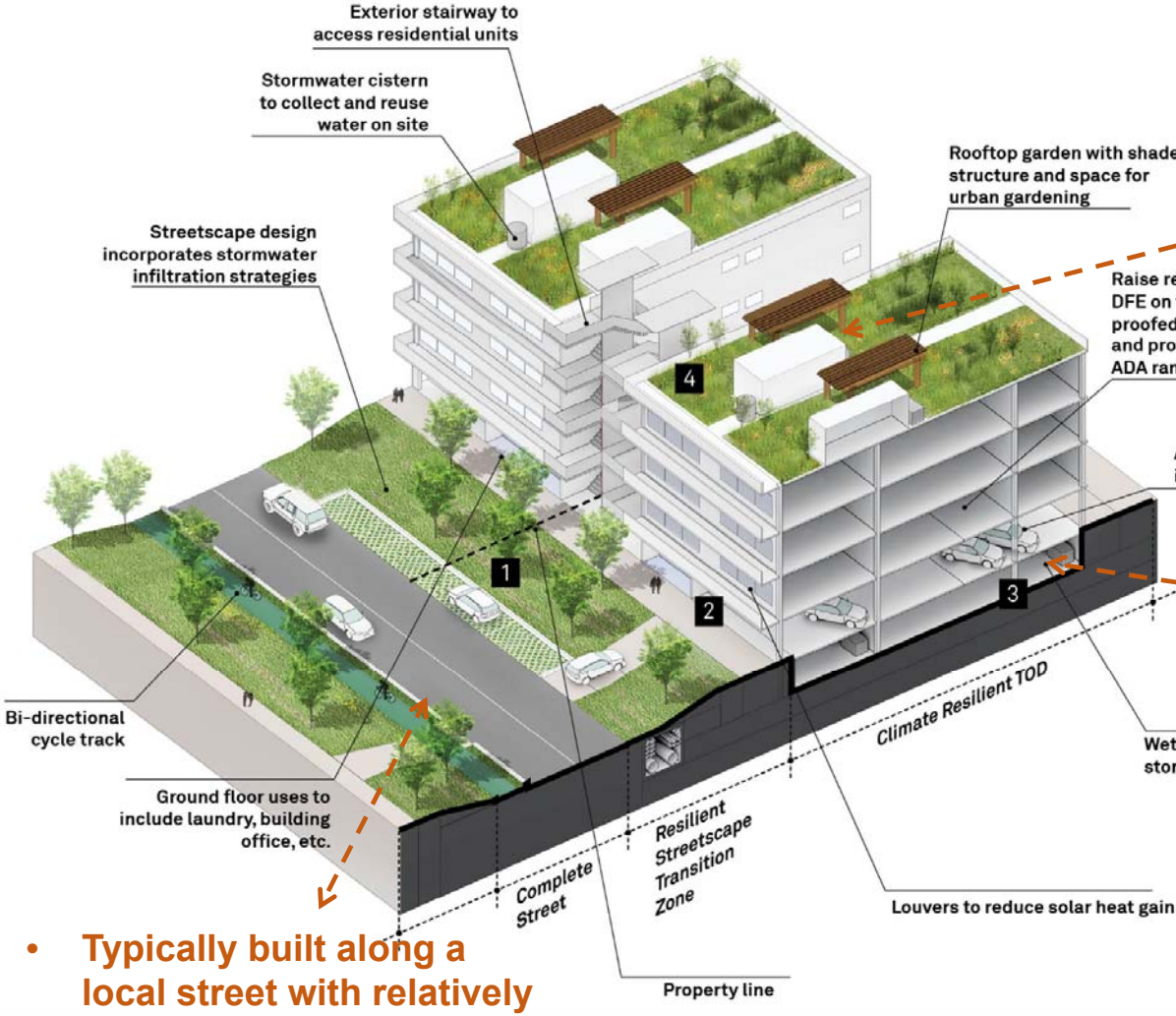
Resilient Streetscape Transition Zone

- **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



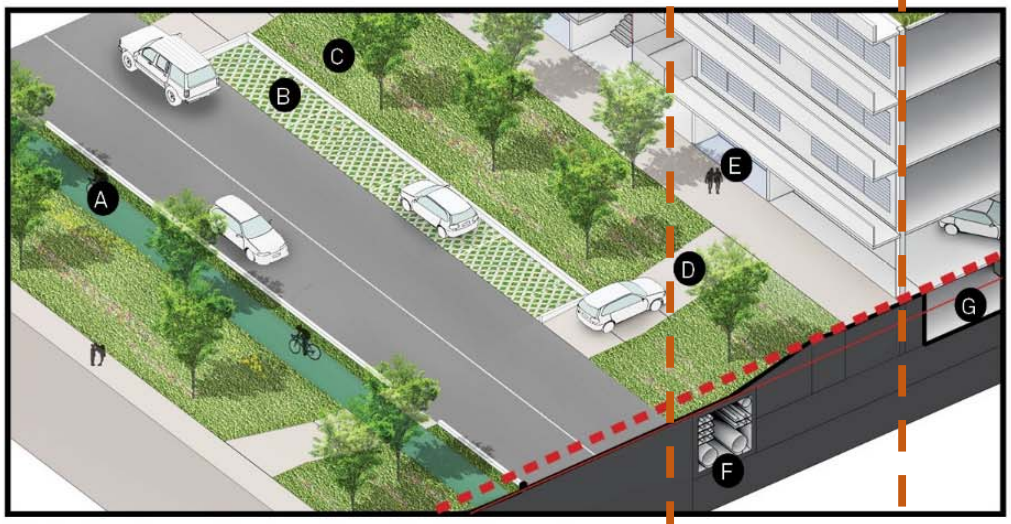
- Site critical mechanical and electrical systems on the roof

