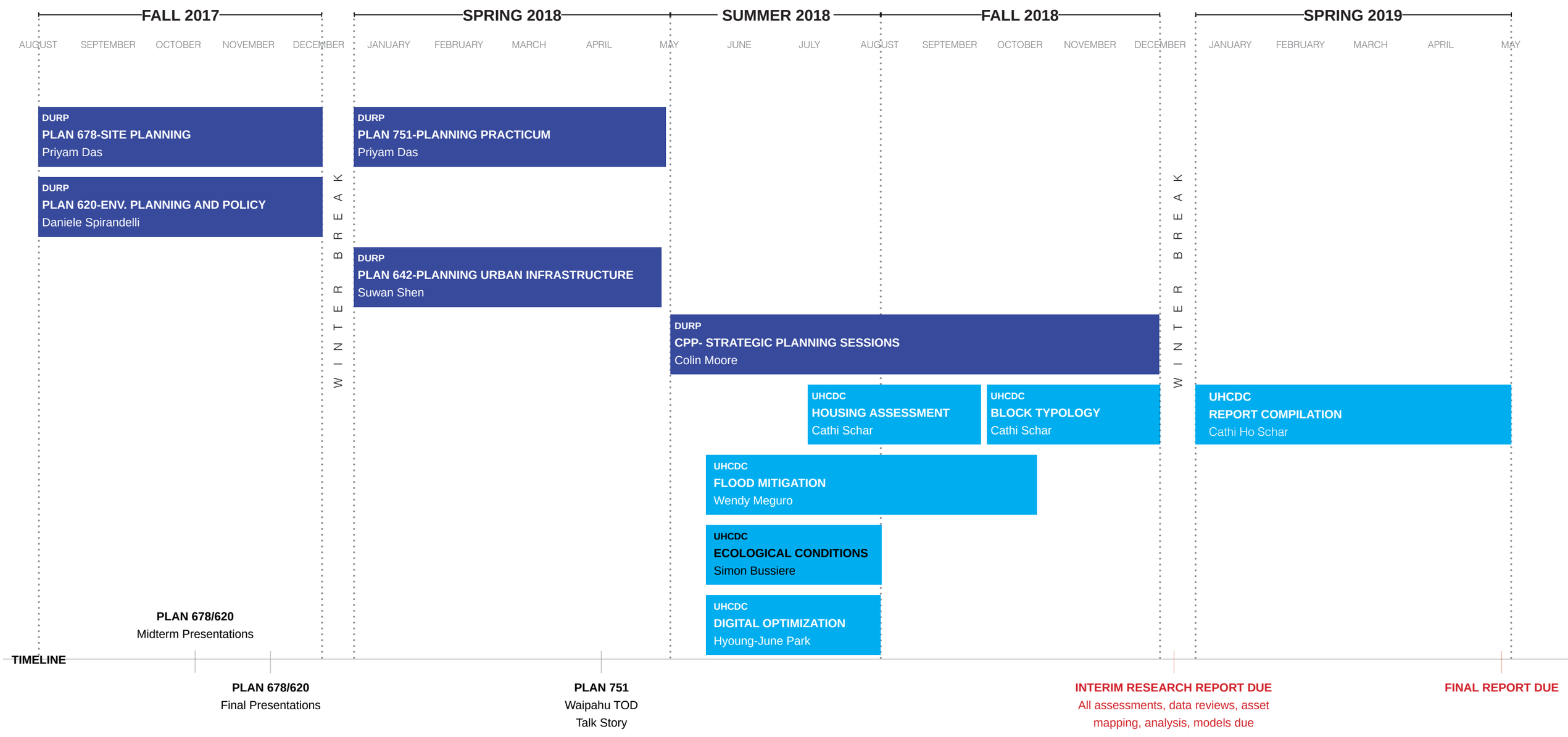
Waipahu TOD Collaboration Phasing + Benchmarks

This collaboration is both a study of the TOD inter-agency communication, community engagement, research, planning, design, and funding process as well as an in-depth, multi-scalar, and multi-disciplinary study of the Waipahu TOD area itself. The Waipahu TOD area acts as a pilot region and problem field to establish an applied research and design framework that supports a macro to micro level system based approach that better informs the funding of capital improvement projects moving forward.



PLAN 678 Site Planning &
PLAN 751 Practicum

PLAN 620 Ecological Hazards

PLAN 642 Infrastructure and
Transportation Planning

Strategic Planning Sessions

ARCH 743
Ecological Asset Study
(Tree Canopy Study)

ARCH 478 Coastal Communi-
ties and Flood Resilience
Flood Mitigation Measures

Design Futures
Digital Optimization

Housing Block Study

TYPOLOGY
Suburban
Urban Center
Urban
General Urban
Downtown
FUNCTIONAL OVERLAY
Entertainment
Institutional
Innovative
Waipahu
Pearlridge
Aloha Stadium
East Kapolei
Airport
Downtown
Ala Moana

WAIPAHU TRANSIT CENTER STATION AREA
Ecological Assets & Strategies

Canopy System

UNIVERSITY OF HAWAI'I
COMMUNITY DESIGN CENTER

TABLE OF CONTENTS

1. Executive Summary
2. Island Climate Data
3. Reference Documents
4. Site Analysis
5. Site Visit
6. Design
    Tree Canopy Typologies

    2035 Plan
    2135 Plan

7. Appendix
    Suggested Species List

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1. Executive Summary

FOR SIMON

Problem

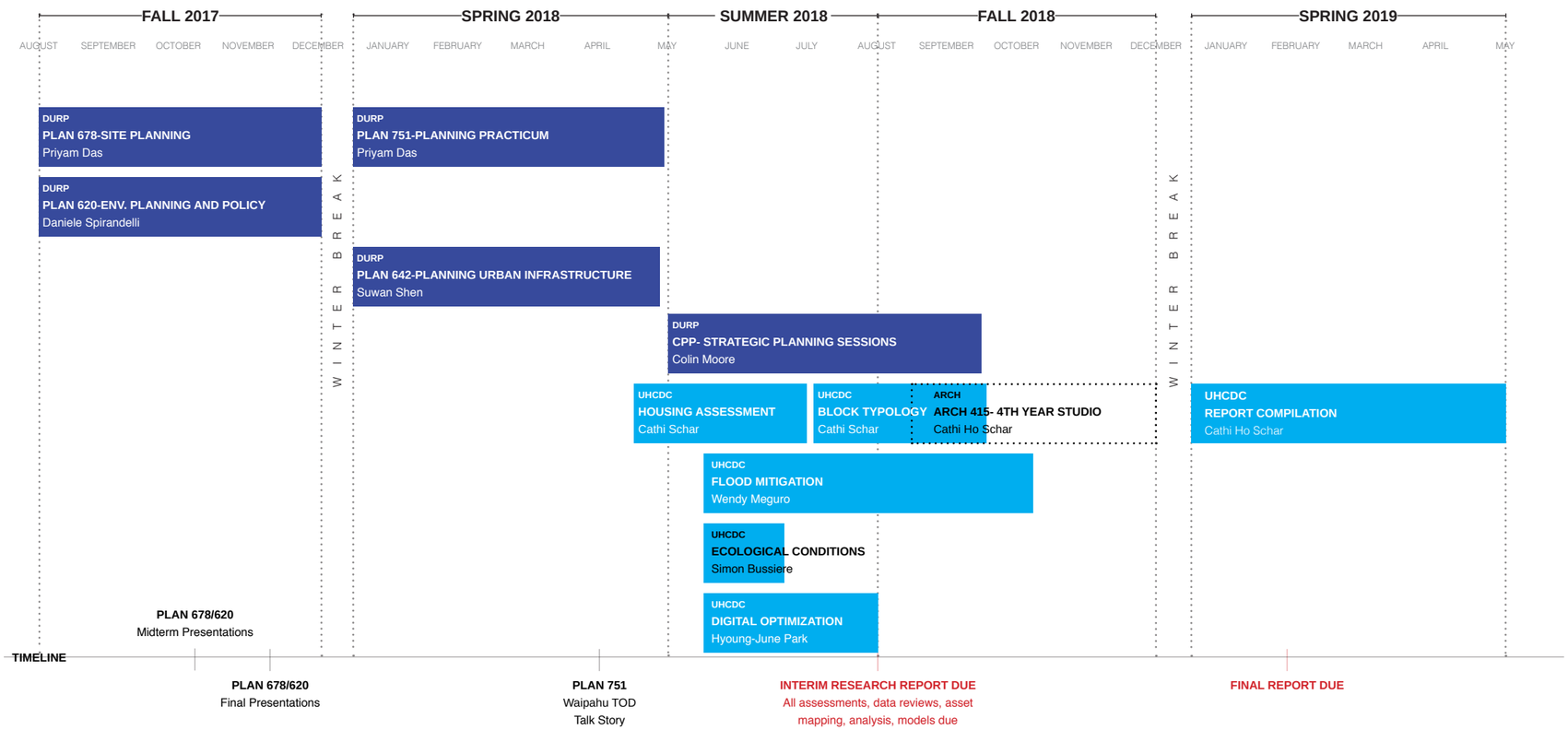
Scope of the Project

Contents of the Documents
Reference Documents
Site Analysis
Design Research
Tree Canopy Typologies
Suggested Species List

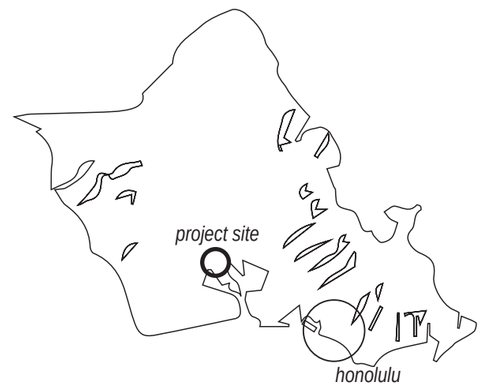
Conclusion
Purpose of the document and its intended use
(importance of urban forests)

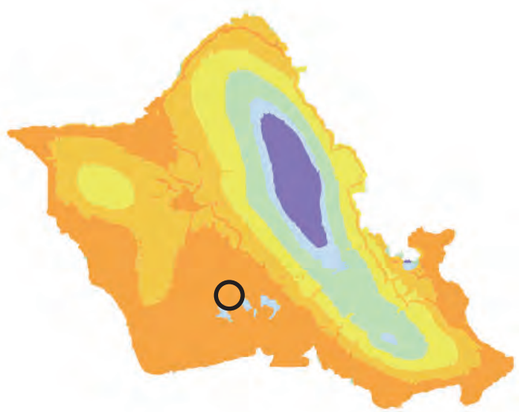
Waipahu TOD Collaboration Phasing + Benchmarks

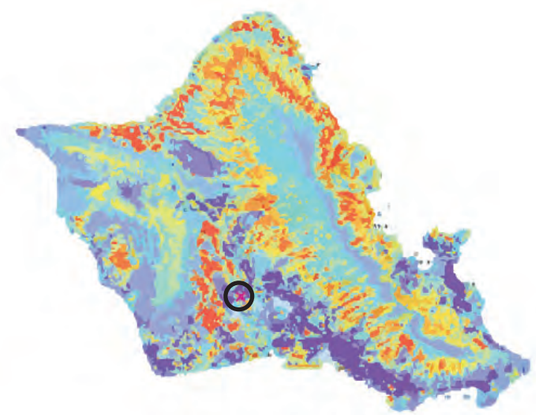
This collaboration is both a study of the TOD inter-agency communication, community engagement, research, planning, design, and funding process as well as an in-depth, multi-scalar, and multi-disciplinary study of the Waipahu TOD area itself. The Waipahu TOD area acts as a pilot region and problem field to establish an applied research and design framework that supports a macro to micro level system based approach that better informs the funding of capital improvement projects moving forward.



2. Island Climate Data







Temperature

According to data collected at Climatedata.org, the average temperature in Waipahu is 24 degrees Celsius or approximately 75 degrees Fahrenheit.

Rainfall

Topographical features on Oahu create areas of high rainfall. Waipahu is located between the Koolau and Waianae mountain ranges and has streams and canals running through it. However, with impervious surfaces covering a significant area of Waipahu, rainfall is quickly drained away from the city with little opportunity to be reabsorbed into the soil

Solar Radiation

Solar radiation is a critical element for Hawaii's goal for a sustainable future. Photovoltaics and solar heating reduce the demand for coal and gas based electricity. Trees can reduce the need for cooling and can also encourage the use of public transportation. Creating comfortable, safe, and walkable corridors encourages residents to use alternative modes of transportation and reduces the emission of harmful gas into the atmosphere.

Transpiration

Transpiration describes the movement of water through a plant to facilitate photosynthesis. A combination of tree shade and transpiration helps to prevent extremes in air temperature of highly vegetated areas. This is because water has a high specific heat capacity and can absorb heat more efficiently than air. Trees can effectively act as heat sinks for urban areas.

Sources:

1. https://en.climate-data.org/location/1401/
2. Giambelluca, T.W., X. Shuai, M.L. Barnes, R.J. Alliss, R.J. Longman, T. Miura, Q. Chen, A.G. Frazier, R.G. Mudd, L. Cuo, and A.D. Businger. 2014. Evapotranspiration of Hawai'i. Final report submitted to the U.S. Army Corps of Engineers—Honolulu District, and the Commission on Water Resource Management, State of Hawai'i.

3. Reference Documents

The scope of the project looks into the Waipahu Rail Station within a half-mile radius.

3a. Transit-Oriented Development Zoning Strategy and Process
3b. Waipahu Neighborhood TOD Plan
3c. A Report on Honolulu's Existing and Possible Tree Canopy
3d. Division of Forestry & Wildlife and its Kaulunani Program and
3e. Smart Trees Pacific. Tree Canopy Interactive Map
3f. Waipahu Town Action Plan
3g. UHM Urban and Regional Planning.
PLAN620 and PLAN678 coursework

3. Reference Documents

State and City Lands

The half-mile radius indicates the scope of this project. The orange zone highlights the proposed TOD special district boundary within which, "a general land use scheme must be created that provides for a deliberate, inclusive process to plan for TOD so that well-defined, meaningful, and appropriate regulatory and incentive programs can be adopted for each area around a transit station or type of station."[2]

Plans for TOD special districts address:[2]

- Land use
- Circulation
- Urban design
- Housing
- Community
- Facilities
- Parking
- Pedestrian amenities
- Historic and cultural enhancements
- Infrastructure
- Opportunities for new development
- Orderly growth
- Improved accessibility around the rail stations

LEGEND

City Land

State Land

Proposed TOD Zone Boundary

Sources:

1. State of Hawaii Office of Planning. STA_05_Waipahu_TC(20150507-KM), June 14, 2015.
2. City and County of Honolulu. Transit-Oriented Development Zoning Strategy and Process, August 2017.

3. Reference Documents

Waipahu Neighborhood TOD Plan

The Waipahu Neighborhood TOD Plan (below) calls for “Higher density land uses...concentrated nearest to the station area to encourage and support walking and transit use, and to maximize access between housing and jobs.” The success of public transit and proposed commercial and industrial improvements depends on human comfort and ease of access. Increasing tree canopy along connecting corridors provides a cooler and more pleasant experience.

- TOD Plan highlights relevant to tree canopy project:
- Restore Kapakahi Stream as a green-walk walkway to connect Hawaii Plantation Village, Pouhala Marsh, Pearl Harbor Historic Trail, and New Festival Marketplace
- Encourage more pedestrian-oriented development along Waipahu Depot Street
- Integrate existing community facilities with the surrounding neighborhood through open spaces and streetscape improvements

LEGEND

Area of TOD proposed plan

Sources:

Honolulu City & County TOD. Waipahu Neighborhood TOD Plan, 2016

3. Reference Documents

Existing Land Cover

An analysis of Waipahu's existing tree canopy is based on land-cover data derived from high-resolution satellite imagery acquired from 2010 and digitally analyzed through Light Detection and Ranging (LiDAR). The imagery data is then calculated to determine where buildings, impervious surfaces and existing tree canopies exist. Each parcel is then measured for percentage of impermeable surfaces, existing tree canopy, and possible tree canopy.

Based on the imagry data from the Tree Canopy Interactive Map, the half-mile radius around Pouhala Station has approximately 9% tree canopy coverage. Coverage percentage was taken by extracting the existing tree canopy layer from the interactive map and dividing the total area of existing tree canopy to the area of the half mile radius.

LEGEND

- Existing Tree Canopy
- Possible Tree Canopy on Vegetated Surface
- Possible Tree Canopy on Impervious Surface
- Building Footprint

Sources:

1. Sean MacFaden & Jarlath O'Neil-Dunne University of Vermont Spatial Analysis Laboratory. A Report on Honolulu's Existing and Possible Tree Canopy, 2010.

2. Division of Forestry & Wildlife and its Kaulunani Program and Smart Trees Pacific. Tree Canopy Interactive Map. http://cchnl.maps.arcgis.com/apps/OnePane/basicviewer/index.html?appid=9f94d7913115442b9e1e991c9c392f76. Accessed June 18, 2018.

3. Reference Documents

Existing Tree Canopy Parcel Map

Within the Tree Canopy Interactive Map, existing tree canopy and possible tree canopy metrics were calculated for each individual parcel both in terms of total area and as a percentage of the land area within each parcel.

Areas with high tree canopy coverage includes:

- Hans L'Orange Park
- Hawaii Plantation Village
- Ted Makalena Golf Course

LEGEND

- 81%-100%
- 61%-80%
- 41%-60%
- 21%-40%
- 0%-20%

Sources:

1. Sean MacFaden & Jarlath O'Neil-Dunne University of Vermont Spatial Analysis Laboratory. A Report on Honolulu's Existing and Possible Tree Canopy, 2010.
2. Division of Forestry & Wildlife and its Kaulunani Program and Smart Trees Pacific. Tree Canopy Interactive Map. http://cchnl.maps.arcgis.com/apps/OnePane/basicviewer/index.html?appid=9f94d7913115442b9e1e991c9c392f76. Accessed June 18, 2018.

3. Reference Documents

Possible Tree Canopy

Within the Tree Canopy Interactive Map, existing tree canopy and possible tree canopy metrics were calculated for each individual parcel both in terms of total area and as a percentage of the land area within each parcel.

Areas with high tree canopy coverage potential includes:

- Industrial lots south of Pouhala Station
- Parking lots
- Recreational Parks

Analysis tool and further analysis is required to identify site-specific areas for improvement and is elaborated in this document.

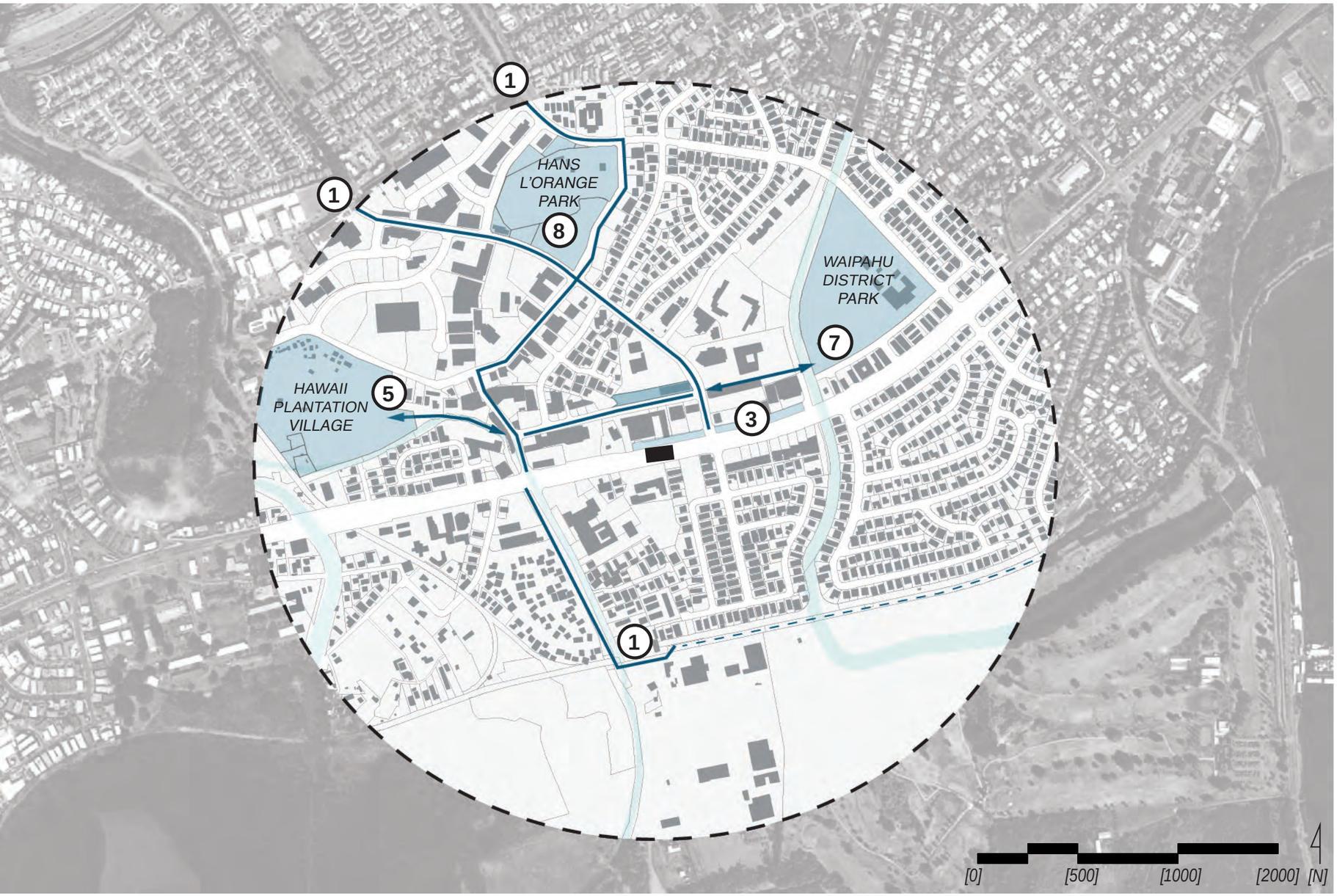
LEGEND

- 81%-100%
- 61%-80%
- 41%-60%
- 21%-40%
- 0%-20%

Sources:

1. Sean MacFaden & Jarlath O'Neil-Dunne University of Vermont Spatial Analysis Laboratory. A Report on Honolulu's Existing and Possible Tree Canopy, 2010.

2. Division of Forestry & Wildlife and its Kaulunani Program and Smart Trees Pacific. Tree Canopy Interactive Map. http://cchnl.maps.arcgis.com/apps/OnePane/basicviewer/index.html?appid=9f94d7913115442b9e1e991c9c392f76. Accessed June 18, 2018.



3. Reference Documents

Waipahu Action Plan

The Waipahu Town Action Plan identifies goals from community discussions on challenges, issues, needs, and opportunities. Overarching goals addressed in the Waipahu Town Action Plan are placemaking, streets as places, catalyst for development, and safety and maintenance. Simple renderings, sections, and plans are included in this document to support each goal and strategy.

Strategies from the Waipahu Town Action Plan stated in the Plan Summary are listed below and visualized on the map. Points in bold indicate strategies relevant and influential to the tree canopy project:

1. **Implement a Network of Connected Bicycle Facilities**
2. Upgrade Waipahu Transit Center
3. **Redesign Moloalo Street**
4. Ugrade Street Lighting
5. **Connect Hawaii's Plantation Village to Waipahu Town Core**
6. Implement Place-making Strategies
7. **Connect Waipahu District Park to Waipahu Town Core**
8. **Develop a Master Plan for Hans L'Orange Park**
9. Address Areawide Flooding
10. Establish Areawide Way-finding
11. Develop Pouhala Marsh Educational Signage

Sources:

City and County of Honolulu. Waipahu Town Action Plan, September 2017.

3. Reference Documents

UHM PLAN 620 & 678 Coursework

PLAN 620, taught by Assistant Professor Dr. Daniele Spirandelli addressed flood adaptation on Kapakahi Stream by implementing green infrastructure strategies. Several teams worked on
projects titled: Flood Impact on Vulnerable Communities, Kapakahi Stream: From Burden to Asset, Mitigating Chronic Inundation and Climate Change Induced Sea Level Rise Through Targeted Ecological Restoration in the Pouhala Marsh System in Waipahu, and Flood Adaptation.

PLAN 678, taught by Associate Professor Priyam Das focused its intervention along Wailani Stream, proposing 6 State parcel lands into 3 different concept proposals: Wai, Flow, and Health and Well Being. PLAN678 students worked to remove the stigma around public services by creating positive spaces for all ages and backgrounds to enjoy. Increasing vegetation and landscaping around the Waipahu town center increases intrinsic values to those who live and work in Waipahu.

LEGEND

PLAN 678 scope of coursework

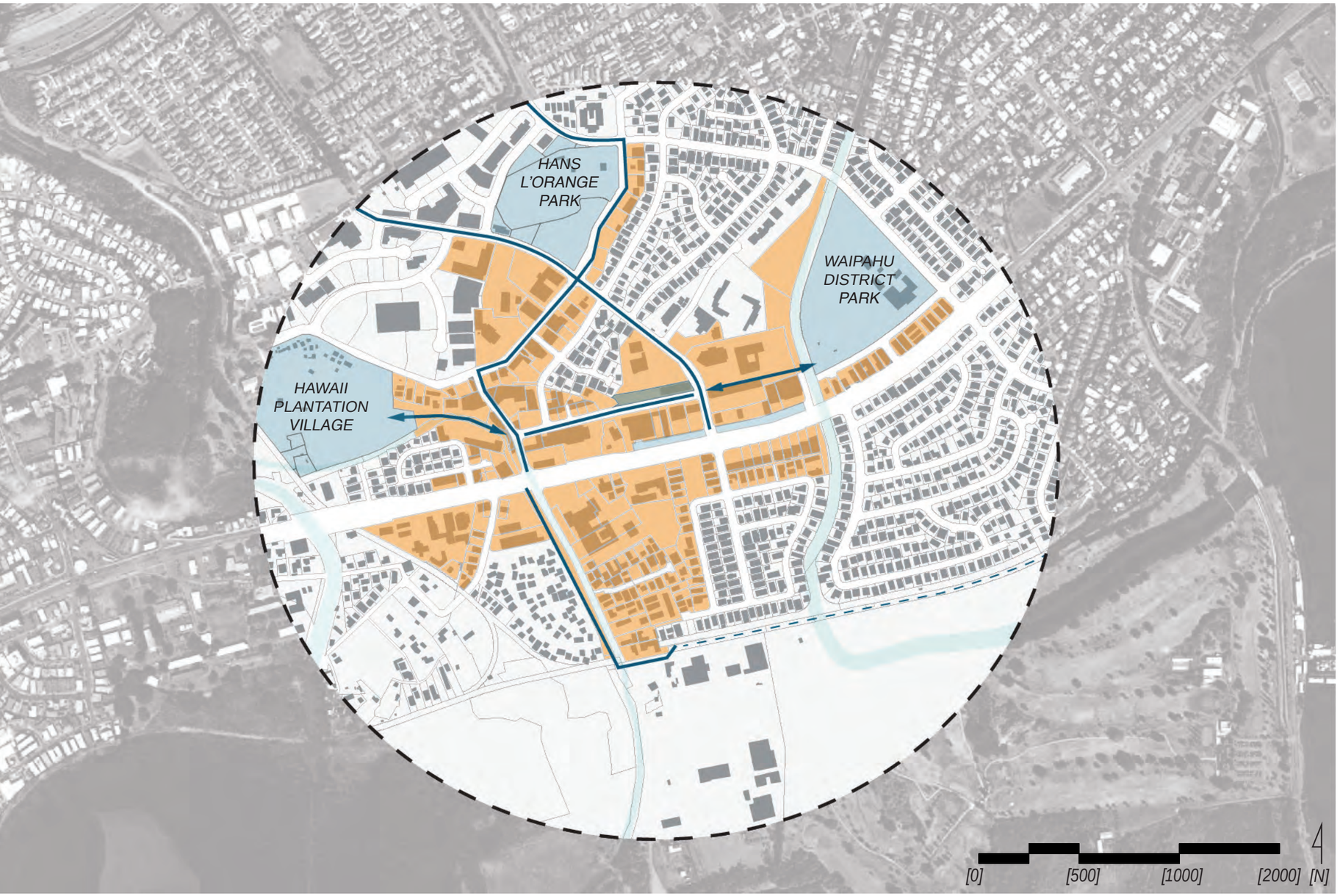
Streams

Source:

University of Hawaii at Manoa Department of Urban and Regional Planning. PLAN620 and PLAN678 coursework. Fall 2017.

4. Site Analysis

Waipahu Action Plan
+
TOD Boundary



Increased tree canopy can provide improved connectivity and ease of transport between destinations in Waipahu. The redevelopment of the TOD special district can provide opportunities to reconnect mauka and makai sections of Waipahu.

Takeaways:

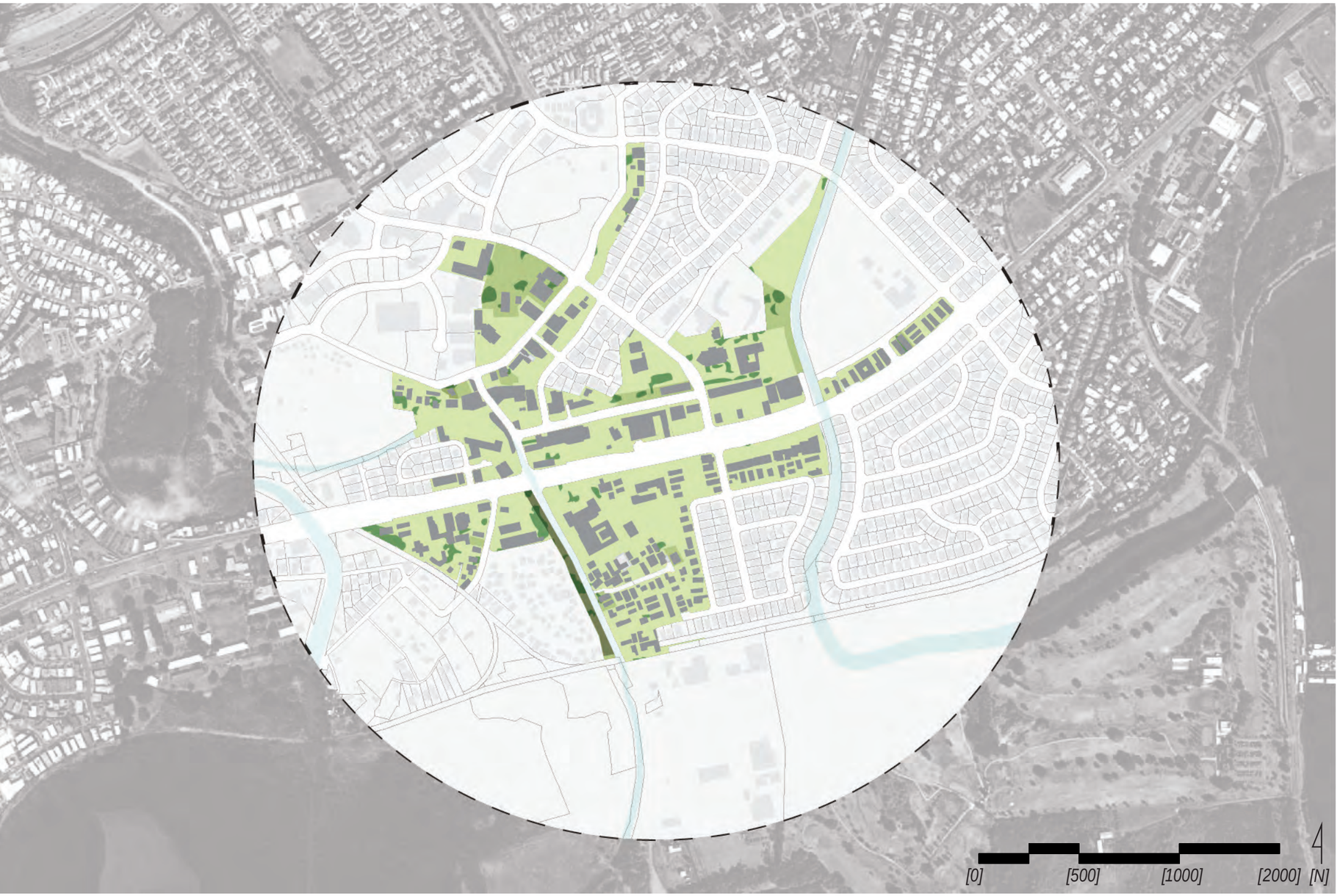
- Bike lanes along main streets and adjacent to a majority of state and city parcels
- Hawaii Plantation Village, Hans L'Orange Park and Waipahu District Park connected to Waipahu Town core especially through improved street and public parcel conditions

LEGEND

- TOD Zone Boundary
- Waipahu Action Plan: Connectivity between parks and core
- Waipahu Action Plan: Bike lanes

Sources:

City and County of Honolulu. Waipahu Town Action Plan, September 2017.



4. Site Analysis

Existing Tree Canopy
+
Existing TC Parcel Map
+
TOD Boundary

By overlapping these three maps, we can visually identify existing tree locations that fall within the TOD special district boundary and large spaces of open land with their percentage of coverage. The half-mile radius around Pouhala Station has particularly large spaces of open land that could be modified for an urban forest.

Takeaways:

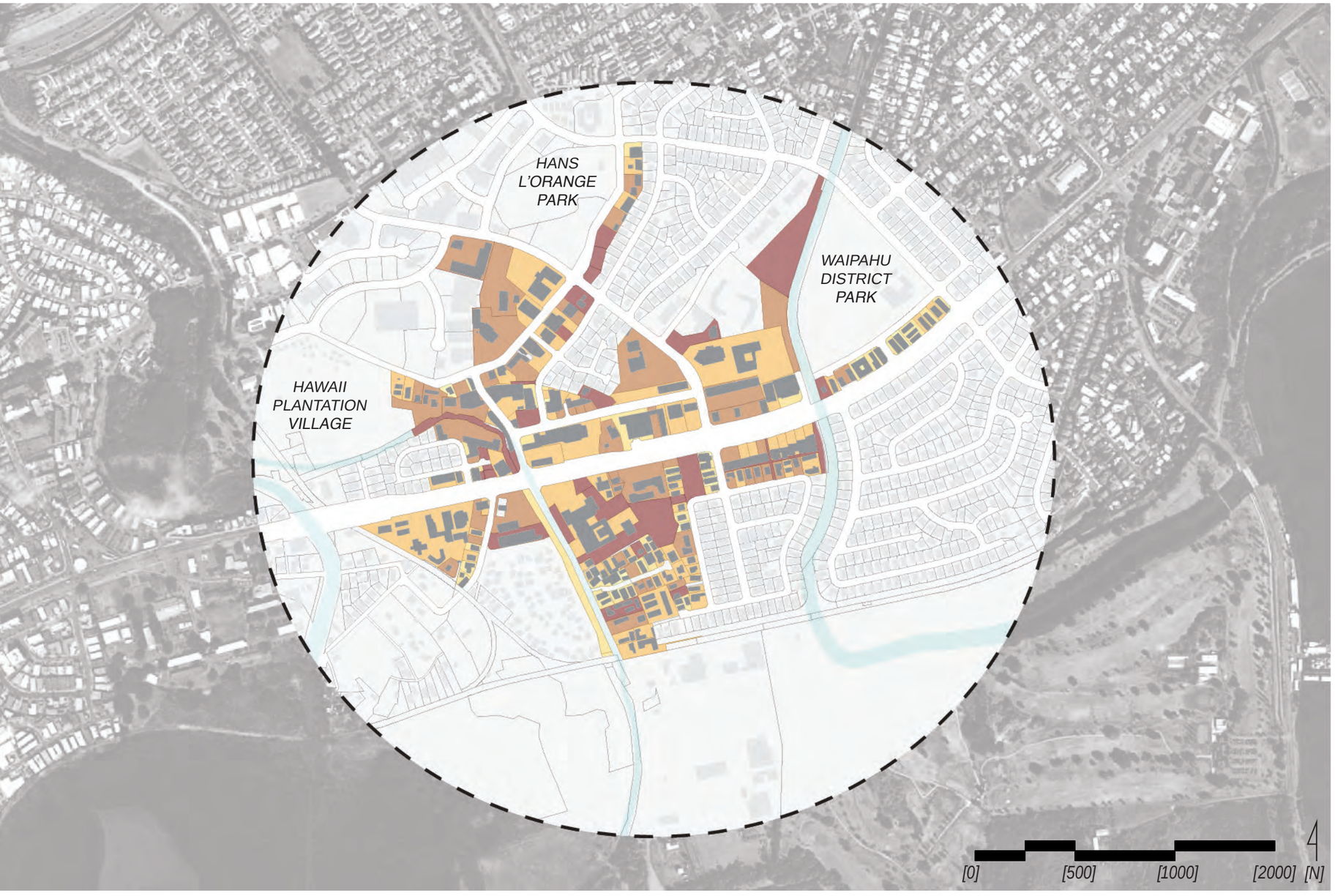
- Existing tree canopy coverage within the quarter-mile radius from Pouhala Station is poor
- Public land parcels average less than 20% tree canopy coverage.

LEGEND

- 41%-60% Existing Tree Canopy Parcel Coverage
- 21%-40% Existing Tree Canopy Parcel Coverage
- 0%-20% Existing Tree Canopy Parcel Coverage
- Building Footprints
- Existing Tree Canopy

Sources:

1. Sean MacFaden & Jarlath O'Neil-Dunne University of Vermont Spatial Analysis Laboratory. A Report on Honolulu's Existing and Possible Tree Canopy, 2010.
2. Division of Forestry & Wildlife and its Kaulunani Program and Smart Trees Pacific. Tree Canopy Interactive Map. http://cchnl.maps.arcgis.com/apps/OnePane/basicviewer/index.html?appid=9f94d7913115442b9e1e991c9c392f76. Accessed June 18, 2018.



4. Site Analysis

Possible TC Parcel Map
+
TOD Boundary

The overlaying of these three parcels identities areas with highest need for tree canopies. Mostly consisting of large, open, and impervious parking lot surfaces, these spaces have the potential to be modified to become urban forests or a similar public asset. Dark red parcels should be placed at highest priority when implementing the 35 by 2035 plan.

Takeaways:

- Public lands provide great opportunities to provide tree canopy coverage
- Large parcels such as Hawaii Plantation Village, Hans L'Orange park, and Waipahu District park are beyond the quarter-mile radius but can become urban-forest destination points.
- Streets within the quarter-mile radius can become desirable and walkable connecting corridors.

LEGEND

- 81%-100% Possible Tree Canopy Parcel Coverage
- 61%-80% Possible Tree Canopy Parcel Coverage
- 41%-60% Possible Tree Canopy Parcel Coverage

Sources:

1. Sean MacFaden & Jarlath O'Neil-Dunne University of Vermont Spatial Analysis Laboratory. A Report on Honolulu's Existing and Possible Tree Canopy, 2010.
2. Division of Forestry & Wildlife and its Kaulunani Program and Smart Trees Pacific. Tree Canopy Interactive Map. http://cchnl.maps.arcgis.com/apps/OnePane/basicviewer/index.html?appid=9f94d7913115442b9e1e991c9c392f76. Accessed June 18, 2018.

4. Site Analysis

Habitat Corridor- Canopy typologies linking Waipahu's green spaces

The heavily urbanized habitat of Waipahu town's center limits the capability of varied flora and fauna to thrive. Encouraging the development of an urban forest encourages biodiversity for greater interactions between species by providing a wider habitat for varied species.

The large parcels of Hawaii Plantation Village, Hans L'Orange park, Waipahu district park, Pouhala marsh, and Ted Makalena Golf Course as well as have the highest potential to house larger populations of trees and wildlife. Corridors that connect these large areas not only encourage movement of people, but also of birds, insects, and other fauna. An understory that lies beneath the canopy of trees also provide unique habitats for other vegetation.

Street trees are then linkways for Waipahu's wildlife. The linear canopy typologies navigate travel patterns for species to migrate and wayfind to other suitable environment

5. Site Visit

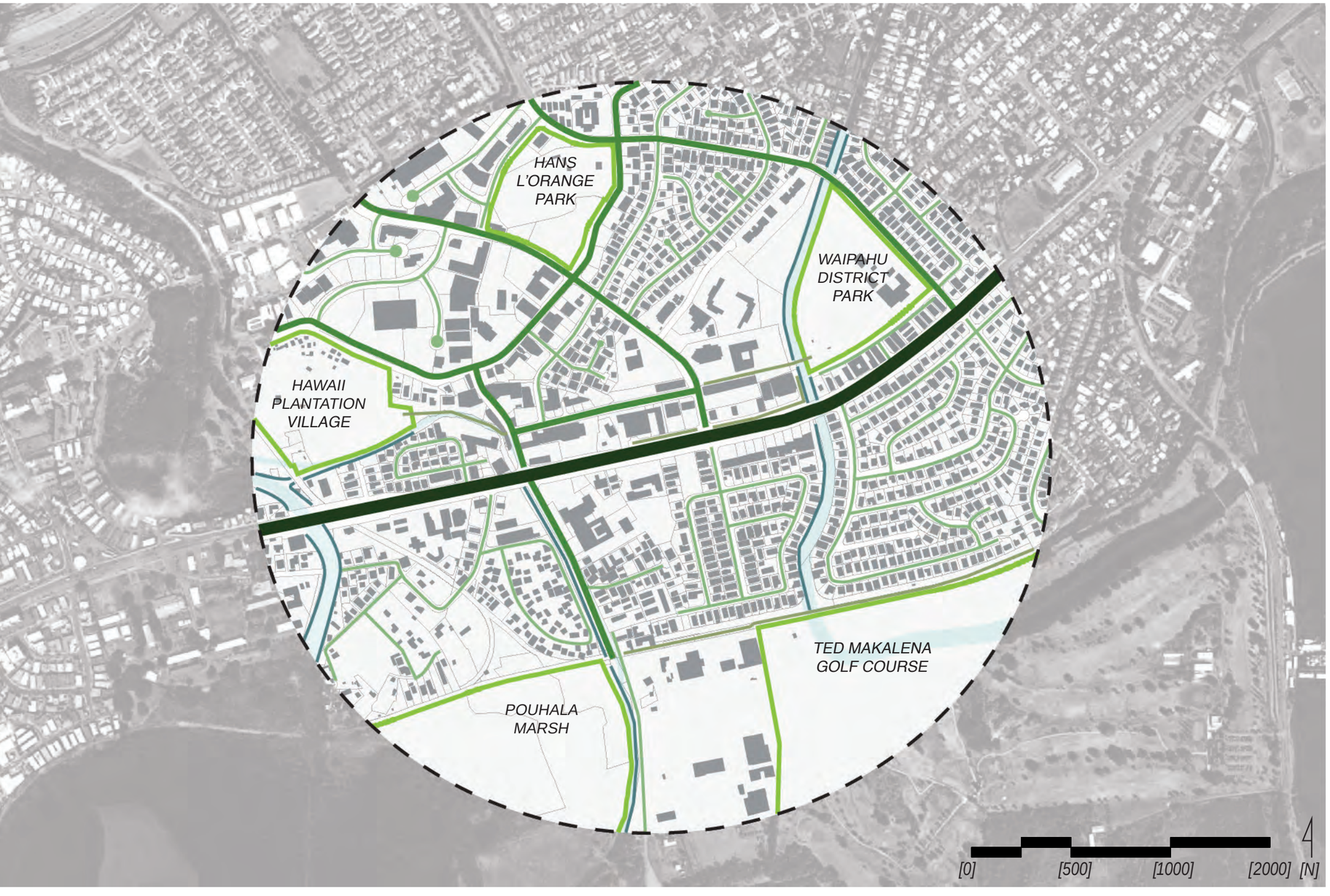
Urban Forester Citizenry Site Inventory

A site visit on July 21, 2018 brought together UHCDC and the Kaulunani Citizen Forester Program groups to perform initial documentation on trees in Waipahu. The visit began at Waipahu District park, along Hikimoe street and up toward Hans L'Orange park. The site visit stressed the importance of trees along corridors for human comfort as it was a clear-sky day with light winds. The row of shower trees along Hans L'Orange park made the walk significantly cooler in comparison to streets closer to Farrington highway.

LEGEND

Walking Path

Trees Identified during site visit



6. Design

Tree Canopy Typology Mapping

Typologies were created to provide visual and spatial examples of tree planting strategies throughout the varied programs around Pouhala Station. Seven typologies were developed to describe street and land area types but are not an exhaustive list and serves for representative uses only.