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

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

Low Rise Walk-up

Resilient Streetscape Transition Zone Detail



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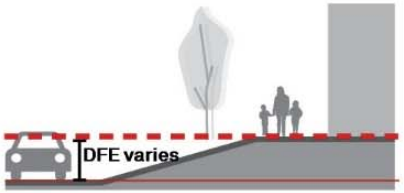
Design Flood Elevation

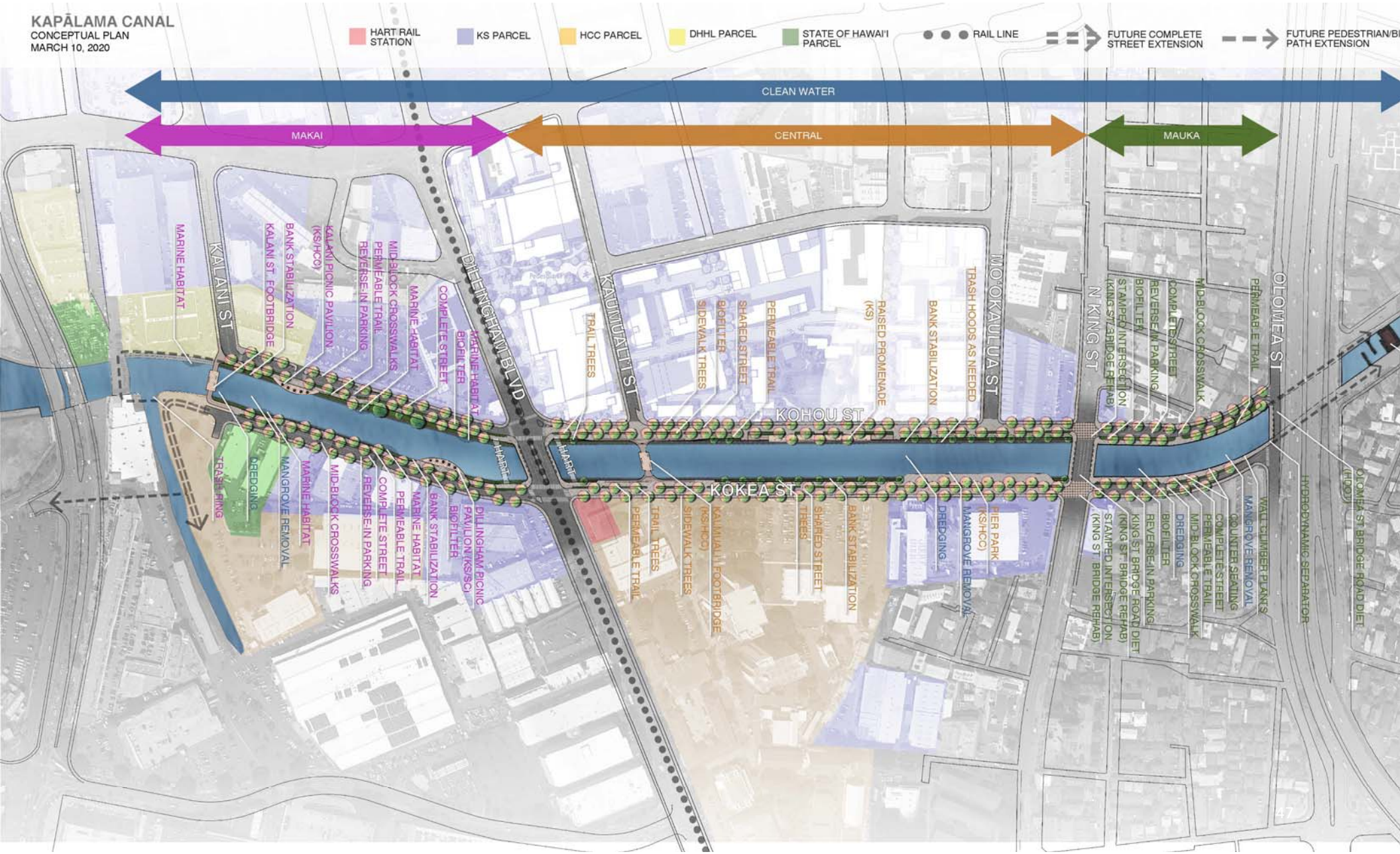
Standard Design Elevation



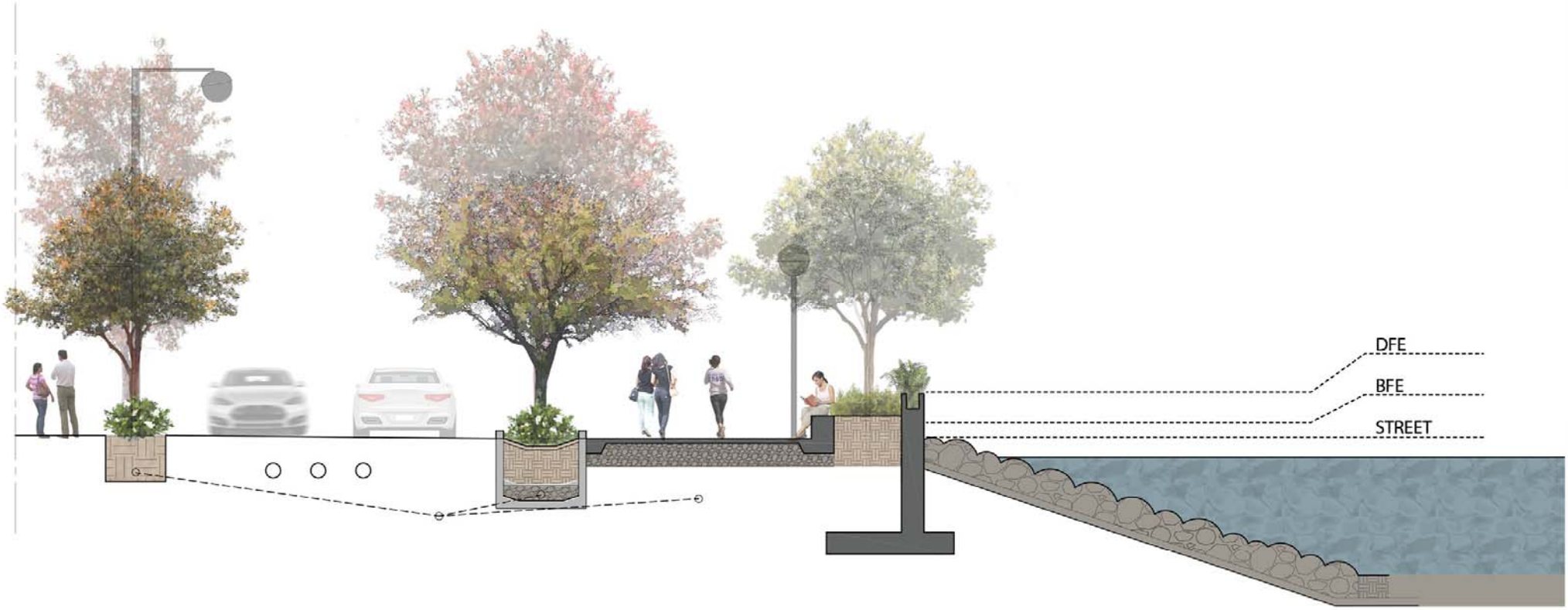
- **A** Cycle track
- **B** Permeable pavement
- **C** Transitional landscape
- **D** Parking entrance
- **E** Building lobby or office use to promote active frontage
- **F** Supporting infrastructure
- **G** Wetflood proofed storage space/basement

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**


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

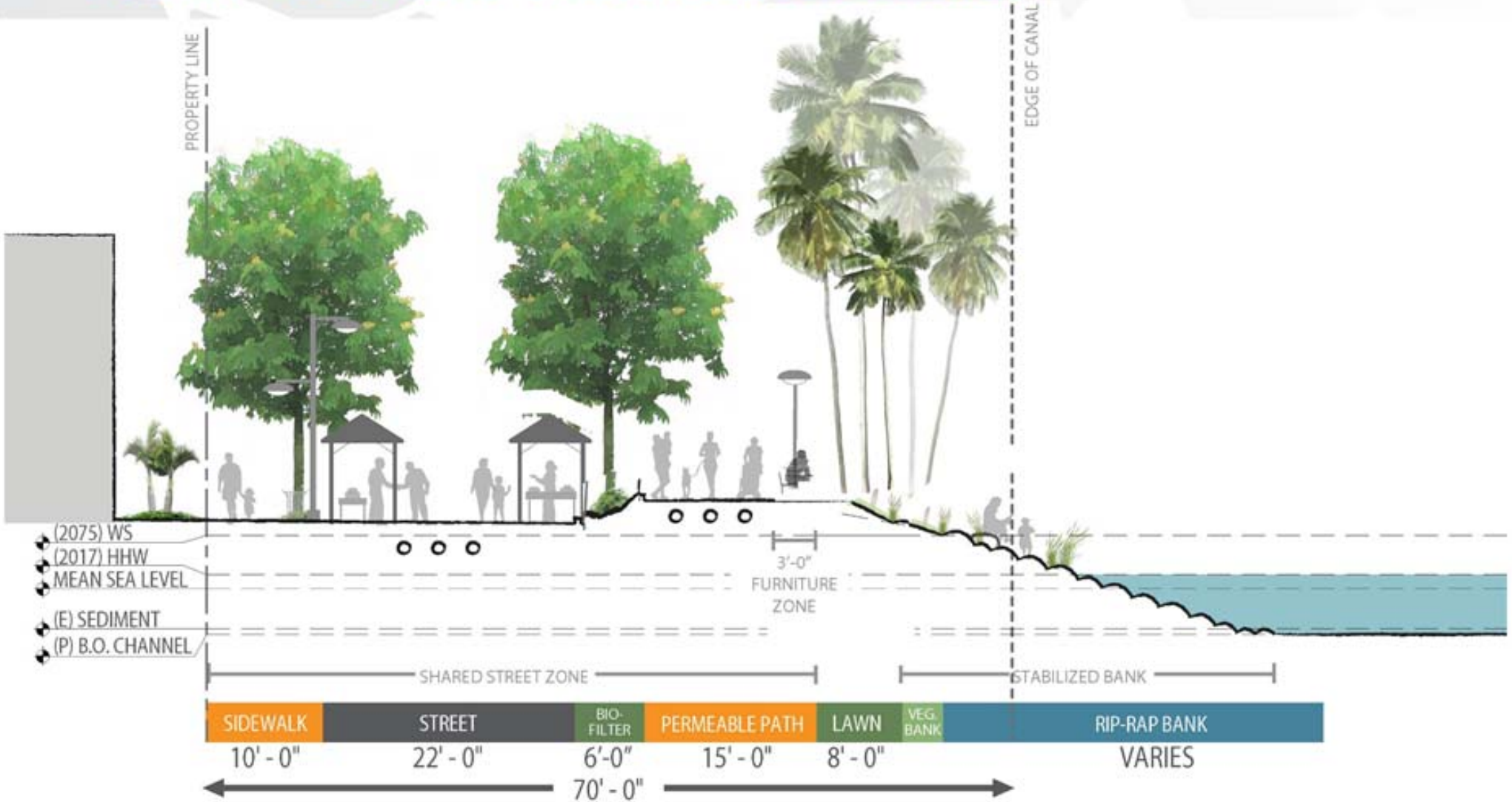
Central Canal: Section D, typ. (SLR +3.2')