1 Highway & Rail

2 Main Roads

3 Pedestrian Streets

4 Residential Streets

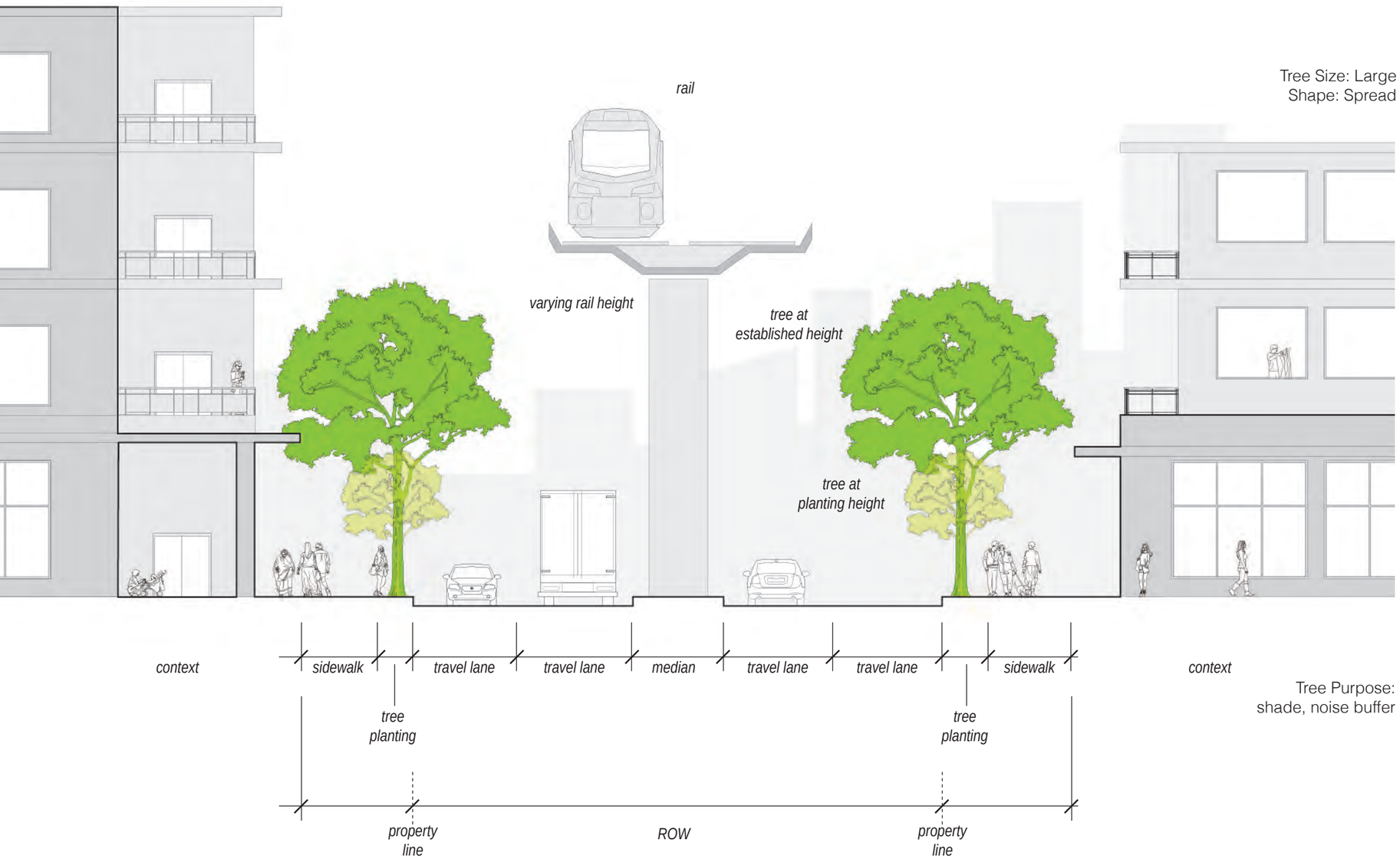
5 Parks & Open Space

6 Stream Edges

7 Parking Lot

Example Streets: Farrington Highway

Tree Size: Large
Shape: Spread



Tree Purpose:
shade, noise buffer

6. Design

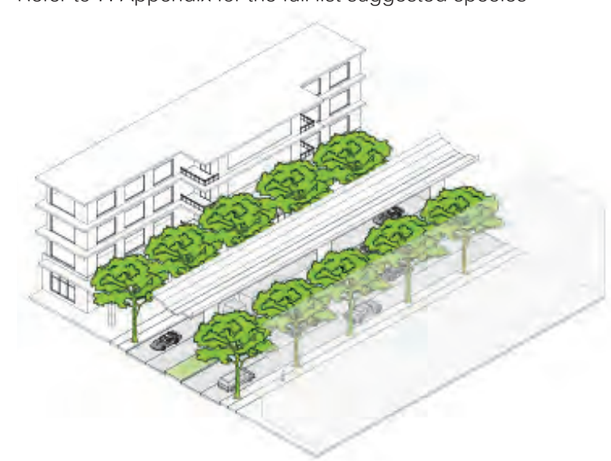
Tree Canopy Typology
1 Rail/Highway

Characteristics:
Principal Arterial
Designed for high vehicular capacity and moderate speed
Highways with the rail typically have 4 or more lanes.
These streets serve as the primary transit routes, equipped with the rail, bus lands and bike lanes.
Also classified under boulevards and parkways.

Top 5 Species List

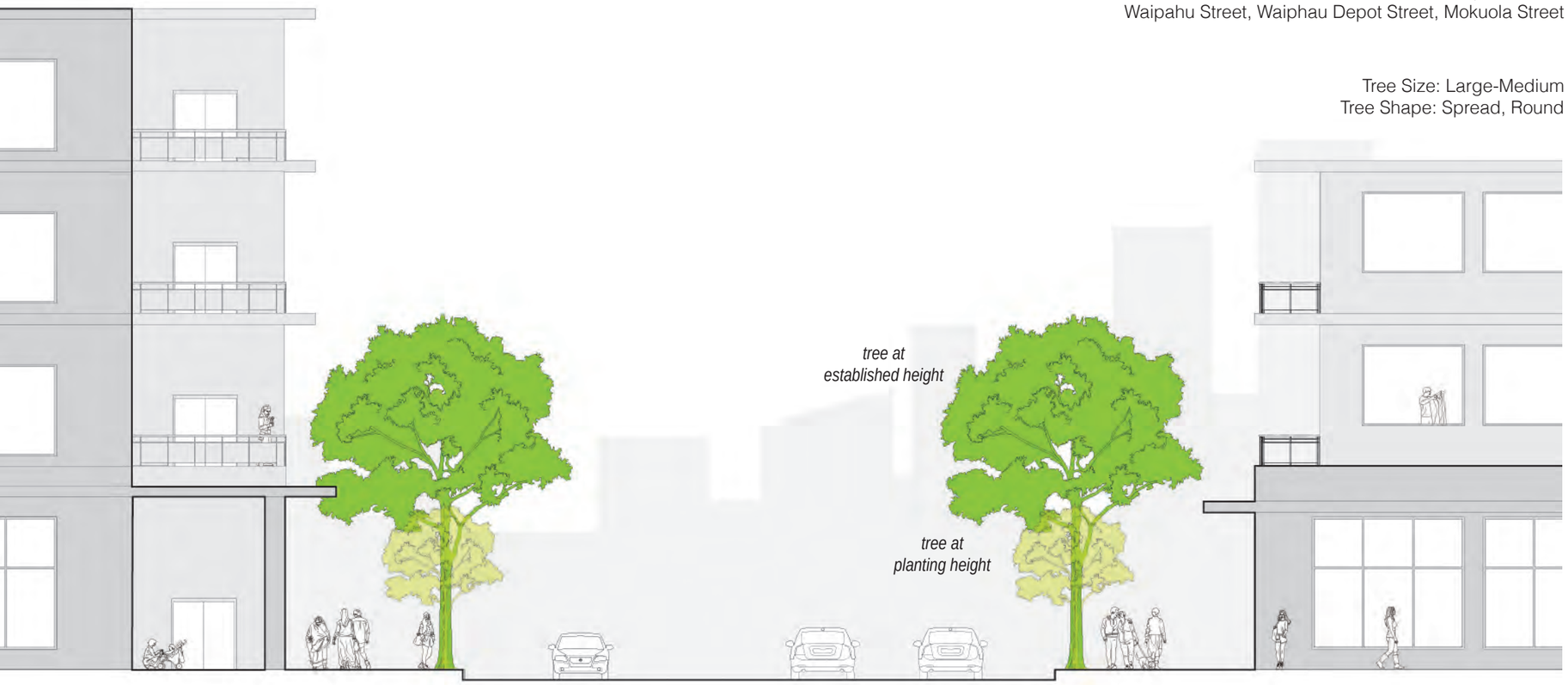
No.	Scientific Name	Common Name
1	*Tabebuia ochracea*	*Yellow Trumpet Tree*
2	*Cassia grandis*	*Pink shower Tree*
3	*Cocos nucifera*	*Niu*
4	*Samanea saman*	*Monkeypod*
5	*Terminalia catappa*	*Tropical Almond*

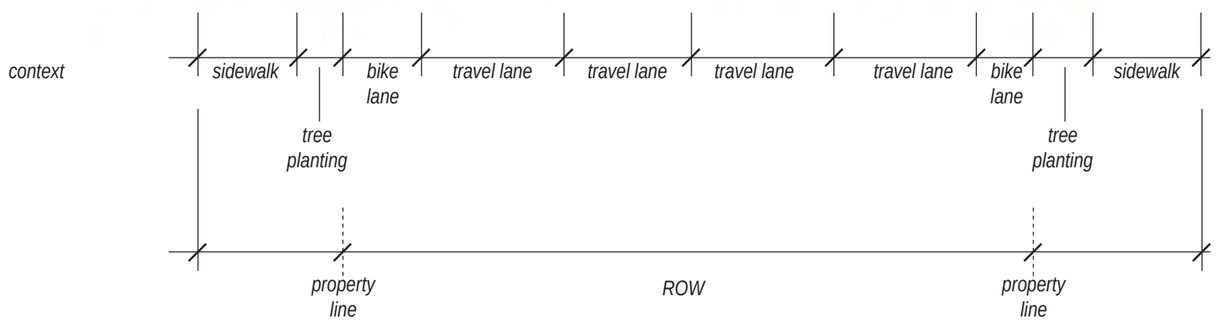
Refer to 7. Appendix for the full list suggested species



Example Streets:
Waipahu Street, Waiphau Depot Street, Mokuola Street

Tree Size: Large-Medium
Tree Shape: Spread, Round





context

Tree Purpose:
shade, noise buffer, focal point, cultural value, wayfinding
Trees should emphasize shade, urban cooling habitat, and walkable streets.

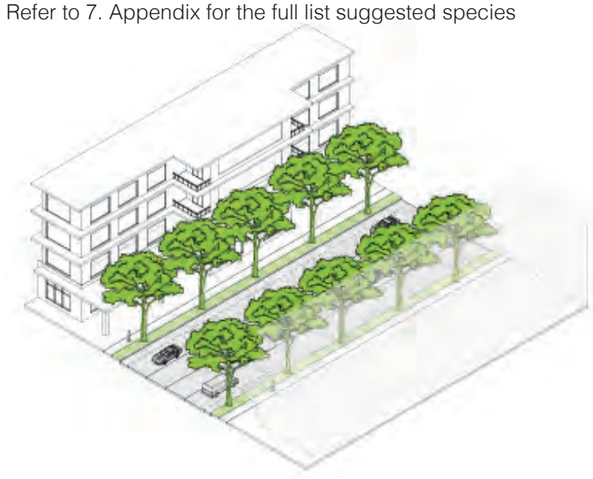
Tree Canopy Typology
2 Main Streets

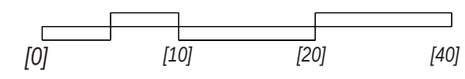
Characteristics:
Minor Arterial
Designed for moderate to high vehicular capacity and moderate speed acting as distance connections between highway/boulevards and urban centers.
Main Streets have two-four lands with bike lanes.
Also classified as avenues

Top 5 Native Species List

No.	Scientific Name	Common Name
1	*Diospyros sandicensis*	*Lama*
2	*Metrosideros polymorpha*	*ʻŌhiʻa lehua*
3	*Reynoldsia sandwicensis*	*ʻOhe makai*
4	*Aleurites moluccana*	*Kukui*
5	*Cocos nucifera*	*Niu*

Refer to 7. Appendix for the full list suggested species





6. Design

Tree Canopy Typology
3 Residential

Example Streets:
Kahulani Street, Awalau Street, streets in R-5 zoning

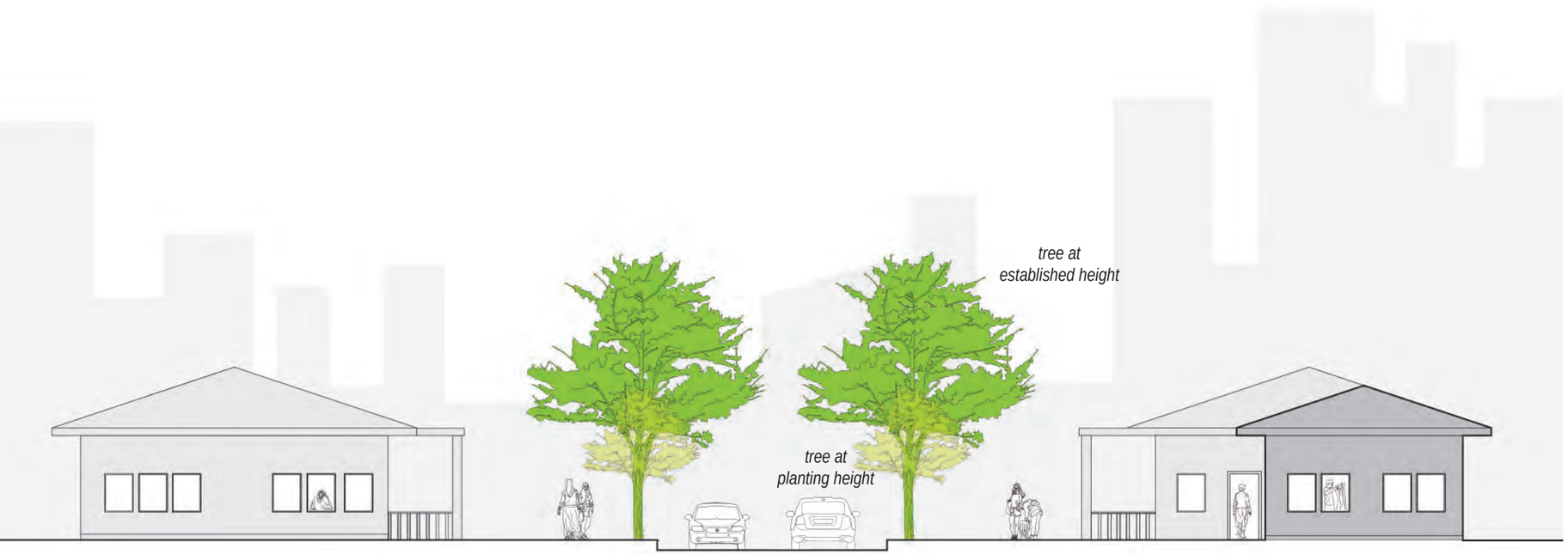
Tree Size: Medium-Small
Tree Shape: Oral, Vase

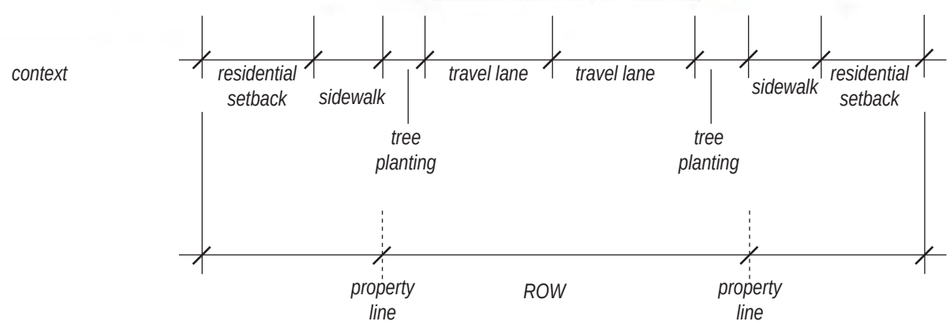
Characteristics:
Local
Residential tree canopy typologies are streets with local and suitable for all urbanized zones and all frontages and uses.
Streets are urban or suburban in character.
Streets have two travel lanes
Also classified as streets

Top 5 Native Species List

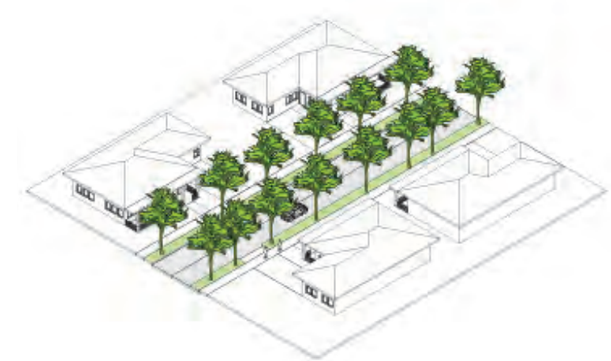
No.	Scientific Name	Common Name
1	*Metrosideros polymorpha*	*ʻŌhiʻa lehua*
2	*Psydrax odorata*	*Alaheʻe*
3	*Thespesia populnea*	*Milo*
4	*Aleurites moluccana*	*Kukui*
5	*Cordia subcordata*	*Kou*

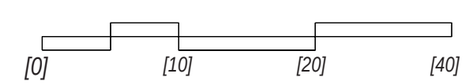
Refer to 7. Appendix for the full list suggested species





Tree Purpose:
Aesthetic, Ornamental
Trees around residential tree canopies should provide little maintenance to reduce green trash falling on private residential property.



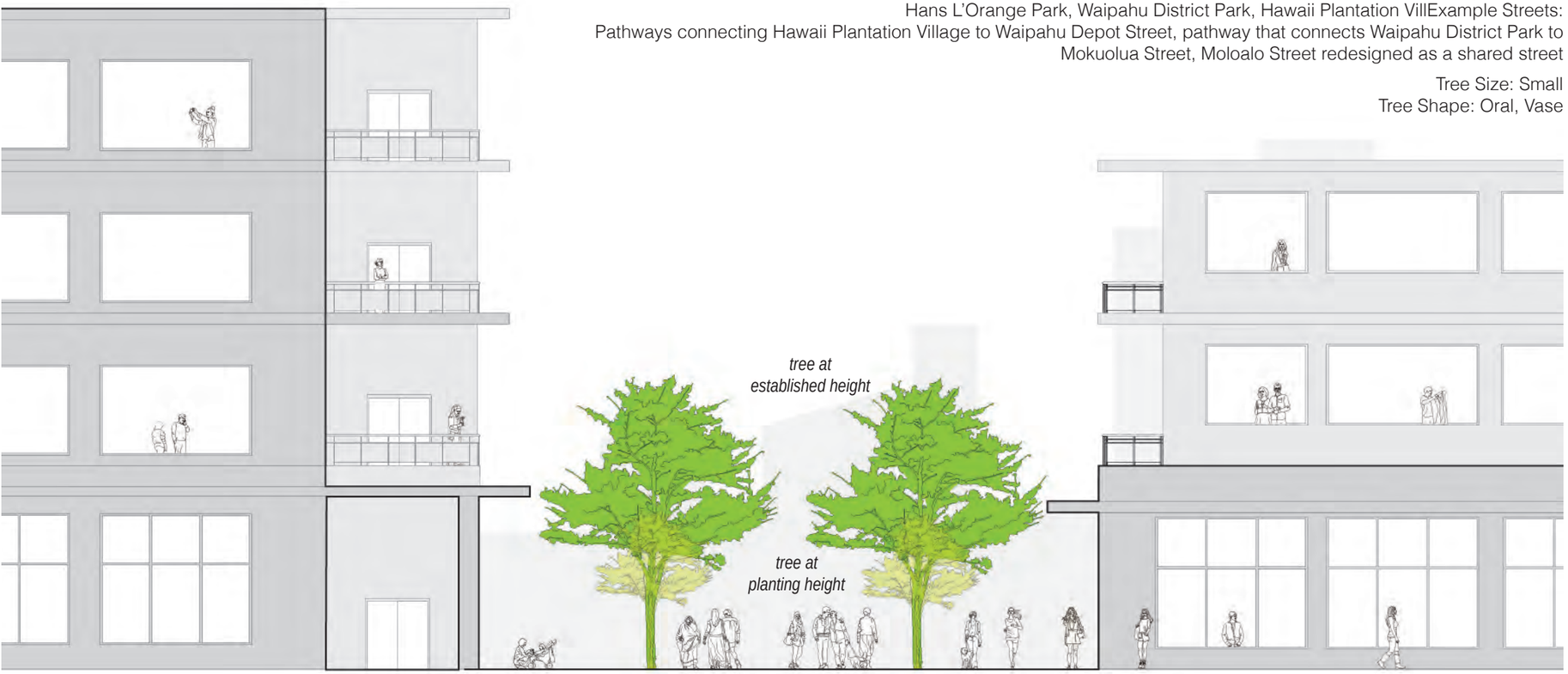


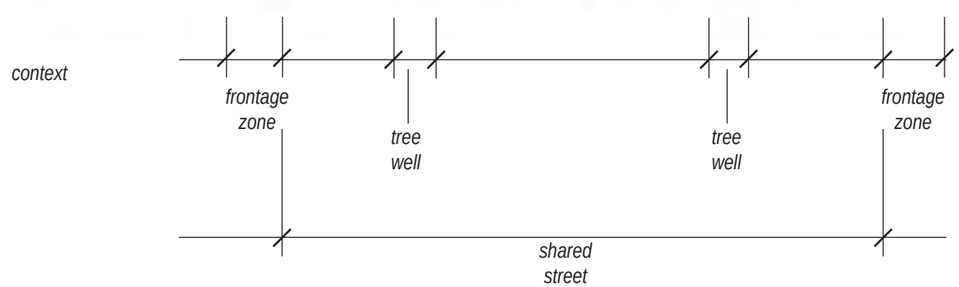
6. Design

Tree Canopy Typology
4 Pedestrian

Example Streets:
Hans L'Orange Park, Waipahu District Park, Hawaii Plantation VillExample Streets:
Pathways connecting Hawaii Plantation Village to Waipahu Depot Street, pathway that connects Waipahu District Park to Mokuolua Street, Moloalo Street redesigned as a shared street

Tree Size: Small
Tree Shape: Oral, Vase





Tree Purpose:
Shade, Aesthetic, Wayfinding
Trees should provide little obstruction for adjacent storefronts, commercial, and mix-use spaces.

Characteristics:
Local
Streets where private automobiles are heavily restricted. Pedestrian typologies take advantage of large volumes of people via multiple types of transit. Streets are lined with stores, restaurants, and entertainment that cater to people of foot. There characteristic streets are meant for destinations. Pedestrian streets can also cater to farmers market, craft fairs, and other events. Pedestrian malls have very slow traffic speed to accommodate pedestrian and bicycles.
Also classified as malls, lanes, alleyways

Top 5 Native Species List

No.	Scientific Name	Common Name
1	*Psydrax odorata*	*Alahe'e*
2	*Cordia subcordata*	*Kou*
3	*Sapindus saponaria*	*Manele*
4	*Thespesia populnea*	*Milo*
5	*Aleurites moluccana*	*Kukui*

Refer to 7. Appendix for the full list suggested species

6. Design

Tree Canopy Typology
5 Parks/Greenspaces

Example Streets:
Hans L'Orange Park, Waipahu District
Park, Hawaii Plantation Village

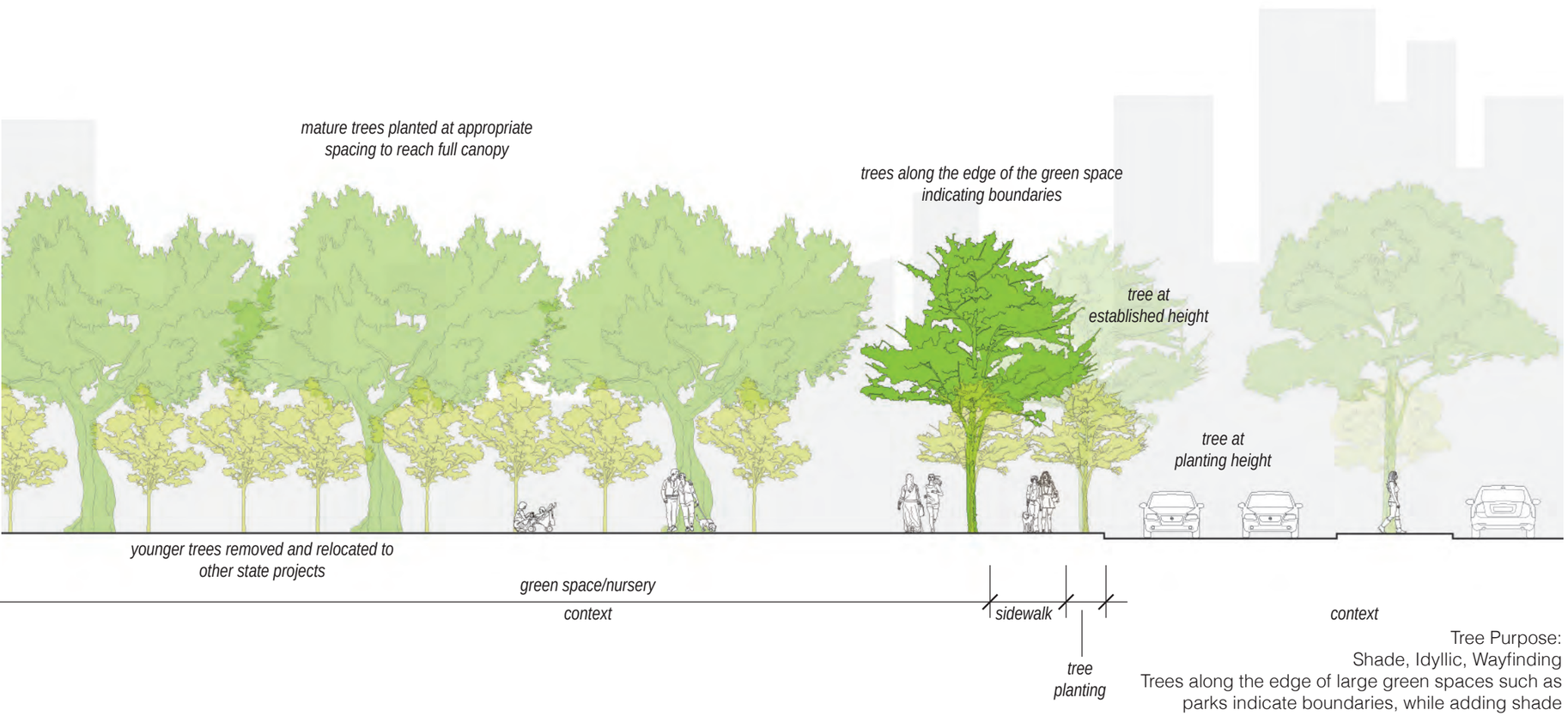
Tree Size: Large
Shape: Spread

Characteristics:
Large, green open spaces are ideal for tree canopy coverage.
Little to none vehicular traffic made.