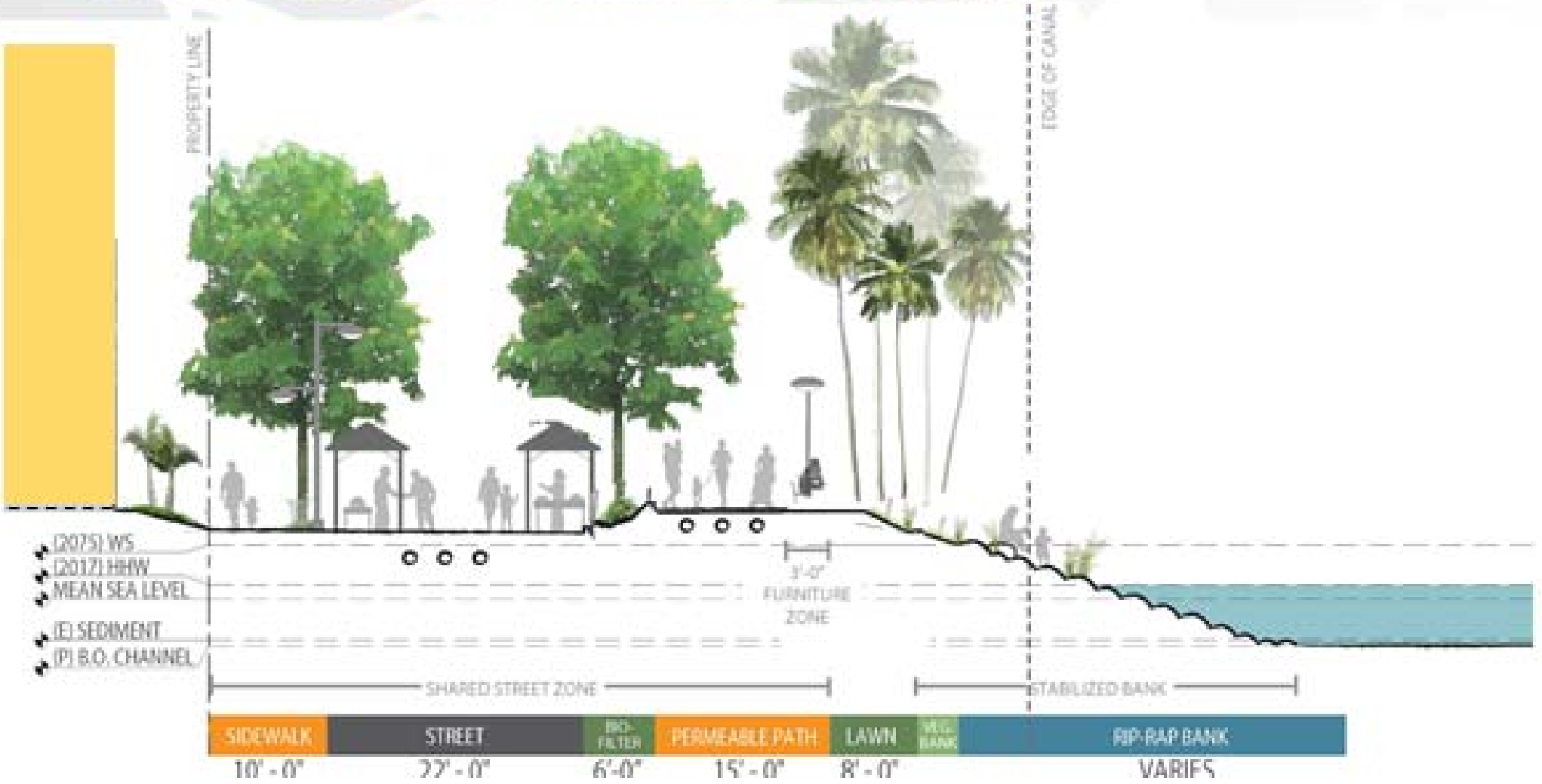
SIDEWALK	STREET	BIO FILTER	PERMEABLE PATH	RAISED LAWN	FLOOD WALL	STABILIZED RIP-RAP
10'-0"	22'-0"	6'-0"	15'-0"	1'-6"		

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

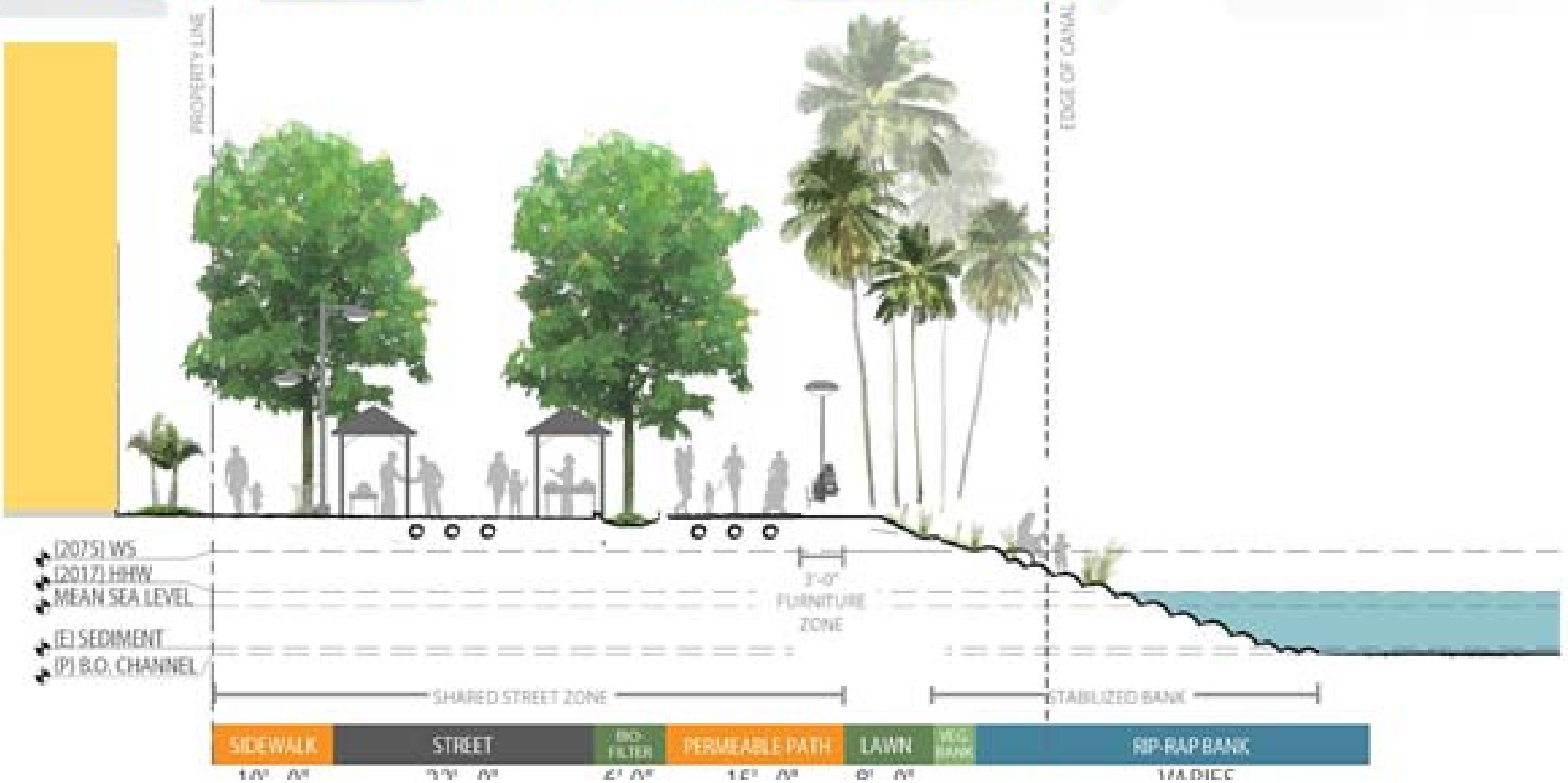
Overall Character: Central Street Section



Overall Character: Central Street Section



Overall Character: Central Street Section



Key Structural Design Outcomes

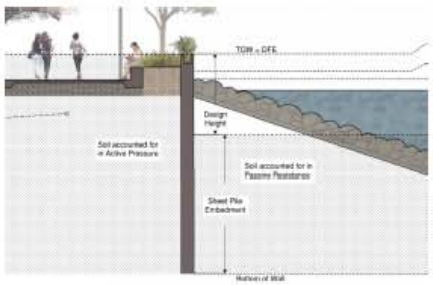
- Inform Cost
  - Wall design height
  - Required embedment
  - Preliminary sizing
- Confirm Feasibility
  - Stability
  - Constructability
- Advise on detailing constraints

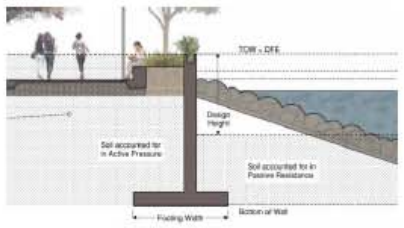
Table 7 Relative Structural Geometry for Representative Sections