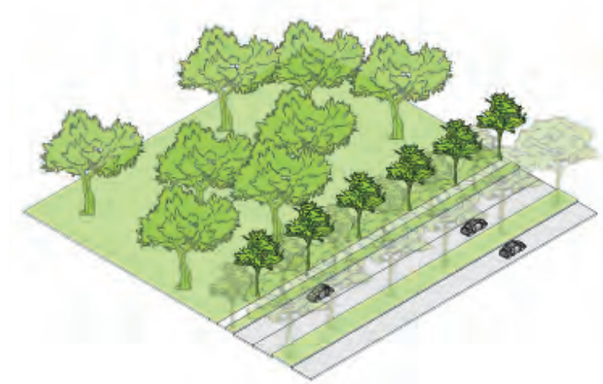
Top 5 Native Species List *Pandanus tectorius - Hala*

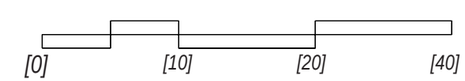
No.	Scientific Name	Common Name
1	*Psydrax odorata*	Alahe'e
2	*Cordia subcordata*	*Kou*
3	*Thespesia populnea*	*Milo*
4	*Aleurites moluccana*	*Kukui*
5	*Salophyllum inophyllum*	*Kamani*

Refer to 7. Appendix for the full list suggested species



Tree Purpose:
Shade, Idyllic, Wayfinding
Trees along the edge of large green spaces such as parks indicate boundaries, while adding shade



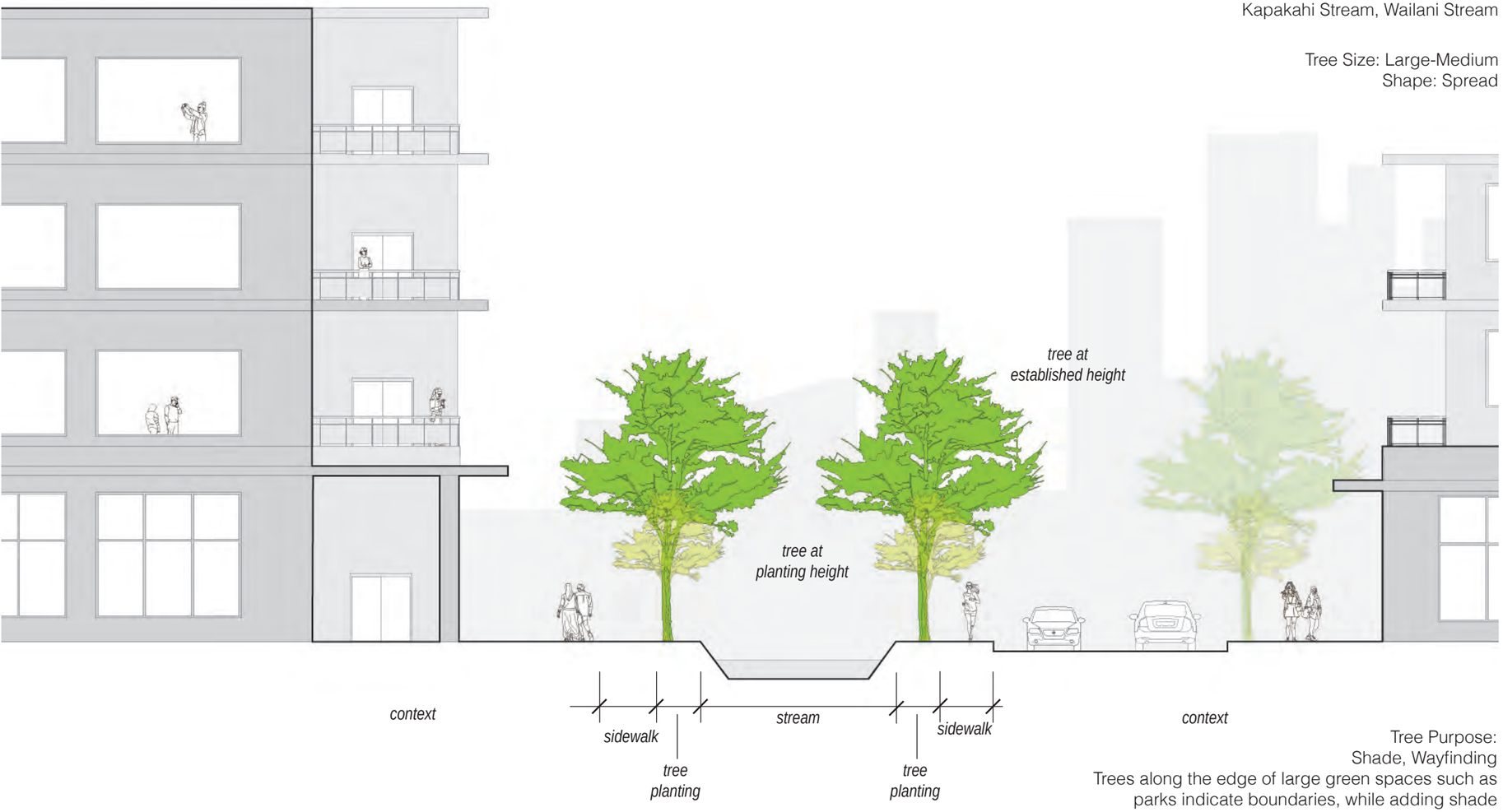


6. Design

Tree Canopy Typology
6 Stream Edges

Example Streets:
Kapakahi Stream, Wailani Stream

Tree Size: Large-Medium
Shape: Spread



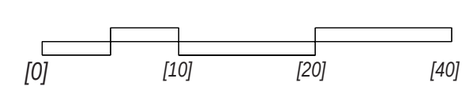
Tree Purpose:
Shade, Wayfinding
Trees along the edge of large green spaces such as parks indicate boundaries, while adding shade

Characteristics:
Little to none vehicular traffic made.
Tree canopies along water features such as streams, canals, lakes, marshland all provide an ecological benefit.

Top 5 Native Species List

No.	Scientific Name	Common Name
1	*Pandanus tectorius*	*Hala*
2	*Thespesia Populnea*	*Milo*
3	*Salophyllm Inophyllm*	*Kamani*
4	*Cordia subcordata*	*Kou*
5	*Cocos nucifera*	*Niu*

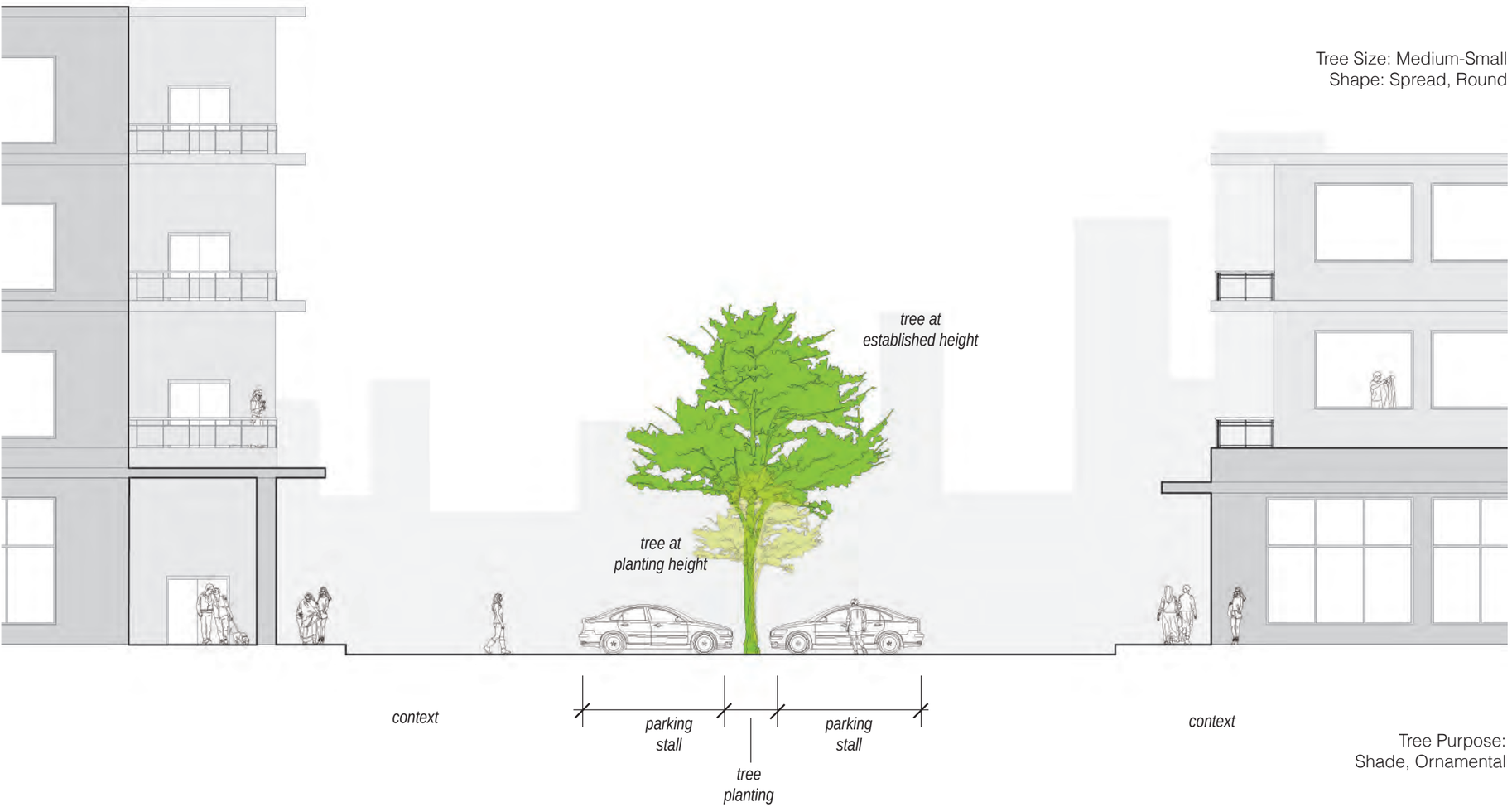
Refer to 7. Appendix for the full list suggested species



6. Design

Tree Canopy Typology
7 Parking Lot

Tree Size: Medium-Small
Shape: Spread, Round



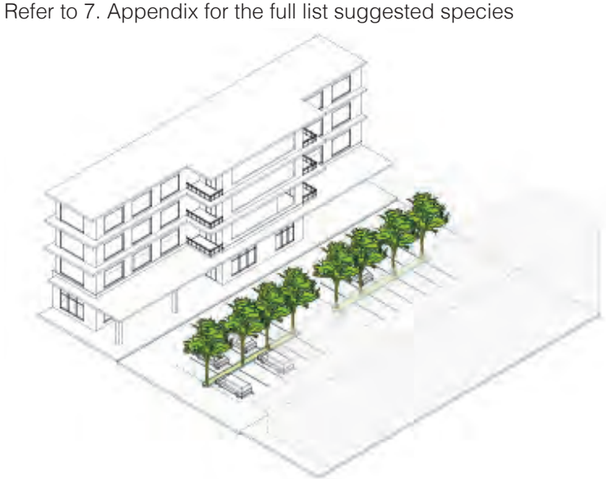
Tree Purpose:
Shade, Ornamental

Characteristics:
Little to none vehicular traffic made.
Trees provide shade on large impervious surfaces.

Top 5 Native Species List

No.	Scientific Name	Common Name
1	*Hibiscus brackenridgei*	Ma‘o hau hele
2	*Metrosideros polymorpha*	*‘Ōhi‘a lehua*
3	*Rauvolfia sandwicensis*	*Hao*
4	*Reynoldsia sandwicensis*	*‘Ohe makai*
5	*Thespesia populnea*	*Milo*

Refer to 7. Appendix for the full list suggested species



6. Design

Parametric Design Tool (2035)

Estimating the number of trees to achieve the 35% by 2035 goal was completed by first examining streets and city and state parcels. The process for city and state parcels was completed by inputting the percent of coverage desired for each space type, the output is the resulting square footage required. Square footages can then be divided by three representative tree sizes (small, medium, and large) to determine how many trees are required. The process for streets was completed by inputting a percentage of total linear feet desired. The resulting amount of linear feet is then divided by the diameter of trees (small, medium, and large) for the total amount of trees required.

Canopy coverage over major and minor roads and the highway is multiplied by two for coverage along both sidewalks.

In this example for 2035, the total coverage percentage result is 36.20% and has a positive net area of 166,884 square feet. The totals list shows the sum of small, medium, and large trees throughout State and City lands, TOD boundary, streets, and parks.

STATE/CITY LAND				
	TOTAL AREA (acres)	TOTAL AREA (sqft)	DESIRED CANOPY COVERAGE (%)	AREA COVERED AT DESIRED % (sqft)
State (excluding TOD zone)	17.66	769,095.36	**35%**	269,183.38
City (excluding parks)	90.49	3,941,744.40	**35%**	1,379,610.54
Total covered area (sqft)				**1,648,793.92**
Estimated tree count				
	SIZE	CANOPY RADIUS (ft)	DESIRED CANOPY COVERAGE (%) (Sum must equal 100)	QUANTITY OF TREES TO MEET DESIRED COVERED LENGTH
	Small	8.00	20.00%	1,640.59
	Medium	15.00	60.00%	1,399.26
	Large	40.00	20.00%	65.61
Total quantity			**35.00%**	3,105.46

HIGHWAY, MAJOR & MINOR RDs, RESIDENTIAL & PEDESTRIAN STREETS				
	TOTAL LENGTH (mi)	TOTAL LENGTH (ft)	DESIRED CANOPY COVERAGE (%)	LENGTH COVERED AT DESIRED % (ft)
Residential	5.29	27,931.20	**10.00%**	2793.12
Industrial/Minor St	3.13	16,526.40	**10.00%**	1652.64
Major ST	2.00	10,560.00	**50.00%**	5280
Rail/Highway	1.00	5,280.00	**50.00%**	2640
Estimated tree count				
	SIZE	CANOPY RADIUS (ft)		QUANTITY OF TREES TO MEET DESIRED COVERED LENGTH
RESIDENTIAL	Small	8.00		349.14
MAJOR RD + MINOR RD (x2)	Medium	15.00		924.35
HIGHWAY (x2)	Large	40.00		132.00
Total quantity				1,405.49
Total covered area (sqft)			**30.00%**	**1,387,126.00**

TOD BOUNDARY				
	TOTAL AREA (acres)	TOTAL AREA (sqft)	DESIRED CANOPY COVERAGE (%)	AREA COVERED AT DESIRED % (sqft)
MAUKA	64.85	2,824,866.00	**30%**	847,459.80
MAKAI	36.96	1,609,977.60	**30%**	482,993.28
Total covered area (sqft)				**1,330,453.08**
Estimated tree count				
	SIZE	CANOPY RADIUS (ft)	DESIRED CANOPY COVERAGE (%) (Sum must equal 100)	QUANTITY OF TREES TO MEET DESIRED COVERED LENGTH
	Small	8.00	20.00%	1,323.83
	Medium	15.00	60.00%	1,129.10
	Large	40.00	20.00%	52.94
Total quantity			**30.00%**	2,505.87

PARKS				
PARKS	TOTAL AREA (acres)	TOTAL AREA (sqft)	DESIRED CANOPY COVERAGE (%)	AREA COVERED AT DESIRED % (sqft)
Plantation	15.96	695,398.00	**35.00%**	243,389.30
L'Orange	9.68	421,816.00	**35.00%**	147,635.60
District park	14.00	609,840.00	**35.00%**	213,444.00
Total covered area (sqft)				**604,468.90**
Estimated tree count				
	Small	8.00	10.00%	106.19
	Medium	15.00	20.00%	60.38
	Large	40.00	70.00%	29.73
Total quantity			**35.00%**	196.30

TOTALS	35.66%	4,970,841.90
Net sqft		92,121.90
Tree quantity	Small	3,419.76
	Medium	3,513.09
	Large	280.28
	TOTAL	7,213.13

6. Design

2035 Plan

The final rendering of the Waipahu Rail Station envisions a tree canopy system that reflects the goals of the Waipahu Action Plan aligned with public lands to create a networked ecology in Waipahu Town.

Public lands became the first prioritize public lands and streets when adding trees. Parks, TOD designated parcels, major streets and the Farrington highways are clearly laid out with trees in this final rendering. Little emphasis was focused on private lands such as residential streets and zoning.

TOTALS	35.66%	4,970,841.90
Net sqft		92,121.90
Tree quantity	Small	3,419.76
	Medium	3,513.09
	Large	280.28
	TOTAL	7,213.13

6. Design

Parametric Design Tool (2135)

Achieving 50% by 2135 is a projected goal created for the potential to expand the idea of urban forests.
This study was completed by first examining streets and city and state parcels. The process for city and state parcels was completed by inputting the percent of coverage desired for each space type, the output is the resulting square footage required. Square footages can then be divided by three representative tree sizes (small, medium, and large) to determine how many trees are required. The process for streets was completed by inputting a percentage of total linear feet desired. The resulting amount of linear feet is then divided by the diameter of trees (small, medium, and large) for the total amount of trees required.

Canopy coverage over major and minor roads and the highway is multiplied by two for coverage along both sidewalks.

In this example for 2135, the total coverage percentage result is 52.03% and has a positive net area of 2,373,943 square feet (in comparison to the 35% goal). The totals list shows the sum of small, medium, and large trees throughout State and City lands, TOD boundary, streets, and parks.

STATE/CITY LAND				
	TOTAL AREA (acres)	TOTAL AREA (sqft)	DESIRED CANOPY COVERAGE (%)	AREA COVERED AT DESIRED % (sqft)
State (excluding TOD zone)	17.66	769,095.36	**40%**	307,638.14
City (excluding parks)	90.49	3,941,744.40	**40%**	1,576,697.76
Total covered area (sqft)				**1,884,335.90**
Estimated tree count				
	SIZE	CANOPY RADIUS (ft)	DESIRED CANOPY COVERAGE (%) (Sum must equal 100)	QUANTITY OF TREES TO MEET DESIRED COVERED LENGTH
	Small	8.00	10.00%	937.48
	Medium	15.00	60.00%	1,599.15
	Large	40.00	30.00%	112.48
Total quantity			**40.00%**	2,649.11

HIGHWAY, MAJOR & MINOR RDs, RESIDENTIAL & PEDESTRIAN STREETS				
	TOTAL LENGTH (mi)	TOTAL LENGTH (ft)	DESIRED CANOPY COVERAGE (%)	LENGTH COVERED AT DESIRED % (ft)
Residential	5.29	27,931.20	**30.00%**	8379.36
Industrial/Minor St	3.13	16,526.40	**30.00%**	4957.92
Major ST	2.00	10,560.00	**75.00%**	7920
Rail/Highway	1.00	5,280.00	**75.00%**	3960
Estimated tree count				
	SIZE	CANOPY RADIUS (ft)		QUANTITY OF TREES TO MEET DESIRED COVERED LENGTH
RESIDENTIAL	Small	8.00		1,047.42
MAJOR RD + MINOR RD (x2)	Medium	15.00		1,717.06
HIGHWAY (x2)	Large	40.00		198.00
Total quantity				2,962.48
Total covered area (sqft)			**52.50%**	**2,419,638.01**

TOD BOUNDARY				
	TOTAL AREA (acres)	TOTAL AREA (sqft)	DESIRED CANOPY COVERAGE (%)	AREA COVERED AT DESIRED % (sqft)
MAUKA	64.85	2,824,866.00	**30%**	847,459.80
MAKAI	36.96	1,609,977.60	**30%**	482,993.28
Total covered area (sqft)				**1,330,453.08**
Estimated tree count				
	SIZE	CANOPY RADIUS (ft)	DESIRED CANOPY COVERAGE (%) (Sum must equal 100)	QUANTITY OF TREES TO MEET DESIRED COVERED LENGTH
	Small	8.00	20.00%	1,323.83
	Medium	15.00	60.00%	1,129.10
	Large	40.00	20.00%	52.94
Total quantity			**30.00%**	2,505.87

PARKS				
PARKS	TOTAL AREA (acres)	TOTAL AREA (sqft)	DESIRED CANOPY COVERAGE (%)	AREA COVERED AT DESIRED % (sqft)
Plantation	15.96	695,398.00	**40.00%**	278,159.20
L'Orange	9.68	421,816.00	**40.00%**	168,726.40
District park	14.00	609,840.00	**40.00%**	243,936.00
Total covered area (sqft)				**690,821.60**
Estimated tree count				
	Small	8.00	10.00%	121.36
	Medium	15.00	20.00%	69.01
	Large	40.00	70.00%	33.97
Total quantity			**40.00%**	224.34

TOTALS	50.15%	6,990,475.14
net required		2,111,755.14
Tree quantity	Small	3,099.14
	Medium	5,078.86
	Large	463.57
	TOTAL	8,641.57

6. Design

2135 Plan

The final rendering of the Waipahu Rail Station envisions a tree canopy system that reflects a expanded networked ecology in Waipahu Town.

In this aggressive approach to an urban forest image of Waiphau, the team's goal was to reach a tree canopy coverage percentage of 50%. The plan is translated with public lands having large percentage of canopy coverage while residential streets also increased more street trees.