		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

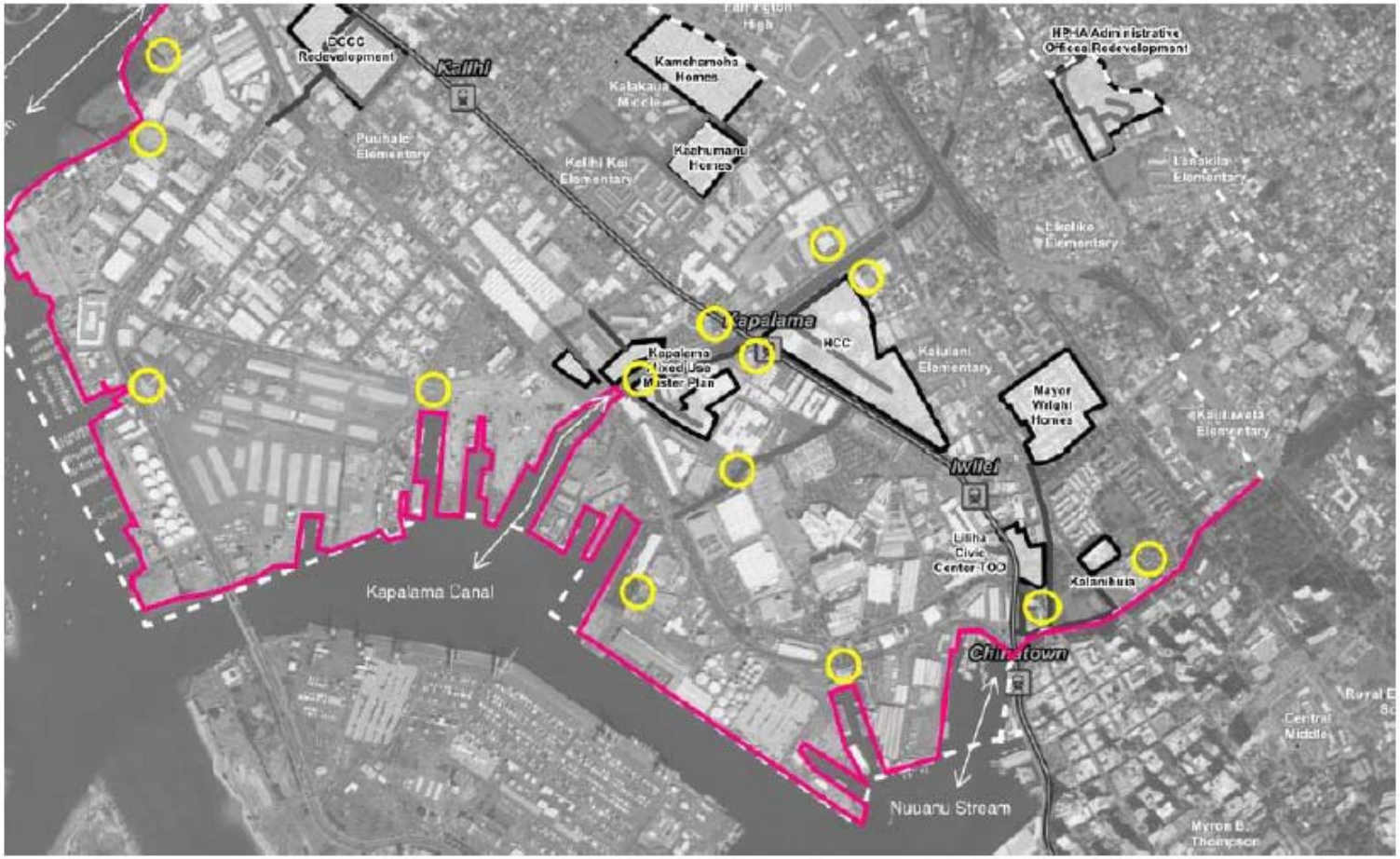
[1] Retained height is small because sheet pile wall it to be installed behind the existing CRM wall which is expected to retain; the sheet pile wall tip elevation is governed by embedment into competent soil (see Section 5)

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



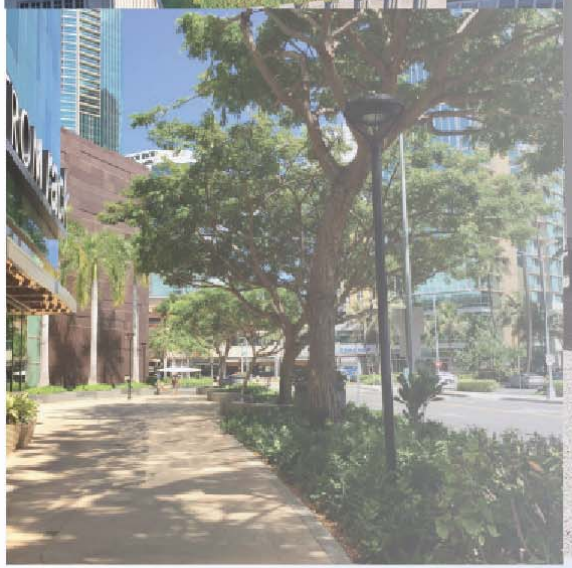


ARUP



Long-Term Upgrades ???

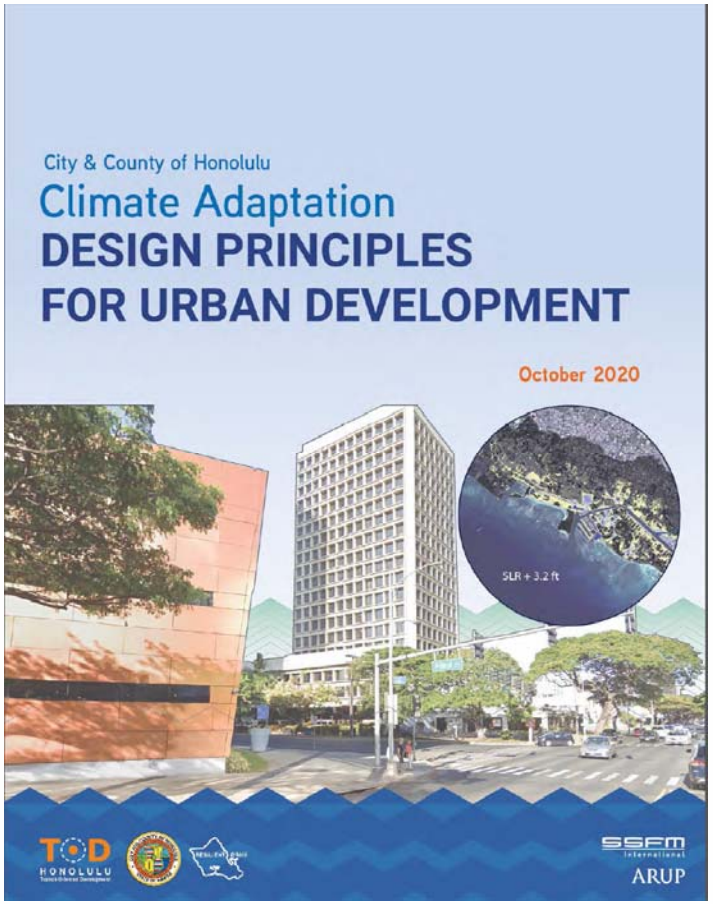
- Upgraded Seawall
- Future Pump Stations