TOTALS	50.15%	6,990,475.14
net required		2,111,755.14
Tree quantity	Small	3,099.14
	Medium	5,078.86
	Large	463.57
	TOTAL	8,641.57

7. Appendix

Suggested Tree Species Master List

The Suggested Tree Species Master List is organized in order of lowest to highest invasive risk as assessed through the Hawaii Pacific Weed Risk Assessment using the WRA designation: low (L), high (H), further evaluation required (E) and a numeric WRA score, for example, the rainbow shower tree is given a rating of L-8, a low risk designation and numeric score of -8.

Plants selected in this master list consist of plants with tolerance to drier conditions, with the half-mile viscinity of the Pouhala Rail Station in Waipahu, Oahu. Application of this list is not recommended for other areas.

This list was compiled from documents from the City and County of Honolulu's Department of Planning and Permitting's 1999 Standards and Procedures for the Planting of Street Trees, City of Honolulu's Center for Urban Forest Research's 2007 Municipal Forest Resource Analysis, and Maui County's Maui County Arborist Committee's 2016 Maui County Planting Plan (third edition).

No.	Invasive Risk (WRA)*	Species	Common Name	Size Rating (L=>40ft M=25-40ft S=<25ft)	Expected Canopy Spread (Ft)	Growth habit, crown density	Wind tol	Salt tol	Flower color, time of flower	Rubbish, maintenance	Water Requirements	Plant litter, other notes
1	Endemic	Acacia koaia	Koaiʻa	S	25	Spreading, open	good	sens	yellow SpWn	low, low maint	dry-med	
2	Poly. Intro	Alaurites moluccana	Kukui	M	30	upright round, dense	med	sens	white	mod, med maint	(dry) med-wet	fruits
3	Poly. Intro	Cocos nucifera	Niu	L	30	upright, open	good	tol	white SpSuFaWn	mod, med maint	dry-med-wet	leaves, nuts
4	Indigenous	Cordia subcordata	Kou	M	25	upright round, dense	med	tol	orange SpSuFaWn	low (fruit), med maint	(Dry) med-wet	flowers, fruits can handle light sea spray
5	Endemic	Diospyros sandicensis	Lama	S	15	spreading, dense	good	sens	inconspic.	none, low maint	dry-med	
6	Indigenous	Dodonaea viscosa	ʻAʻaliʻi	S	8	spreading medium	good	tol	n/a	none, low maint	dry-med	
7	endemic	Erythrina sandwicensis	wiliwili	M	25	spreading, med	good	mod	red, orange, white, green, yellow SpSu	mod, med maint	dry-med	pods
8	endemic	Gardnenia brighmii	Nānū	S	10	round, dense	good	sens	white SpSuWn	none, low maint	dry-med	
9	Endemic	Hibiscus brackenridgei ***	Maʻo hau hele	S	8	round, dense	good	sens	yellow SpWn	mod, low maint		flowers
10	Endemic	Metrosideros polymorpha[1]	ʻŌhiʻa lehua	S	15	round, open	good	sens	red, orange, yellow SpSuWn	none, low maint	(Dry) med-wet	Evergreen, does well in urban settings. Canopy may take years to become full
11	Indigenous	Nesoluma polynesicum	Keahi	S	15	round, dense	good	sens	inconspic.	none, low maint	dry	fruits
12	Indigenous	Pandanus tectorius	Hala	M	20	round, dense	good	tol	white SpSuFaWn	high, high maint	(dry) med-wet	fruits
13	Indigenous	Psydrax odorata	Alaheʻe	S	8	upright round, dense	good	sens	white SpWn	none, low maint	dry-med	fruits
14	Endemic	Rauvolfia sandwicensis	Hao	S	15	upright round, med	good	sens	inconspic.	none, low maint	dry-med	
15	Endemic	Reynoldsia sandwicensis	ʻOhe makai	M	20	round, med	good	sens	inconspic.	low, low maint	dry	
16	Poly. Intro	Salophyllum inophyllum	Kamani	L	30	upright round, dense	good	tol	White SpSuFa	mod, med maint	(dry) med-wet	nuts
17	Indigenous	Sapindus saponaria[2,3]	Manele	L	40	upright round, dense	good	mod	White Fa	none, low maint	dry-med	fruits
18	Indigenous/ Endemic	Thespesia populnea	Milo	M	25	round, dense	good	tol	yellow SpSuFa	mod, med maint	(dry) med-wet	fruits
19	L-8	Colvillea racemosa	Colville's glory	M	25	upright round, med	good	mod	orange SuFa	low, low maint	dry-med-wet	flowers, pods
20	L-7	Bauhinia × blakeana	Hong kong orchid tree	M	25	round, open	med	sens	purple SpSuFa	mod, med maint	(dry) med-wet	flowers, pods

Native species

Low Invasive Risk

Further Invasive Risk Evaluation Needed

High Invasive Risk

Sources:

1.Hawaii-Pacific Weed Risk Assessment. [All species listed]. www.hpwra.org. Accessed June 14, 2018.
2. Ernest H. Rezents. Maui County Planting Plan. Maui County Arborist Committee, Third Edition. March 9, 2016.
3. City and County of Honolulu Department of Planning and Permitting. Standards and Procedures for the Planting of Street Trees. July 1999.

No.	Invasive Risk (WRA)*	Species	Common Name	Size Rating (L=>40ft M=25-40ft S=<25ft)	Expected Canopy Spread (Ft)	Growth habit, crown density	Wind tol	Salt tol	Flower color, time of flower	Debris fall, maintenance	Water Requirements	Plant debris type, other notes
21	L-6	Guaiacum officinale	lignum vitae	S	12	upright round, med	med	mod	lavender blue Sp	none, low maint	dry-med-wet	flowers, fruits
22	L-5	Cassia grandis	pink shower tree	L	30	upright round, open	med	sens	pink SpSu	mod, med maint	dry-med-wet	flowers, pods
23	L-5	Dracaena draco	dragon tree	S	20	upright round, open	good	tol	yellow Wn	none, low maint	dry-med	succulent
24	L-5	Ficus elastica	Rubber tree	L	60	round, dense	good	tol	inconspic.	high, high maint	dry-med-wet	buttressing roots
25	L-5	Plumeria rubra	plumeria	S	15	round, dense	good	tol	red, white, yellow, etc. SpSuFa	none, low maint	(Dry) med-wet	flowers
26	L-4	Cochlospermum vitifolium	Buttercup tree	M	30	upright round, med	med	mod	yellow Wn	none, low maint	dry-med-wet	flowers, fruits
27	L-4	Harpullia pendula	Tulipwood	M	20	upright round, med	med	sens	inconspic.	none, low maint	(Dry) med-wet	flowers, seeds
28	L-4	Lagerstroemia speciosa	Pride of India	L	25	upright round, med	med	sens	lavender SpSu	none, low maint	(Dry) med-wet	flowers, pods
29	L-4	Tabebuia berteroi	Hispaniolan rosy trumpet	M	20	upright round, med	med	sens	light pink SpSuFa	mod (flowers), med maint	dry-med-wet	flowers, pods
30	L-4	Tabebuia donnell-smithii	Gold tree	L	30	upright, med	poor	mod	yellow SpSu	mod, med maint	dry-med-wet	Landmark tree (decorative) flowers, pods
31	L-4	Thespesia grandiflora	maga	M	25	upright round, dense	med	sens	red SuFa	none, low maint	dry-med-wet	invasive roots
32	L-3	Conocarpus erectus	buttonwood	S	20	round, dense	good	tol	inconspic.	none, low maint	dry-med	fruits
33	L-3	Gliricidia sepium	madre de cacao	S	20	round, open	good	tol	violet SpWn	mod, med maint	dry-med	flowers, pods
34	L-3	Tabebuia ochracea	yellow trumpet tree	M	30	upright round, med	med	sens	yellow SpSu	mod, low maint	dry-med-wet	flowers, pods
35	L-3	Tamarindus indica	Tamarind	L	30	upright round, dense	good	mod	yellow/green SpSuFaWn	none, low maint	dry-med-wet	flowers, edible pods
36	L-2	Erythrina variegata	Indian coral tree	L	8	upright, dense	good	sens	orange Wn	mod, low maint	(Dry) med	saltwater tolerant drought tolerant in the winter flowers, pods
37	L-2	Heritiera littoralis[2]	Looking glass tree	L	20	spreading, med	med	tol	inconspic.	none, low maint	(Dry) med-wet	buttressing roots fruiting can tolerate occasional inundation by salt water so long as the salt is then flushed out by fresh water
38	L-2	Pseudobombax ellipticum	shaving brush tree	L	35	upright round, med	med	mod	pink, white SpWn	mod, med maint	dry-med	flowers, fruits
39	L-2	Saccharum officinarum	Sugar cane	Barrier	5	upright, dense	good	mod	white SpWn	mod, med maint	(dry) med	Historically significant crop
40	L-1	Cordia sebestena	kou haole	S	15	upright round, dense	good	mod	red/orange SpSuFa	low (fruit), med maint	low-med	flowers, fruits

7. Appendix

Suggested Tree Species Master List

The Suggested Tree Species Master List is organized in order of lowest to highest invasive risk as assessed through the Hawaii Pacific Weed Risk Assessment using the WRA designation: low (L), high (H), further evaluation required (E) and a numeric WRA score, for example, the rainbow shower tree is given a rating of L-8, a low risk designation and numeric score of -8.

Plants selected in this master list consist of plants with tolerance to drier conditions, with the half-mile viscinity of the Pouhala Rail Station in Waipahu, Oahu. Application of this list is not recommended for other areas.

This list was compiled from documents from the City and County of Honolulu's Department of Planning and Permitting's 1999 Standards and Procedures for the Planting of Street Trees, City of Honolulu's Center for Urban Forest Research's 2007 Municipal Forest Resource Analysis, and Maui County's Maui County Arborist Committee's 2016 Maui County Planting Plan (third edition).

- Native species
- Low Invasive Risk
- Further Invasive Risk Evaluation Needed
- High Invasive Risk

Sources:

1.Hawaii-Pacific Weed Risk Assessment. [All species listed]. www.hpwra.org. Accessed June 14, 2018.
2. Ernest H. Rezents. Maui County Planting Plan. Maui County Arborist Committee, Third Edition. March 9, 2016.
3. City and County of Honolulu Department of Planning and Permitting. Standards and Procedures for the Planting of Street Trees. July 1999.

No.	Invasive Risk (WRA)*	Species	Common Name	Size Rating (L=>40ft M=25-40ft S=<25ft)	Expected Canopy Spread (Ft)	Growth habit, crown density	Wind tol	Salt tol	Flower color, time of flower	Rubbish, maintenance	Water Requirements	Plant litter, other notes
41	L-1	Delonix regia	royal poinciana	M	40	spreading, med	good	sens	red, orange SpSu	mod (fruit), med maint	dry-med-wet	"invasive roots flowers, pods"
42	L-1	Eucalyptus torquata	coral gum	M	30	upright round, dense	good	mod	pink/yellow, pink/white Fa	none, low maint	dry-med	flowers
43	L0	Ceratonia siliqua	Carob	S	20	upright round, med	good	mod	inconspic.	low, low maint	dry-med-wet	pods
44	L0	Callistemon citrinus	red bottlebrush	S	15	upright round, dense	good	mod	red SpSuFaWn	none, low maint	dry-med	flowers
45	L0	Pterocarpus rohrii	bloodwood	S	15	round, dense	good	sens	golden/yellow Sp	none, low maint	dry-med-wet	pods
46	L0	Tipuana tipu	Rosewood	M	25	spreading, open	good	tol	yellow SpSu	none, low maint	dry-med	flowers, pods
47	L1	Samanea saman	Monkeypod	L	80	spreading, dense	med	sens	pink SpSu	mod, med maint	(Dry) med-wet	flowers, pods
48	L1	Tabebuia heterophylla	Pink trumpet tree	L	25	upright round, dense	med	mod	pink SpSuFa	none, low maint	dry-med-wet	flowers, pods
49	L2	Catalpa longissima[1]	Jamaica oak	L	25	upright, dense	good	mod	white SpSu	none, low maint	(dry) med	Tolerant to unfavorable conditions, but slow growing flowers, pods
50	L3	Enterolobium cyclocarpum	ear tree	L	80	upright spreading, open	good	mod	white	low, med maint	dry-med	"Wide canopy, but tall roots may cause infrastructure damage pods"
51	L3	Ficus benghalensis	Banyan tree	L	70	upright round, dense	good	tol	red Fa	mod, med maint	dry-med-wet	buttressing roots
52	L3	Tabebuia aurea	Silver trumpet tree	L	20	upright round, med	med	mod	yellow SpSu	none, low maint	dry-med	"Does well in many conditions Drought, innundation, poor soil tolerant flowers, pods"
53	L4	Ficus benjamina	weeping banyan	L	70	spreading, dense	good	tol	inconspic	low, low maint	dry-med-wet	
54	L4	Terminalia catappa	Tropical almond	L	60	spreading, med	good	tol	white Fa	high, high maint	dry-med-wet	salt tolerant, coastal plant buttressing roots fruits contain tannins and may stain sidewalks
55	L6	Erythrina crista-galli	coral tree	S	15	round, med	good	tol	red Sp	low, low maint	dry-med	flowers, pods
56	E	Ficus macrophylla	Moreton bay fig	L	60	round, dense	good	tol	inconspic	mod, high maint	dry-med-wet	buttressing roots fruits
57	E	Noronhia emarginata*	Madagascar olive	M	25	upright round, dense	good	tol	inconspic	mod, med maint	dry-med-wet	fruits
58	E	Senna surattensis*	kolomona	S	10	round, med	good	mod	yellow SpSuFaWn	none, low maint	dry-med	flowers, pods

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The master list plant selection foremost takes the environmental conditions within close proximity to the Pouhala Rail Station in Waipahu. The list should be closely reviewed before application to other areas.

This list was compiled from documents from the City and County of Honolulu's Department of Planning and Permitting's 1999 Standards and Procedures for the Planting of Street Trees, City of Honolulu's Center for Urban Forest Research's 2007 Municipal Forest Resource Analysis, and Maui County's Maui County Arborist Committee's 2016 Maui County Planting Plan (third edition).

- Native species
- Low Invasive Risk
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No.	Invasive Risk (WRA)*	Species	Common Name	Size Rating (L=>40ft M=25-40ft S=<25ft)	Expected Canopy Spread (Ft)	Growth habit, crown density	Wind tol	Salt tol	Flower color, time of flower	Rubbish, maintenance	Water Requirements	Plant litter, other notes
59	H10	Cupaniopsis anacardioides	Tuckeroo	M								Listed on the 1999 Official Street Tree List
60	H10	Ficus microcarpa	Chinese banyan	L								Listed on the 1999 Official Street Tree List
61	H7	Pimenta dioica	Allspice	S								Listed on the 1999 Official Street Tree List
62	H8	Bauhinia variegata	Orchid tree	M								White to purple orchid flowers aesthetically similar to the Hong Kong orchid tree

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Plants selected in this master list consist of plants with tolerance to drier conditions, with the half-mile viscinity of the Pouhala Rail Station in Waipahu, Oahu. Application of this list is not recommended for other areas.

This list was compiled from documents from the City and County of Honolulu's Department of Planning and Permitting's 1999 Standards and Procedures for the Planting of Street Trees, City of Honolulu's Center for Urban Forest Research's 2007 Municipal Forest Resource Analysis, and Maui County's Maui County Arborist Committee's 2016 Maui County Planting Plan (third edition).

- Native species
- Low Invasive Risk
- Further Invasive Risk Evaluation Needed
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2. Ernest H. Rezents. Maui County Planting Plan. Maui County Arborist Committee, Third Edition. March 9, 2016.
3. City and County of Honolulu Department of Planning and Permitting. Standards and Procedures for the Planting of Street Trees. July 1999.

7. Appendix

Suggested Tree Species Master List

1	HIGHWAY/RAIL TREES		
No.	**SIZE**	**SCIENTIFIC NAME**	**COMMON NAME**
	M	Tabebuia ochracea	yellow trumpet tree
	L	Cassia grandis	pink shower tree
	L	Catalpa longissima	Yokewood
3	**L**	**Cocos nucifera**	**Niu**
	L	Enterolobium cyclocarpum	earpod tree
	L	Samanea saman	Monkeypod
	L	Tabebuia aurea	Silver trumpet tree
	L	Tabebuia donnell-smithii	Gold tree
	L	Terminalia catappa	Tropical almond

2	MAIN-STREET TREES		
No.	**SIZE**	**SCIENTIFIC NAME**	**COMMON NAME**
5	**S**	**Diospyros sandicensis**	**Lama**
10	**S**	**Metrosideros polymorpha**	**ʻŌhiʻa lehua**
40	S	Cordia sebestena	Kou haole
32	S	Conocarpus erectus	Buttonwood
33	S	Gliricidia sepium	Madre de cacao
25	S	Plumeria rubra	Plumeria
21	S	Guaiacum officinale	Lignum vitae
44	S	Callistemon citrinus	Red bottlebrush
43	S	Ceratonia siliqua	Carob
15	**M**	**Reynoldsia sandwicensis**	**ʻOhe makai**
18	**M**	**Thespesia populnea**	**Milo**
42	M	Eucalyptus torquata	Coral gum
34	M	Tabebuia ochracea	Yellow trumpet tree
26	M	Cochlospermum vitifolium	Buttercup tree
27	M	Harpullia pendula	Tulipwood
28	M	Lagerstroemia speciosa	Pride of India
29	M	Tabebuia berteroi	Hispaniolan rosy trumpet
20	M	Bauhinia × blakeana	Hong kong orchid tree
19	M	Colvillea racemosa	Colville's-glory
46	M	Tipuana tipu	Rosewood
48	M	Tabebuia heterophylla	Pink trumpet tree
2	**M**	**Aleurites moluccana**	**Kukui**
37	L	Heritiera littoralis	Looking glass tree
49	L	Catalpa longissima	Jamaican oak
52	L	Tabebuia aurea	Silver trumpet tree
3	**L**	**Cocos nucifera**	**Niu**

3	PEDESTRIAN-STREET TREES		
No.	**SIZE**	**SCIENTIFIC NAME**	**COMMON NAME**
13	**S**	**Psydrax odorata**	**Alaheʻe**
32	S	Conocarpus erectus	buttonwood
23	S	Dracaena draco	dragon tree
25	S	Plumeria rubra	plumeria
21	S	Guaiacum officinale	lignum vitae
43	S	Ceratonia siliqua	Carob
4	**M**	**Cordia subcordata**	**Kou**
17	**M**	**Sapindus saponaria**	**Manele**
18	**M**	**Thespesia populnea**	**Milo**
41	M	Delonix regia	royal poinciana
34	M	Tabebuia ochracea	yellow trumpet tree
28	M	Lagerstroemia speciosa	Pride of India
29	M	Tabebuia berteroi	Hispaniolan rosy trumpet
20	M	Bauhinia × blakeana	Hong kong orchid tree
19	M	Colvillea racemosa	Colville's-glory
46	M	Tipuana tipu	Rosewood
48	M	Tabebuia heterophylla	Pink trumpet tree
2	**M**	**Aleurites moluccana**	**Kukui**
36	L	Erythrina variegata	Indian coral tree
22	L	Cassia grandis	pink shower tree
47	L	Samanea saman	Monkeypod
52	L	Tabebuia aurea	Silver trumpet tree
54	L	Terminalia catappa	Tropical almond
16	**L**	**Salophyllum inophyllum**	**Kamani**

Suggested Tree Species Master List

4	RESIDENTIAL STREET TREES		
No.	**SIZE**	**SCIENTIFIC NAME**	**COMMON NAME**
25	S	Plumeria rubra	Plumeria
10	**S**	**Metrosideros polymorpha**	**‘Ōhi‘a lehua**
32	S	Conocarpus erectus	Buttonwood
13	**S**	**Psydrax odorata**	**Alahe‘e**
34	M	Tabebuia ochracea	Yellow trumpet tree
27	M	Harpullia pendula	Tulipwood
28	M	Lagerstroemia speciosa	Pride of India
48	M	Tabebuia heterophylla	Pink trumpet tree
18	**M**	**Thespesia populnea**	**Milo**
17	**M**	**Sapindus saponaria**	**Manele**
2	**M**	**Aleurites moluccana**	**Kukui**
4	**M**	**Cordia subcordata**	**Kou**
20	M	Bauhinia × blakeana	Hong kong orchid tree
29	M	Tabebuia berteroi	Hispaniolan rosy trumpet
26	M	Cochlospermum vitifolium	Buttercup tree
54	L	Terminalia catappa	Tropical almond
52	L	Tabebuia aurea	Silver trumpet tree
22	L	Cassia grandis	pink shower tree
36	L	Erythrina variegata	Indian coral tree

5	PARK/OPEN SPACE TREES		
No.	**SIZE**	**SCIENTIFIC NAME**	**COMMON NAME**
1	**S**	**Acacia koaia**	**Koai‘a**
5	**S**	**Diospyros sandicensis**	**Lama**
8	**S**	**Gardnenia brighmii**	**Nānū**
9	**S**	**Hibiscus brackenridgei**	**Ma‘o hau hele**
10	**S**	**Metrosideros polymorpha**	**‘Ōhi‘a lehua**
14	**S**	**Rauvolfia sandwicensis**	**Hao**
6	**S**	**Dodonaea viscosa**	**‘A‘ali‘i**
11	**S**	**Nesoluma polynesicum**	**Keahi**
13	**S**	**Psydrax odorata**	**Alahe‘e**
40	S	Cordia sebestena	kou haole
32	S	Conocarpus erectus	buttonwood
33	S	Gliricidia sepium	madre de cacao
23	S	Dracaena draco	dragon tree
25	S	Plumeria rubra	plumeria
21	S	Guaiacum officinale	lignum vitae
44	S	Callistemon citrinus	red bottlebrush
43	S	Ceratonia siliqua	Carob
45	S	Pterocarpus rohrii	bloodwood
55	S	Erythrina crista-galli	coral tree
7	**M**	**Erythrina sandwicensis**	**wiliwili**
15	**M**	**Reynoldsia sandwicensis**	**‘Ohe makai**
4	**M**	**Cordia subcordata**	**Kou**
12	**M**	**Pandanus tectorius**	**Hala**
17	**M**	**Sapindus saponaria**	**Manele**
18	**M**	**Thespesia populnea**	**Milo**
41	M	Delonix regia	royal poinciana
42	M	Eucalyptus torquata	Coral gum
34	M	Tabebuia ochracea	yellow trumpet tree
26	M	Cochlospermum vitifolium	Buttercup tree
27	M	Harpullia pendula	Tulipwood
28	M	Lagerstroemia speciosa	Pride of India
29	M	Tabebuia berteroi	Hispaniolan rosy trumpet
31	M	Thespesia grandiflora	maga
20	M	Bauhinia × blakeana	Hong kong orchid tree
19	M	Colvillea racemosa	Colville’s-glory
46	M	Tipuana tipu	Rosewood

5	PARK/OPEN SPACE TREES		
No.	**SIZE**	**SCIENTIFIC NAME**	**COMMON NAME**
34	M	Tabebuia heterophylla	Yellow trumpet tree
2	**M**	**Aleurites moluccana**	**Kukui**
37	L	Heritiera littoralis	Looking glass tree
36	L	Erythrina variegata	Indian coral tree
38	L	Pseudobombax ellipticum	shaving brush tree
35	L	Tamarindus indica	Tamarind
30	L	Tabebuia donnell-smithii	Gold tree
48	L	Cassia grandis	pink shower tree
24	L	Ficus elastica	Rubber tree
47	L	Samanea saman	Monkeypod
49	L	Catalpa longissima	Jamica oak
50	L	Enterolobium cyclocarpum	Ear tree
51	L	Ficus benghalensis	Banyan tree
52	L	Tabebuia aurea	Silver trumpet tree
53	L	Ficus benjamina	weeping banyan
54	L	Terminalia catappa	Tropical almond
16	**L**	**Salophyllum inophyllum**	**Kamani**

6	STREAM EDGE		
No.	**SIZE**	**SCIENTIFIC NAME**	**COMMON NAME**
34	M	Tabebuia ochracea	Yellow trumpet tree
22	L	Cassia grandis	pink shower tree
49	L	Catalpa longissima	Jamaica oak
3	**L**	**Cocos nucifera**	**Niu**
50	L	Enterolobium cyclocarpum	Ear tree
51	L	Samanea saman	Monkeypod
52	L	Tabebuia aurea	Silver trumpet tree
53	L	Tabebuia donnell-smithii	Gold tree
54	L	Terminalia catappa	Tropical almond

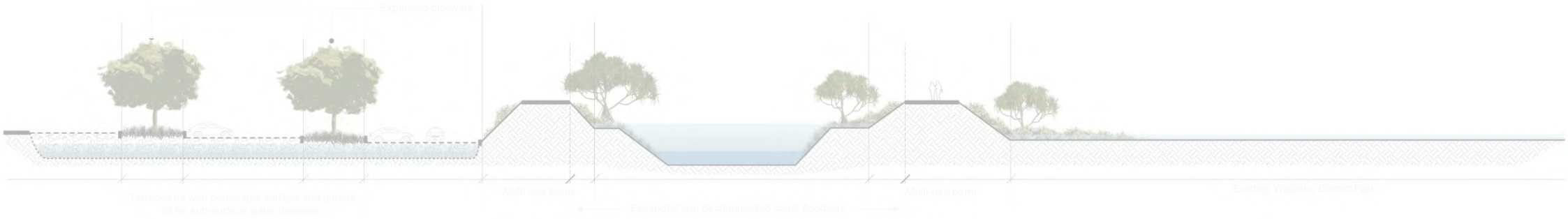
7	PARKING LOT TREES		
No.	**SIZE**	**SCIENTIFIC NAME**	**COMMON NAME**
9	**S**	**Hibiscus brackenridgei**	**Ma‘o hau hele**
10	**S**	**Metrosideros polymorpha**	**‘Ōhi‘a lehua**
14	**S**	**Rauvolfia sandwicensis**	**Hao**
40	S	Cordia sebestena	Kou haole
32	S	Conocarpus erectus	Buttonwood
43	S	Ceratonia siliqua	Carob
45	S	Pterocarpus rohrii	Bloodwood
15	**M**	**Reynoldsia sandwicensis**	**‘Ohe makai**
18	**M**	**Thespesia populnea**	**Milo**
42	M	Eucalyptus torquata	Coral gum
34	M	Tabebuia ochracea	Yellow trumpet tree
26	M	Cochlospermum vitifolium	Buttercup tree
27	M	Harpullia pendula	Tulipwood
28	M	Lagerstroemia speciosa	Pride of India
29	M	Tabebuia berteroi	Hispaniolan rosy trumpet
31	M	Thespesia grandiflora	Maga
20	M	Bauhinia × blakeana	Hong kong orchid tree
19	M	Colvillea racemosa	Colville’s-glory
46	M	Tipuana tipu	Rosewood
48	M	Tabebuia heterophylla	Pink trumpet tree
2	**M**	**Aleurites moluccana**	**Kukui**
37	L	Heritiera littoralis	Looking glass tree
38	L	Pseudobombax ellipticum	Shaving brush tree
30	L	Tabebuia donnell-smithii	Gold tree
49	L	Catalpa longissima	Jamaican oak
52	L	Tabebuia aurea	Silver trumpet tree

Waipahu Transit Oriented Development (TOD) Collaboration: Proof of Concept Research, Planning, and Design Study

Flood Resilience Design Criteria

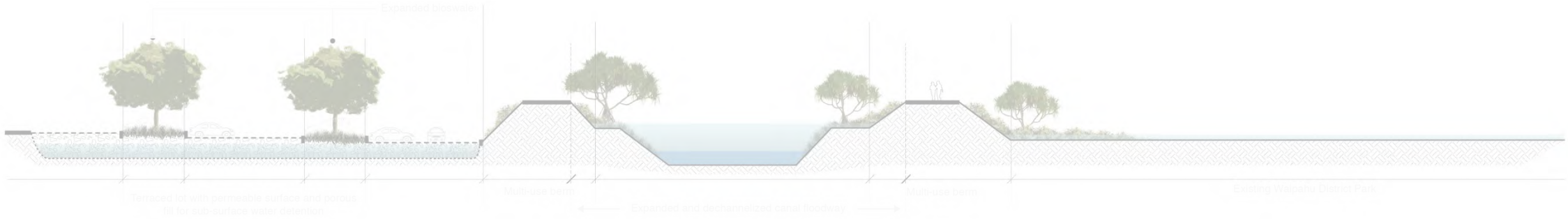
Principal Investigator: Wendy Meguro, AIA, LEED AP BD+C
Assistant Professor of Sustainable Building & Community Design
School of Architecture
Sea Grant College Program
University of Hawaii at Manoa

Junior Research Associate: Rebecca Ogi



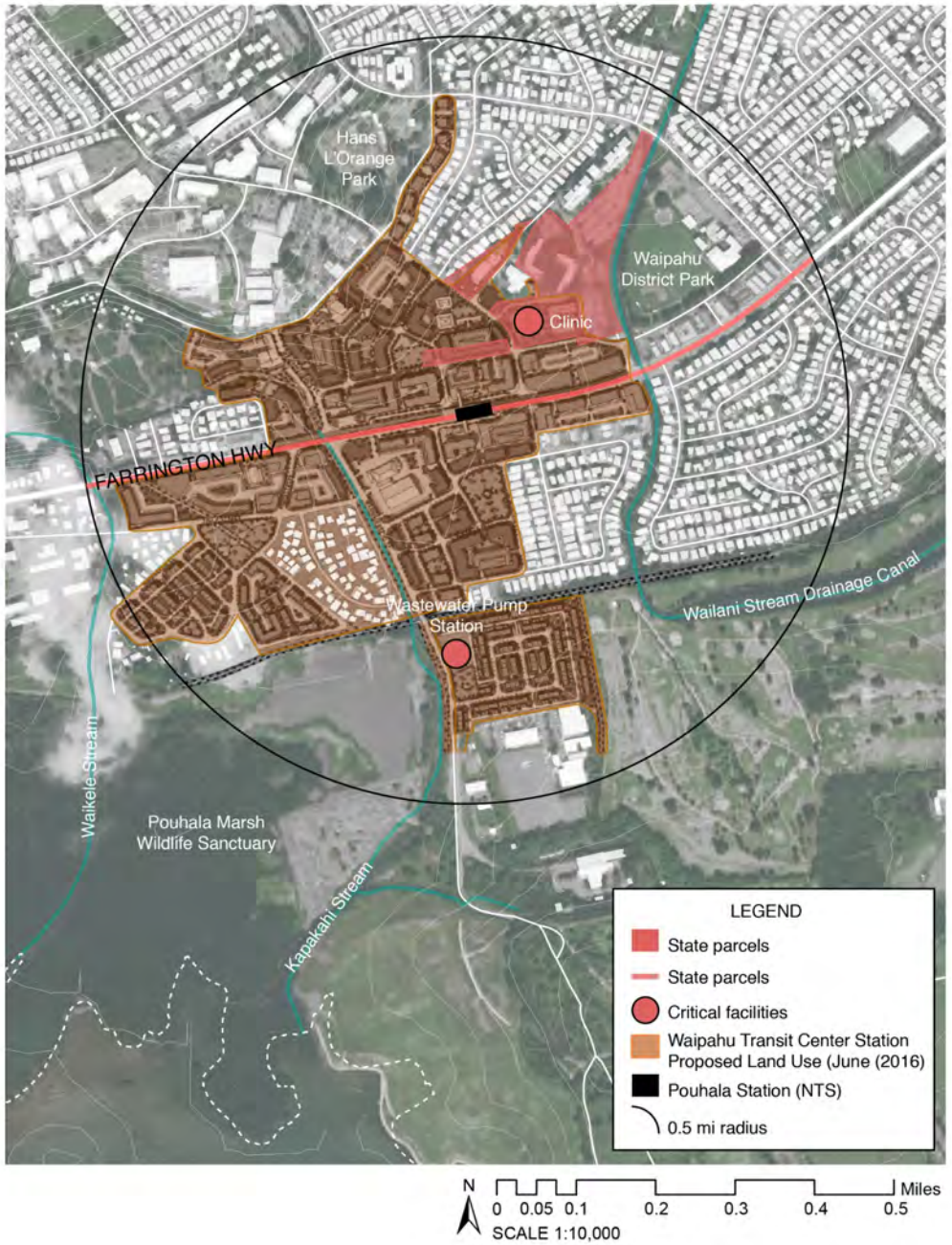
PRESENTATION OUTLINE

- RESEARCH AND METHODS
- FLOOD MAPPING
- PLANNING-SCALE FLOOD RESILIENCE DESIGN CRITERIA
- BUILDING-SCALE FLOOD RESILIENCE DESIGN CRITERIA



RESEARCH AND METHODS

WAIPAHU T.O.D. STUDY SITE



SITE ANALYSIS

RESEARCH AND METHODS

WAIPAHU T.O.D. STUDY SITE

Zone AEF

"Floodway area" a special flood hazard area consisting of the portion of zone AE. Designated on flood insurance rate maps as a floodway

Zone AE

"Flood fringe area" subject to 1% annual chance flood (100-year flood). Flood insurance and floodplain management standards apply

Zone X (dot)

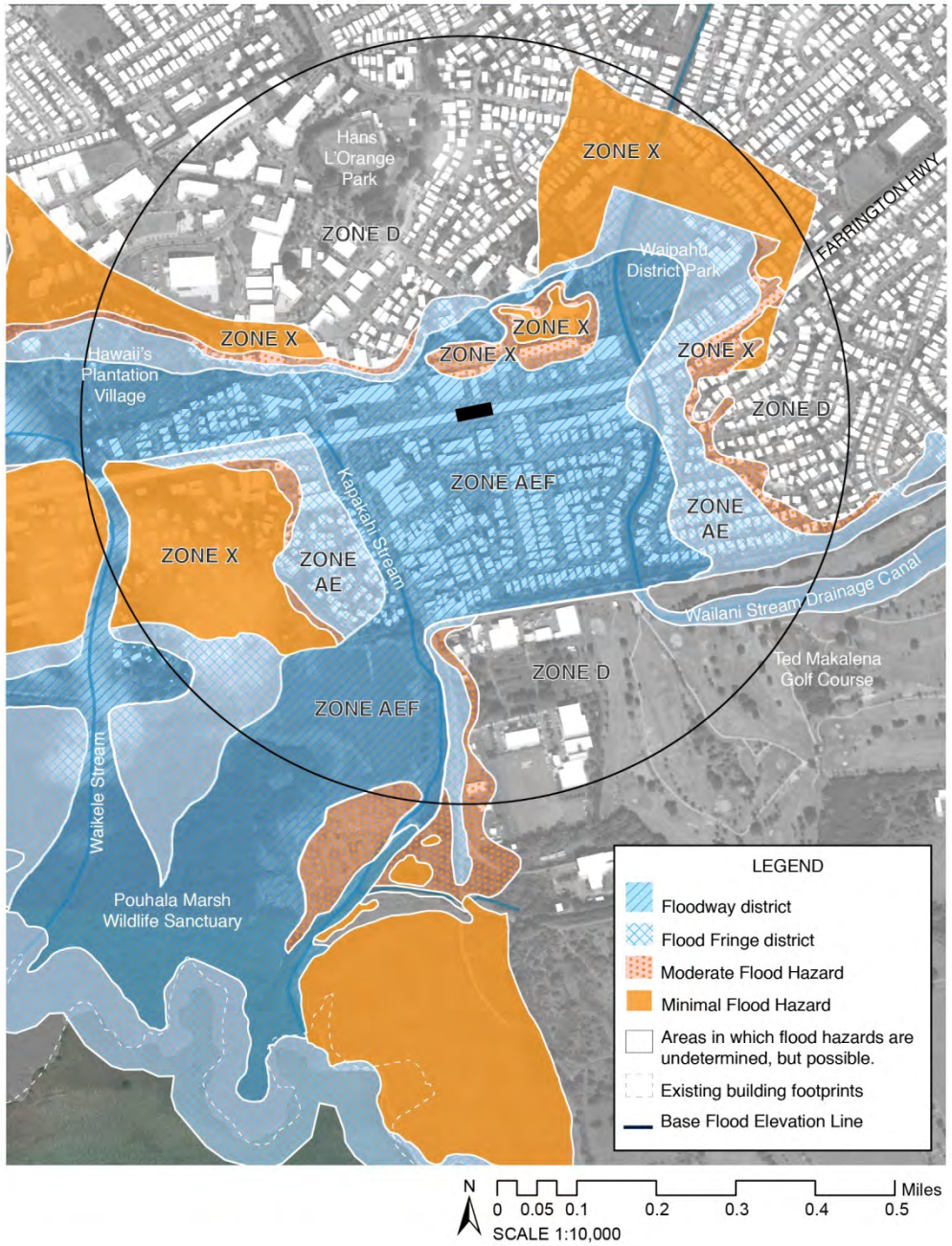
Moderate flood hazard areas are the areas between the limits of the base flood and the 0.2% annual chance flood (500-year flood)

Zone X (solid)

Areas of minimal flood hazard, are areas outside the SFHA and higher than the elevation of the 0.2% annual chance flood

Zone D

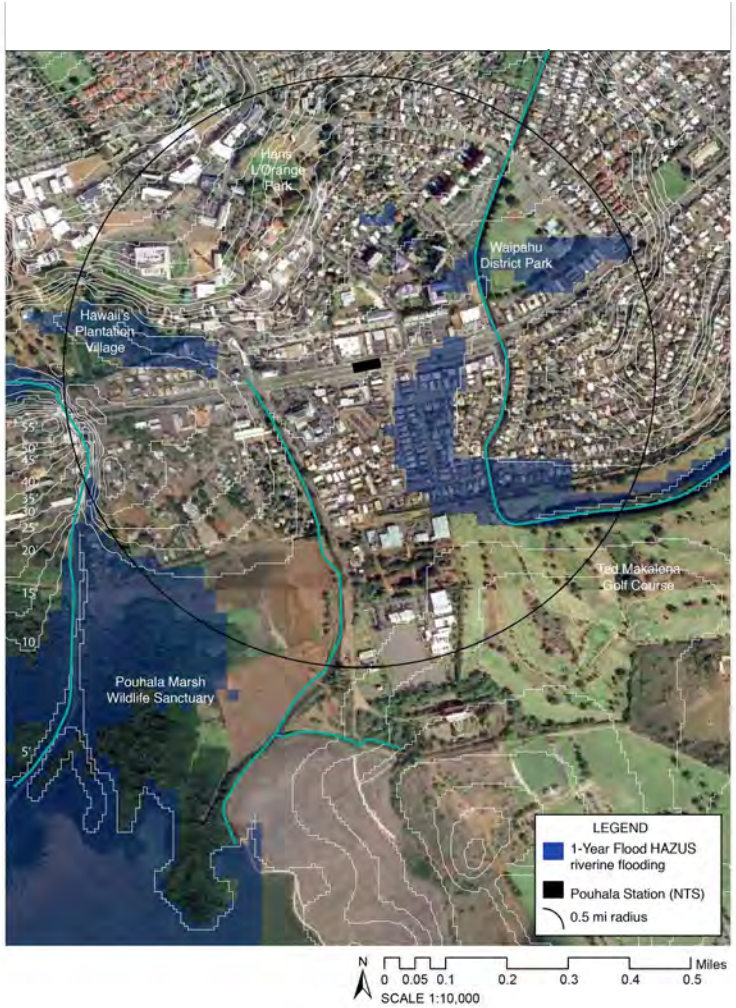
Areas where there are possible but undetermined flood hazards, as no analysis of flood hazards has been conducted