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



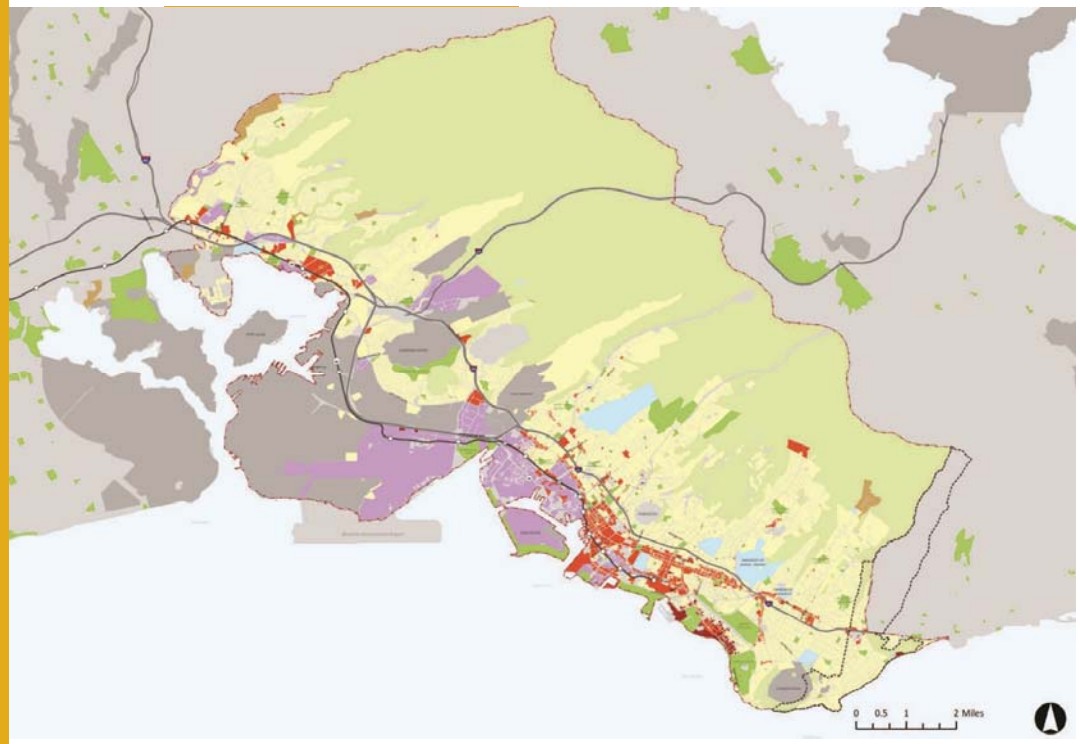
Download a copy at
www.honolulu.gov/tod

CLIMATE ADAPTATION PLANNING ACTIVITIES

Adaptation may require measures to protect or enhance existing development, as well as determining when retreat or relocation is called for. Current or upcoming City initiatives include:

- ❑ **Climate Adaptation Strategy** (underway at **climatereadyoahu.org**) to provide policy guidance and an islandwide adaptation framework
- ❑ **Climate Resilience Design Guidelines** (upcoming): DDC/CCSR are developing Future Conditions Climate Resilience Design Guidelines that incorporate forward-looking climate change data to inform the design of City and private facilities and infrastructure
- ❑ **Updates to Special Management Area & Shoreline Setback Regulations (**underway) will incorporate sea level rise projections
- ❑ **Primary Urban Center Development Plan** update (underway)

The Primary Urban Center Area stretches from Waiʻalae-Kāhala to Pearl City, mauka to makai



PRIMARY URBAN CENTER DEVELOPMENT PLAN

What is the PUC DP?

- The Primary Urban Center Development Plan (PUC DP) helps to direct growth and development in the PUC, with just over 45% of the island's population.

- PUC DP policies are guided by many factors including existing and projected conditions, environmental resource protection, infrastructure capacities planning, and community preferences.

Potential SLR Impacts in the PUC

SLR has emerged as a pressing issue moving into the future for the Primary Urban Center

Based on current conditions and with no action, projected impacts of 3.2 feet of sea level rise by 2100 are extensive:

- Chronic flooding of over 1,700 acres
- Potential flooding of over 1600 structures and 24 miles of road
- Displacement of at least 4,200 residents
- Economic losses of $7+ billion

Source: PUC DP Sea Level Rise & Climate Change White Paper, December 2018, UH Sea Grant

PUC DP Sea Level Rise Pop-up Workshops

SLR Pop-Ups engaged public opinions on:

- Low Impact Development
- Resilient Building Guidelines
- Development Restrictions tied to benchmarks
- “Pausing” new density in impacted areas
- Resilient Infrastructure
- Incentivized Retreat
- New Adaptation Funding
- Private Sea Walls

- **Summary results available at www.pucdp.com/conversation**

What's next for the PUC DP?

- The Public Review Draft for the PUC DP is anticipated by the end of this year.
- 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.