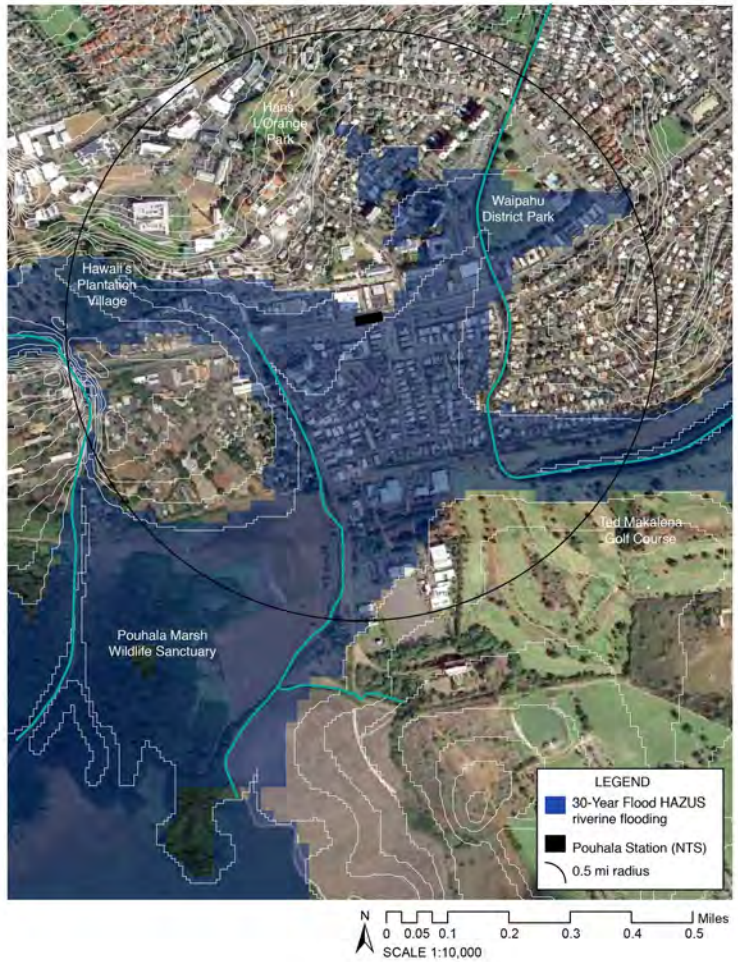


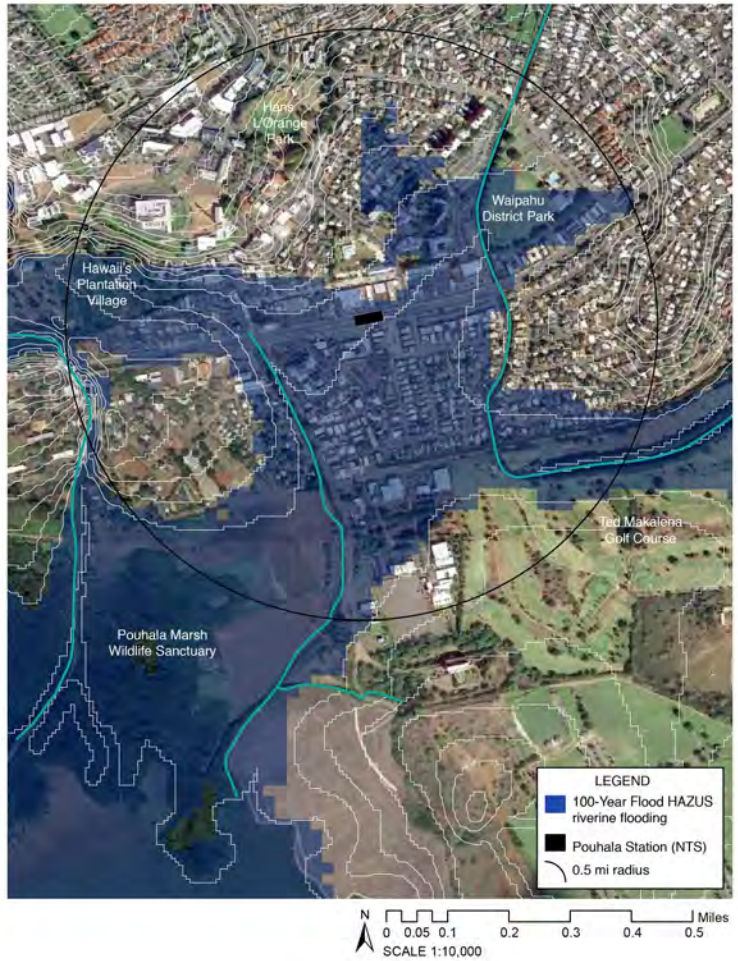
SITE ANALYSIS – Riverine flooding

RESEARCH AND METHODS

HAZUS RIVERINE FLOODING – 1, 30, 100-YEAR FLOOD



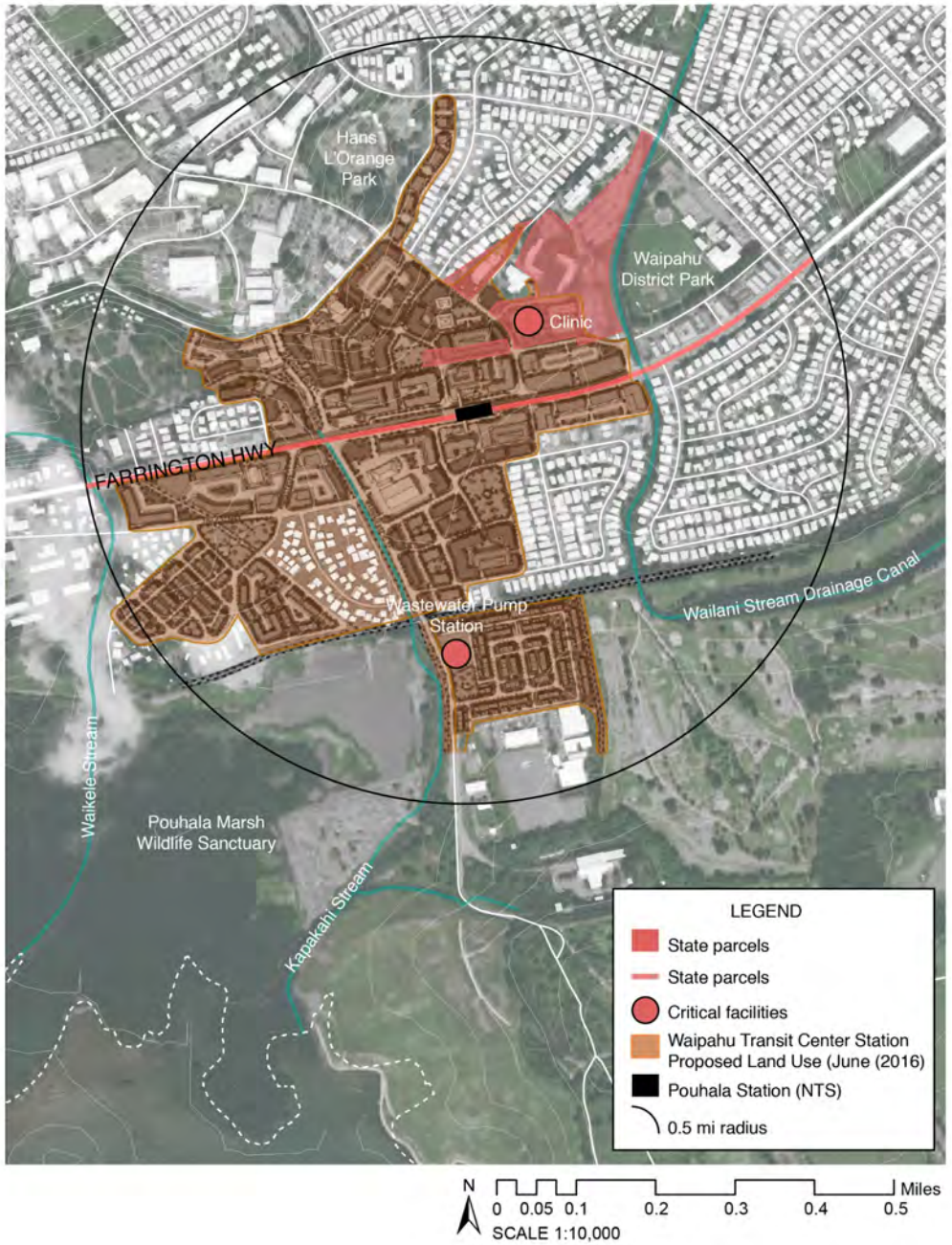




SITE ANALYSIS – Riverine flooding

RESEARCH AND METHODS

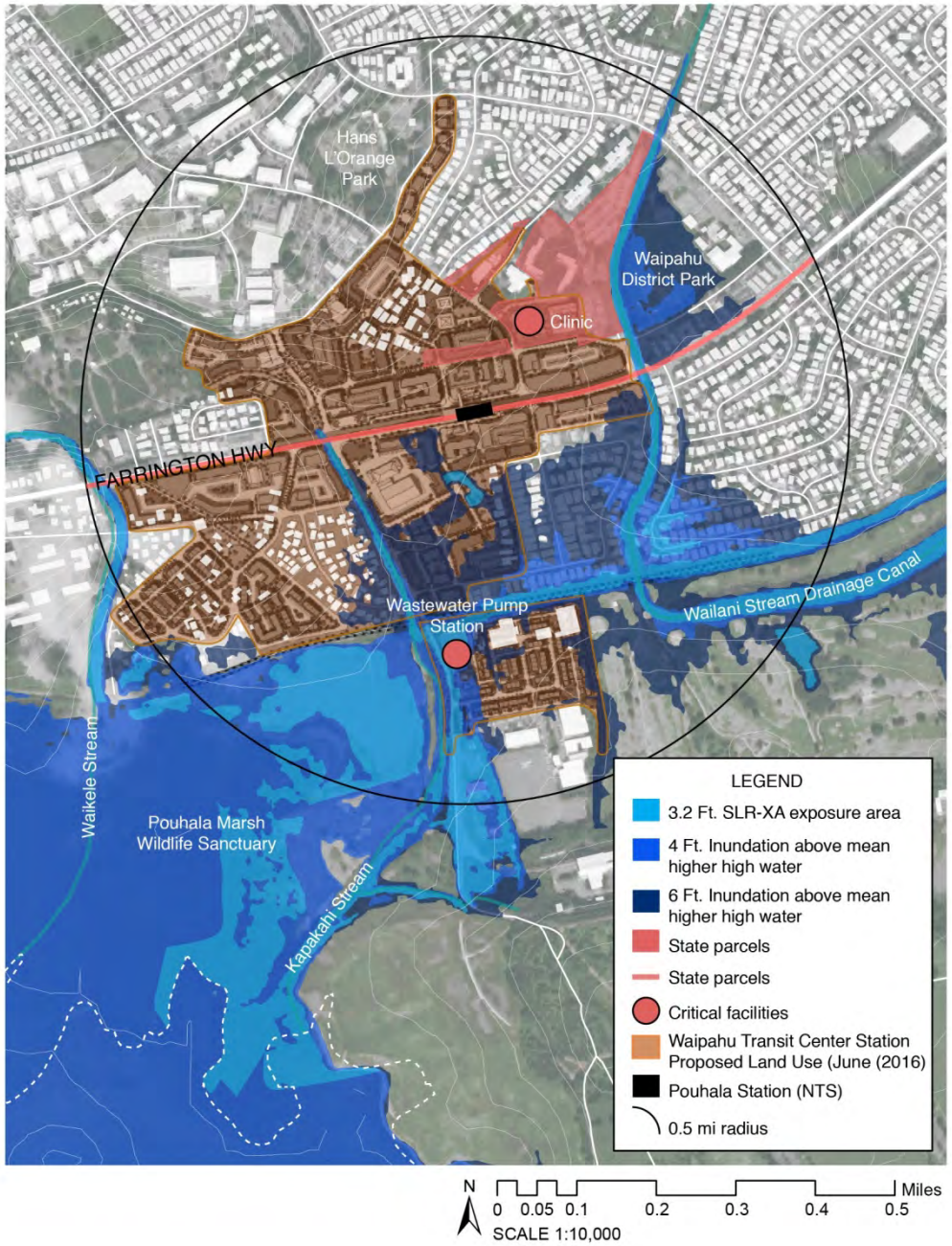
WAIPAHU T.O.D. STUDY SITE



SITE ANALYSIS

RESEARCH AND METHODS

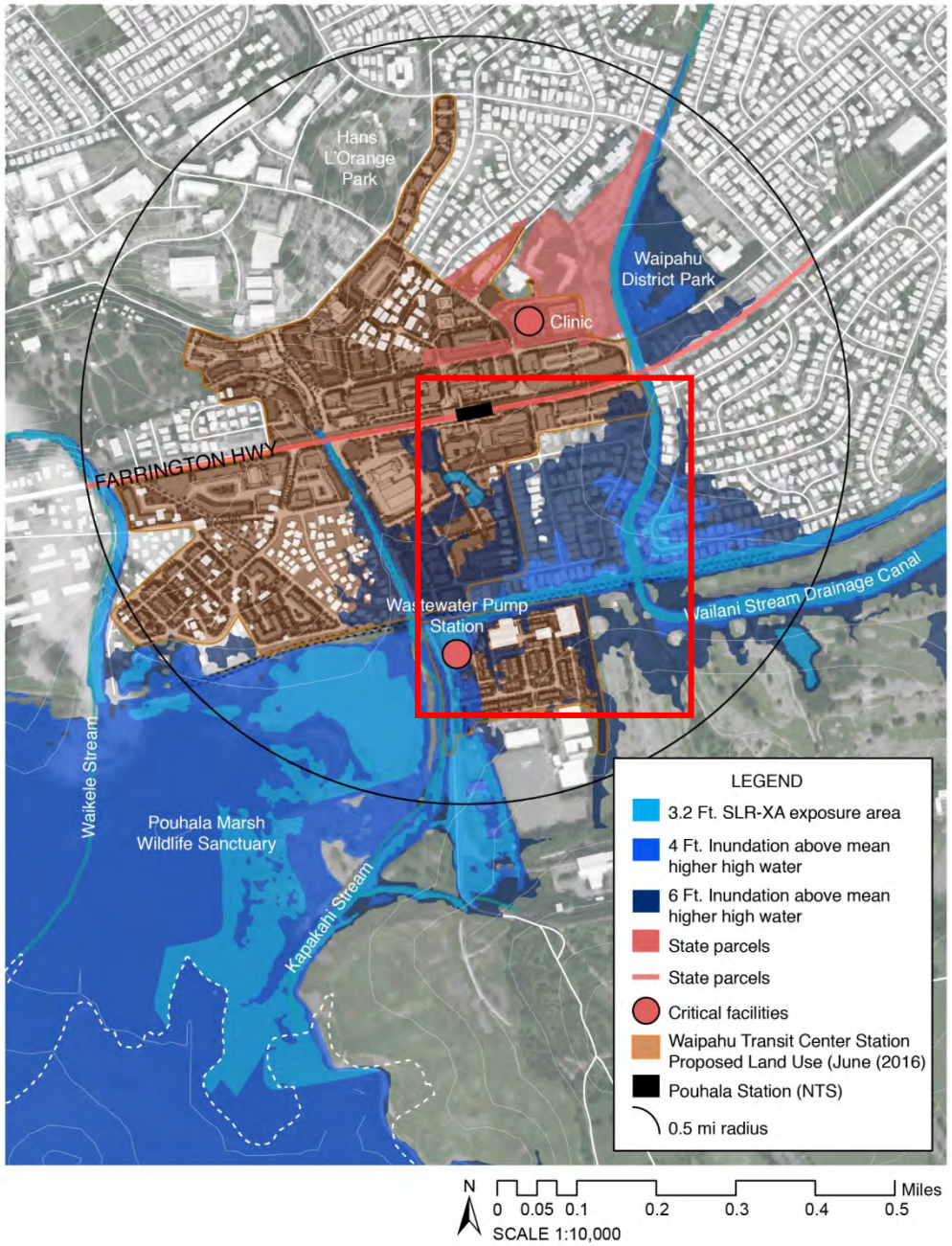
EXTENTS OF PREDICTED FLOODING



SITE ANALYSIS – Sea level rise

RESEARCH AND METHODS

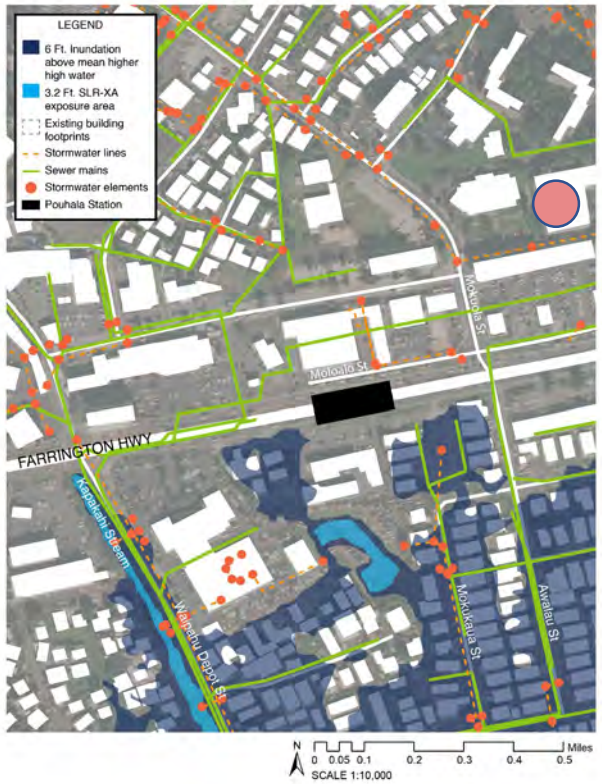
WAIPAHU T.O.D. STUDY SITE



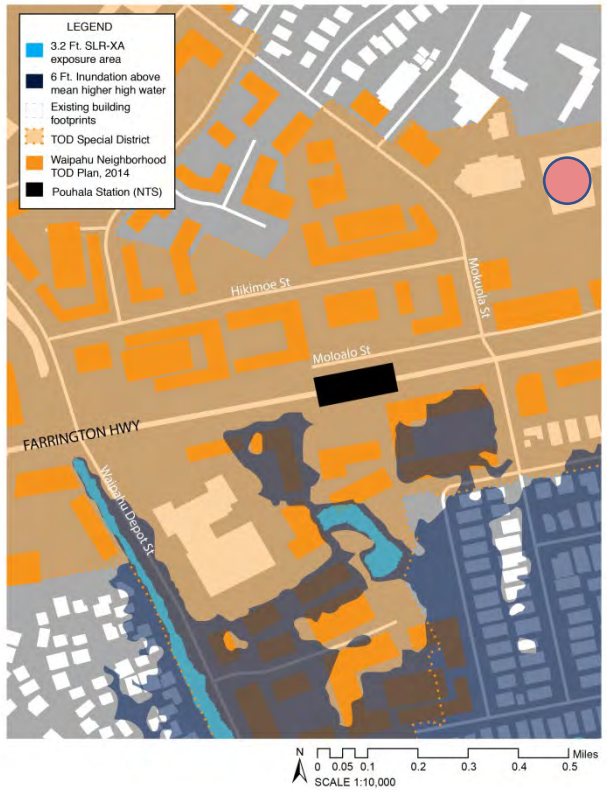
SITE ANALYSIS – Sea level rise

RESEARCH AND METHODS

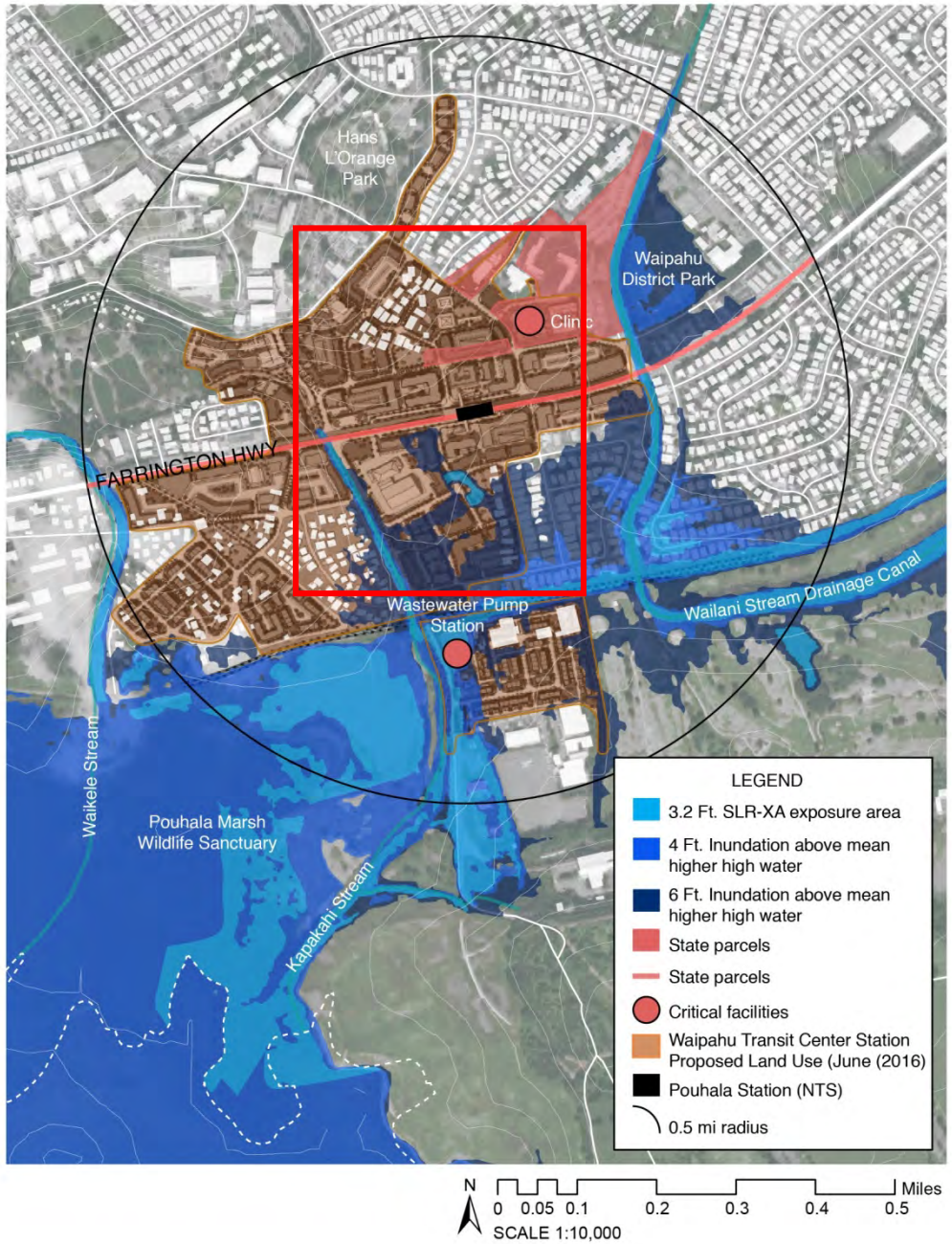
WAIPAHU T.O.D. STUDY SITE



Existing underground utilities



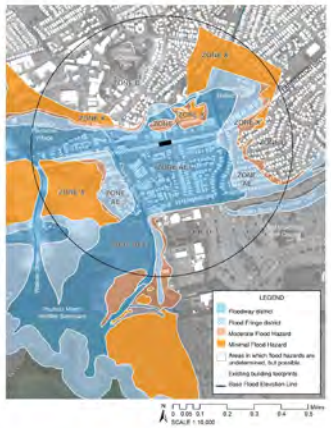
New TOD with SLR overlay

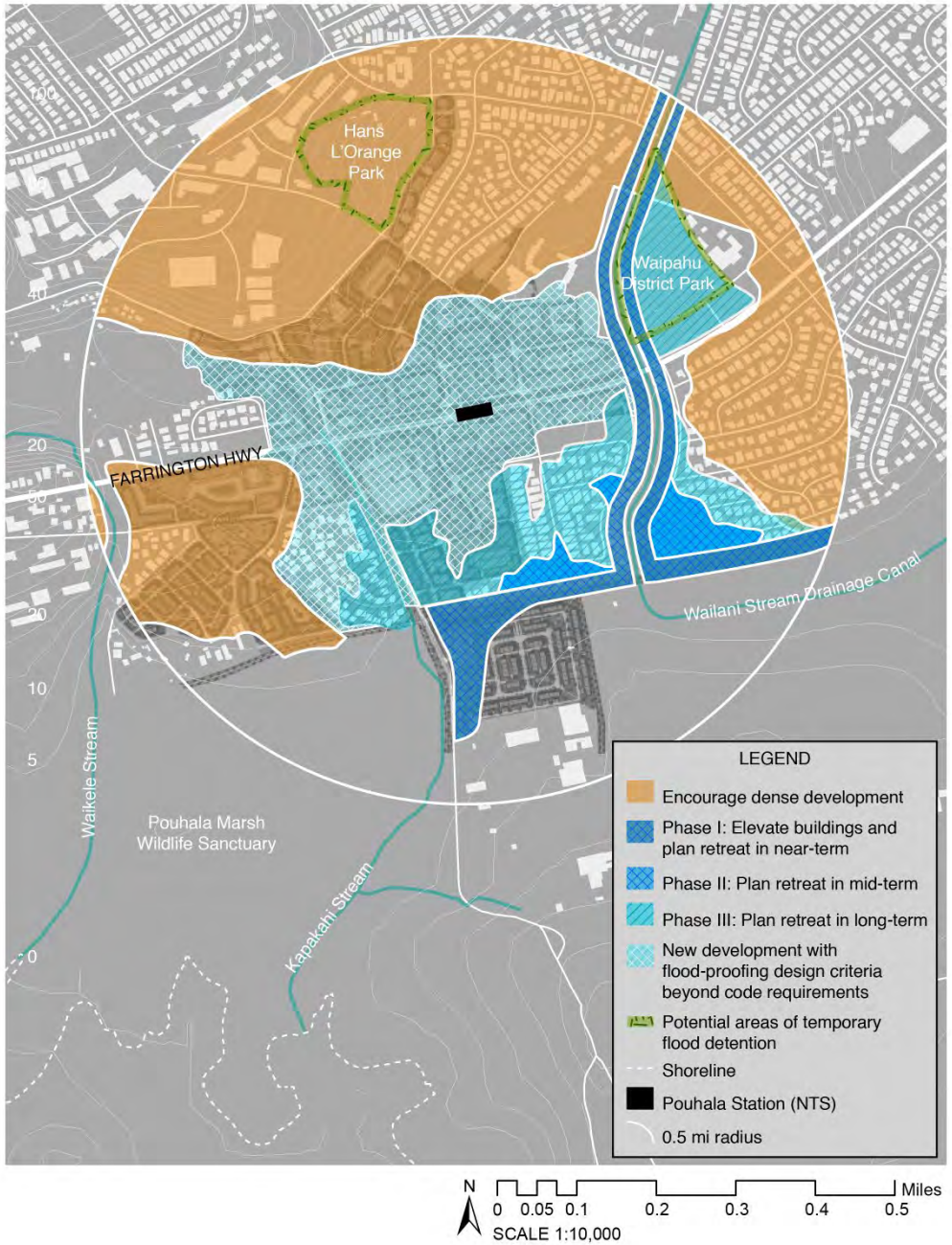


SITE ANALYSIS – Sea level rise

RESEARCH AND METHODS

CONSIDERATIONS FOR DEVELOPMENT AND PLANNED RETREAT

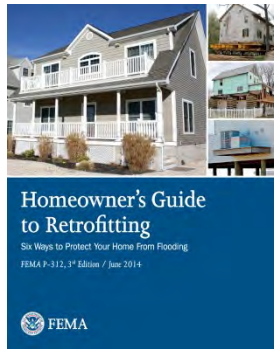


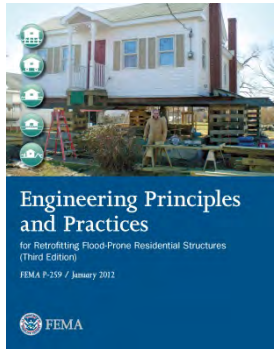


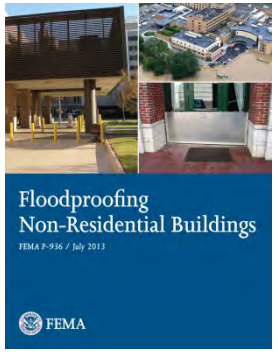
SITE PLANNING

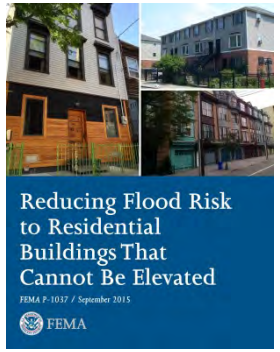
RESEARCH AND METHODS

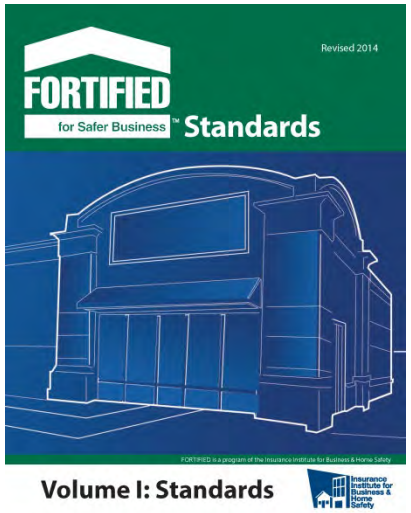
STANDARDS AND EMERGING BENCHMARKS FOR RESILIENCY

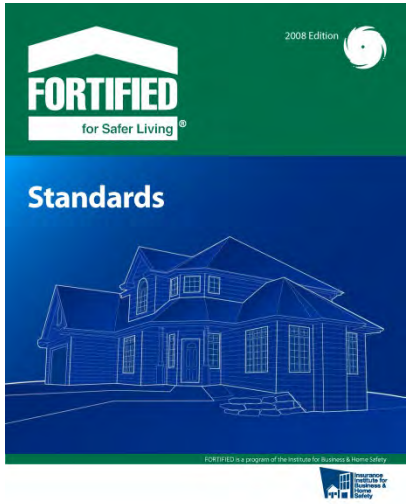