LOCAL POLICY & REGULATIONS

GREENING IWILEI AND KAPALAMA

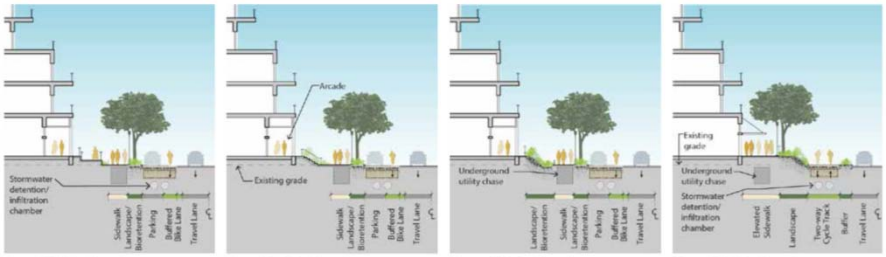


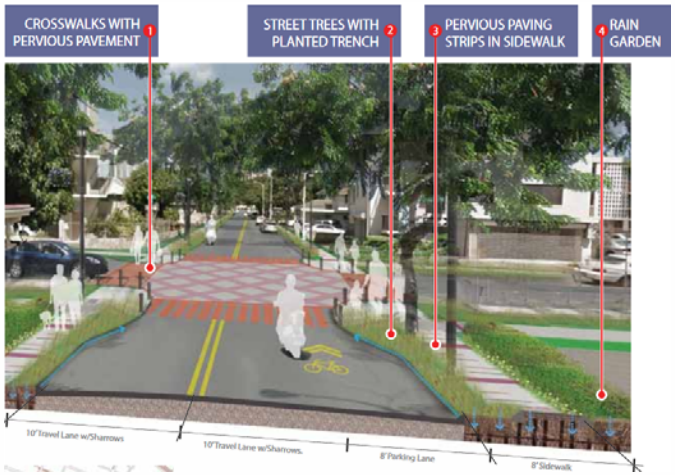
Figure 28A. Building relation to street option, section A- at Ramp

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*

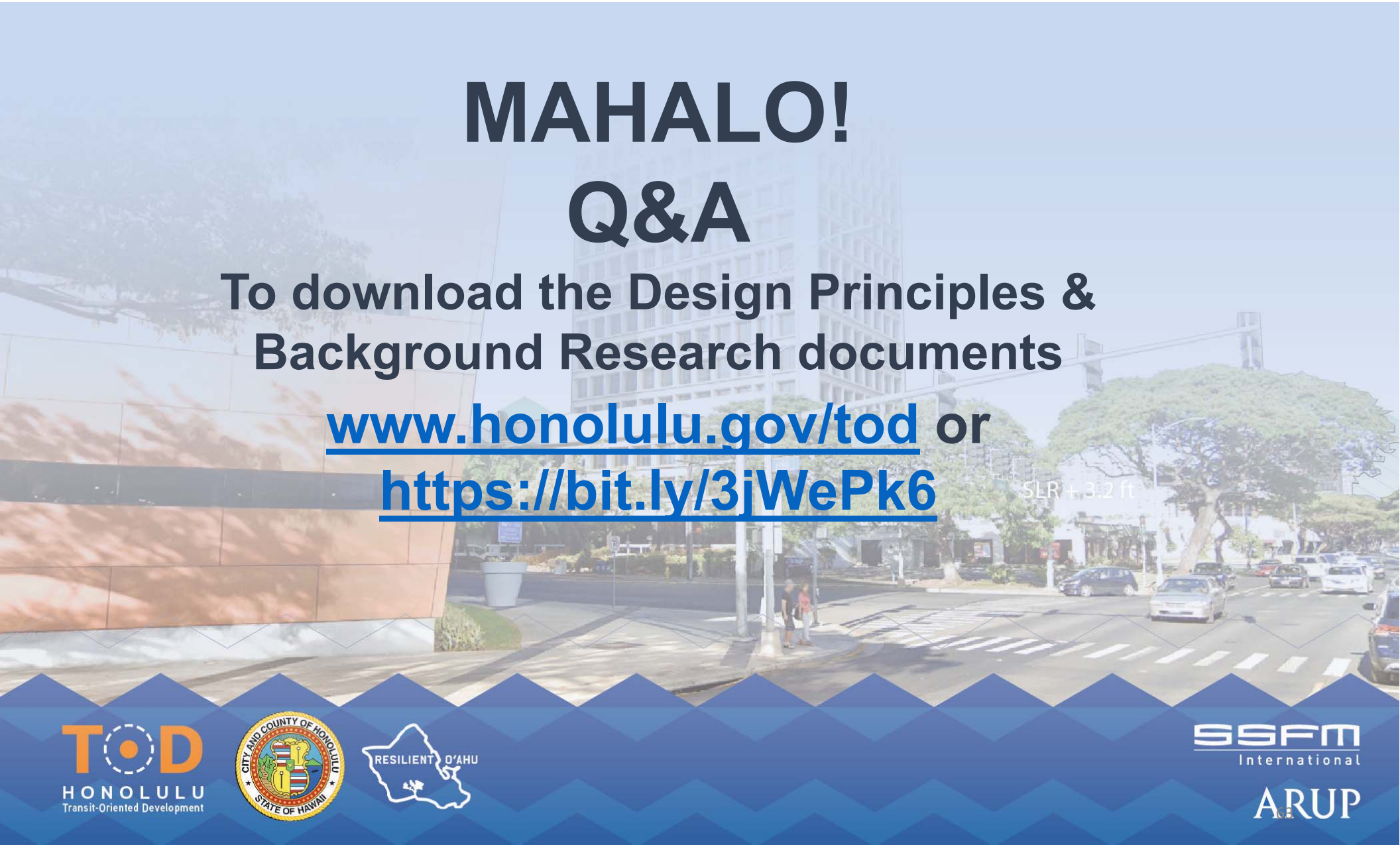
IDENTIFIED NEEDS & GAPS

- 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

MAHALO!
Q&A

To download the Design Principles & Background Research documents

www.honolulu.gov/tod or https://bit.ly/3jWePk6



TOD HONOLULU Transit-Oriented Development

CITY AND COUNTY OF HONOLULU STATE OF HAWAII

RESILIENT O'AHU

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