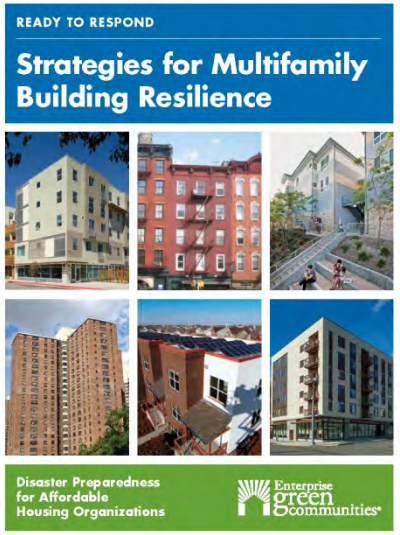


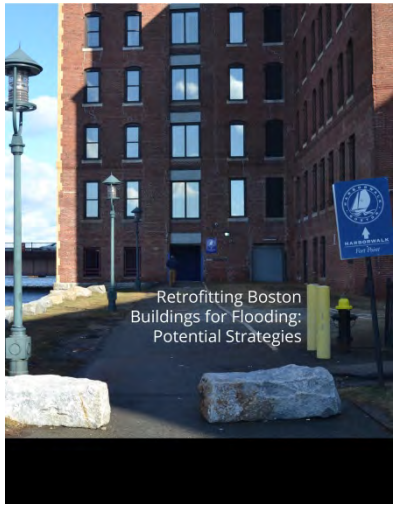






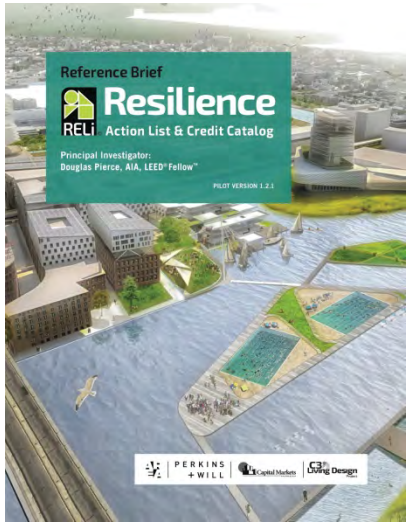






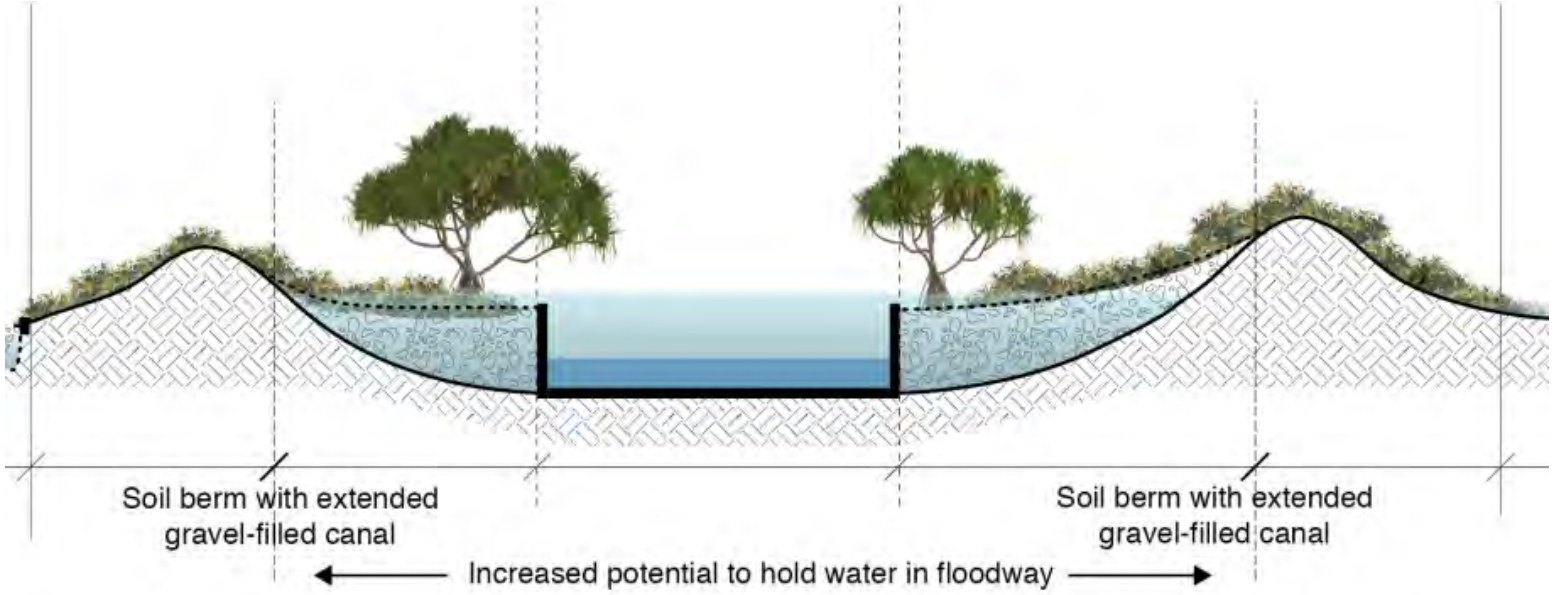
U.S. GREEN BUILDING COUNCIL LEED USGBC

LEED v4

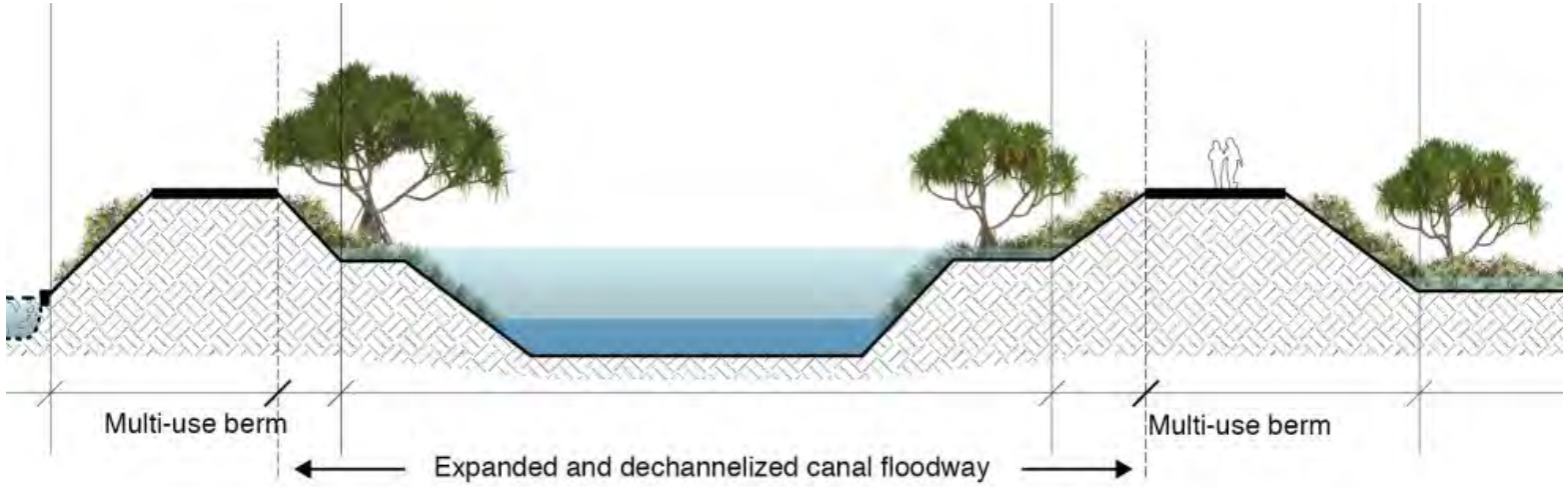


PLANNING SCALE RESILIENCE DESIGN CRITERIA

RAISED BERMS

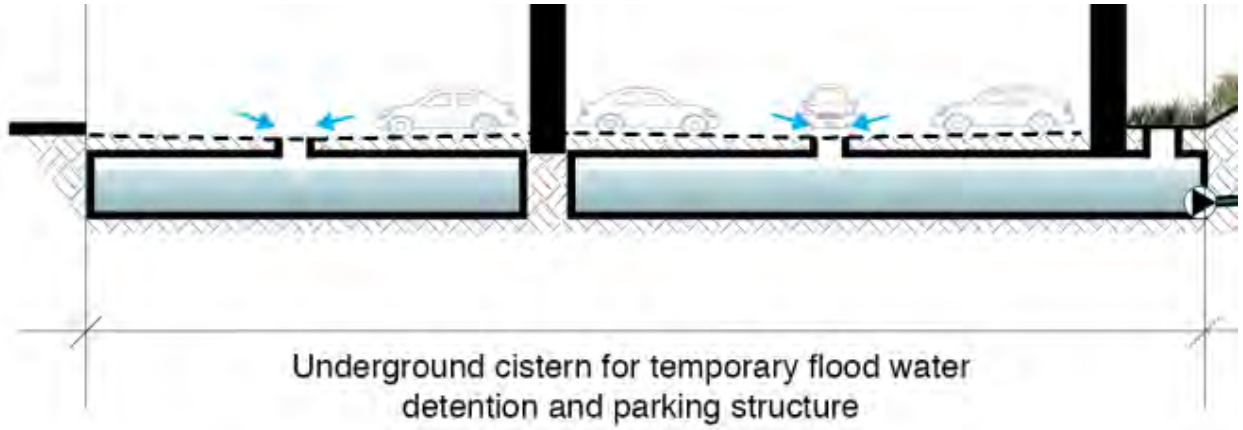


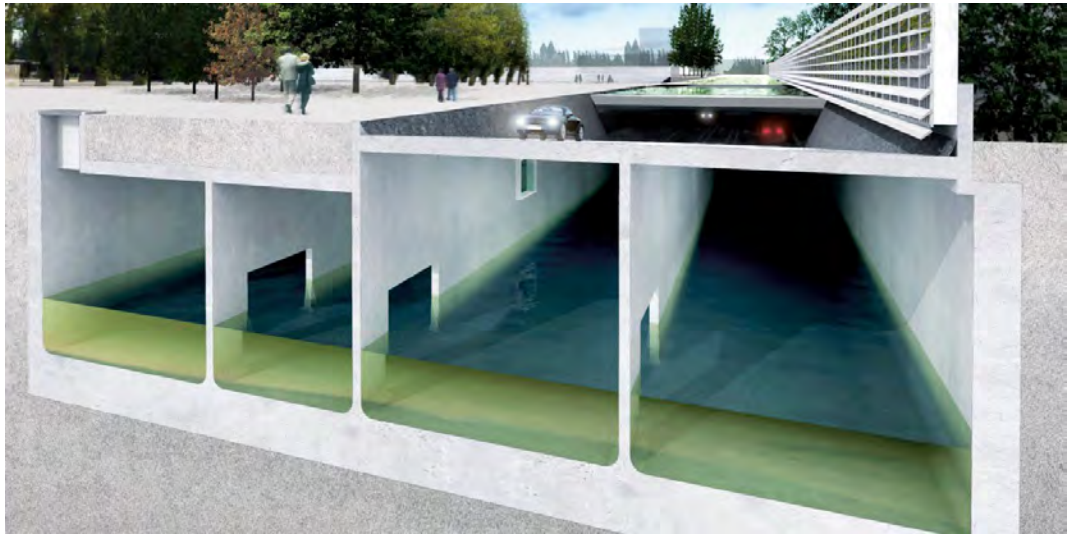
PLANNING-SCALE FLOOD MITIGATION
EXPANSION OF EXISTING STREAM FLOODWAYS



PLANNING SCALE RESILIENCE DESIGN CRITERIA

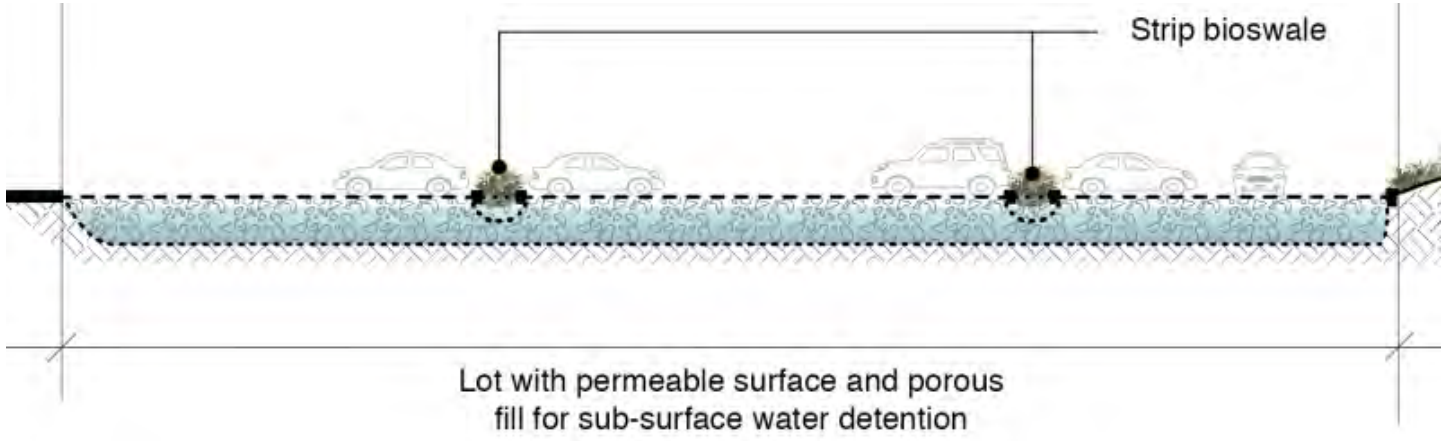
UNDERGROUND CISTERN





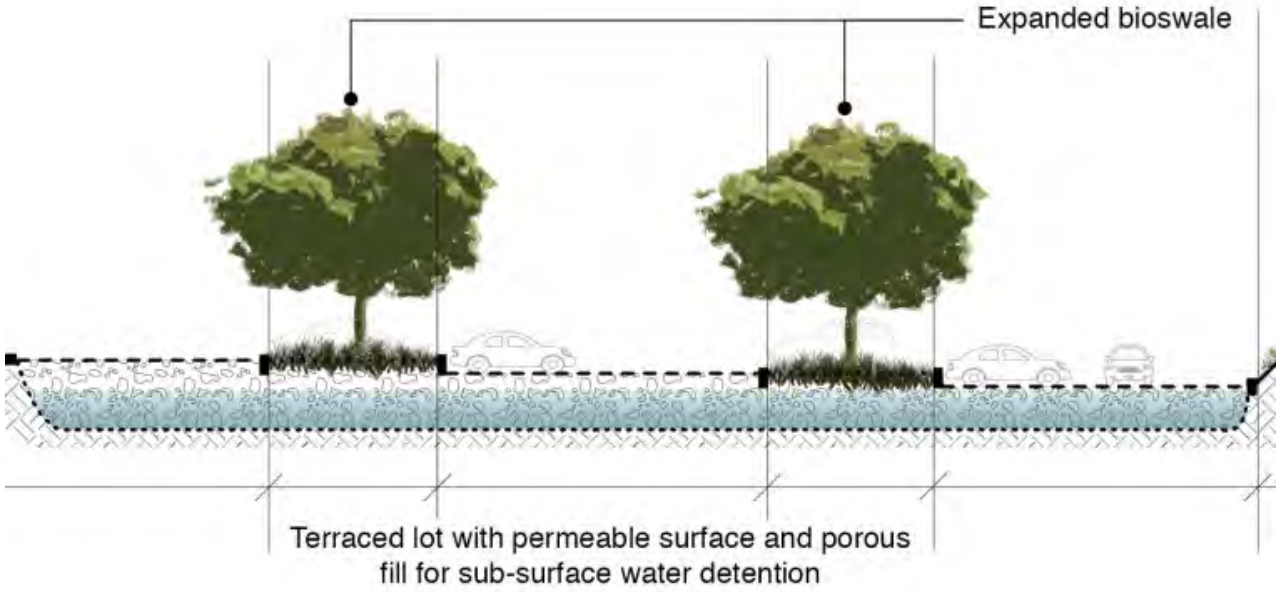
PLANNING SCALE RESILIENCE DESIGN CRITERIA

GRAVEL-DETENTION AREAS, PERMEABLE SURFACE



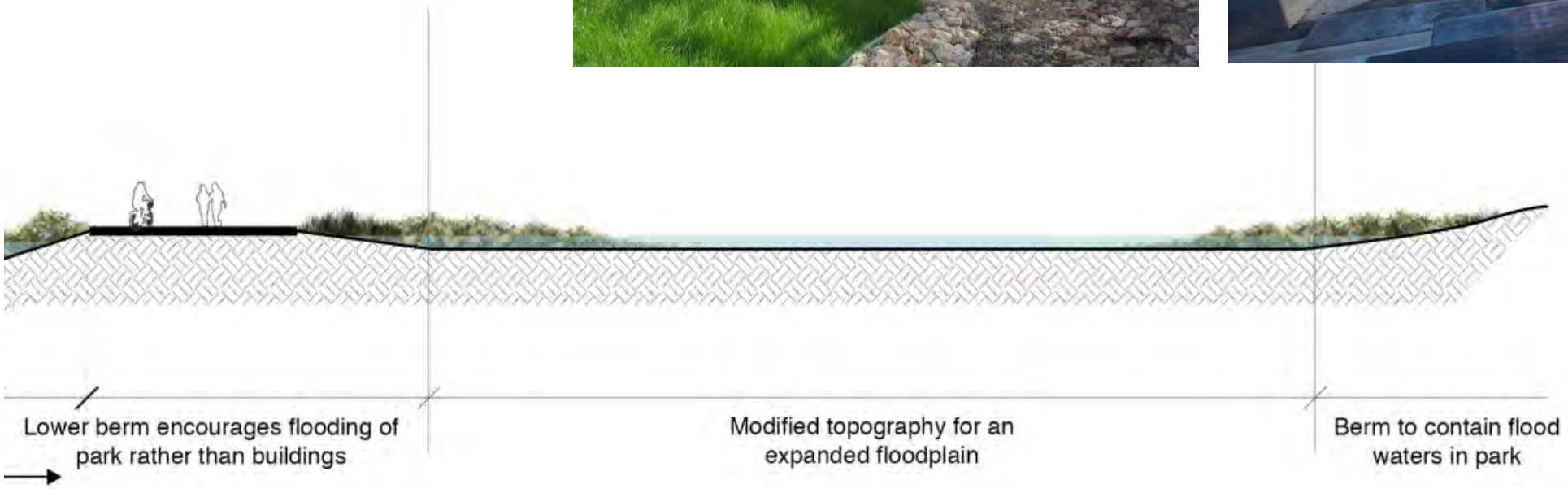
PLANNING SCALE RESILIENCE DESIGN CRITERIA

BIO-SWALES



PLANNING SCALE RESILIENCE DESIGN CRITERIA

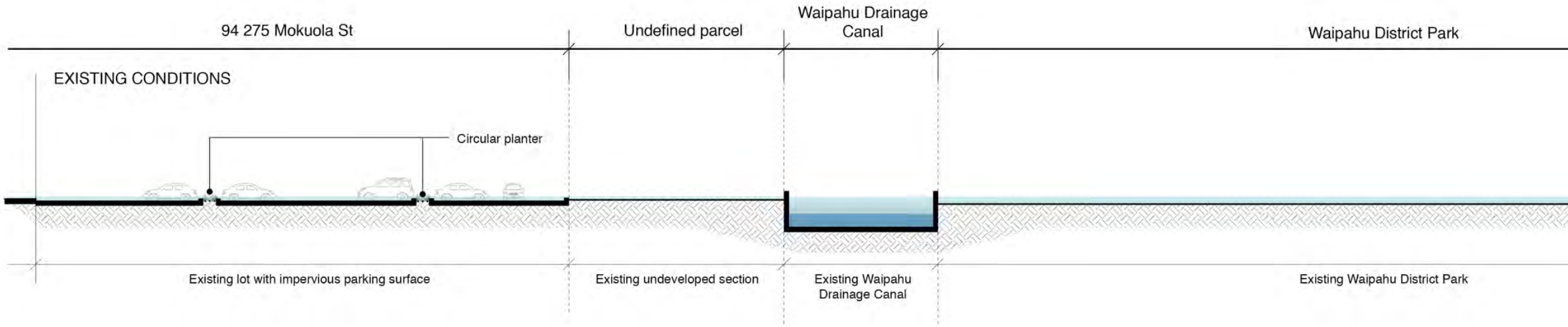
FLOODABLE DETENTION AREAS



FLOOD RESILIENCE DESIGN CRITERIA - Sections

PLANNING SCALE RESILIENCE DESIGN CRITERIA

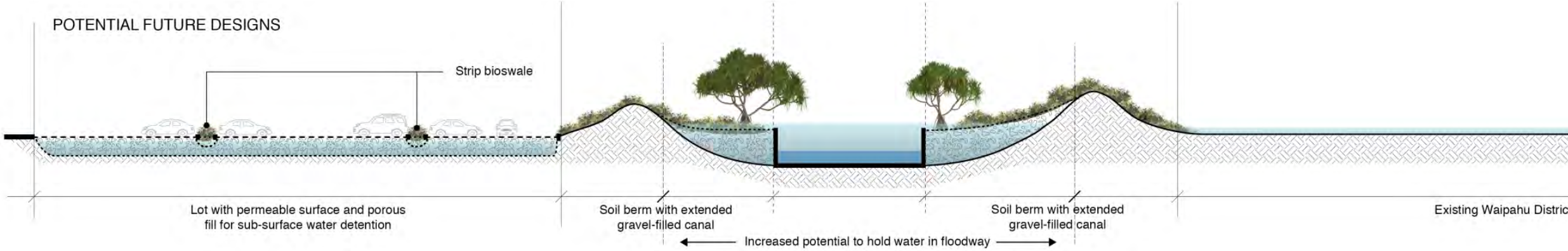
WAIPAHU DISTRICT PARK - EXISTING



FLOOD RESILIENCE DESIGN CRITERIA - Sections

PLANNING SCALE RESILIENCE DESIGN CRITERIA

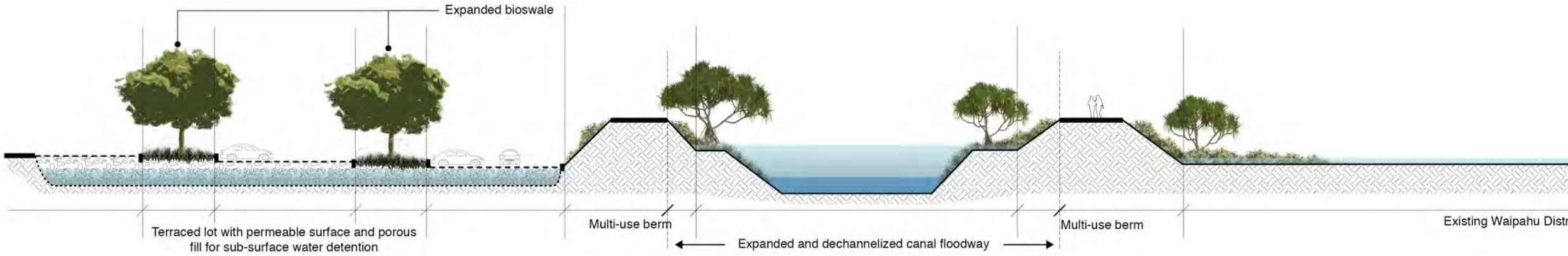
WAIPAHU TOD – SCHEME 1



FLOOD RESILIENCE DESIGN CRITERIA - Sections

PLANNING SCALE RESILIENCE DESIGN CRITERIA

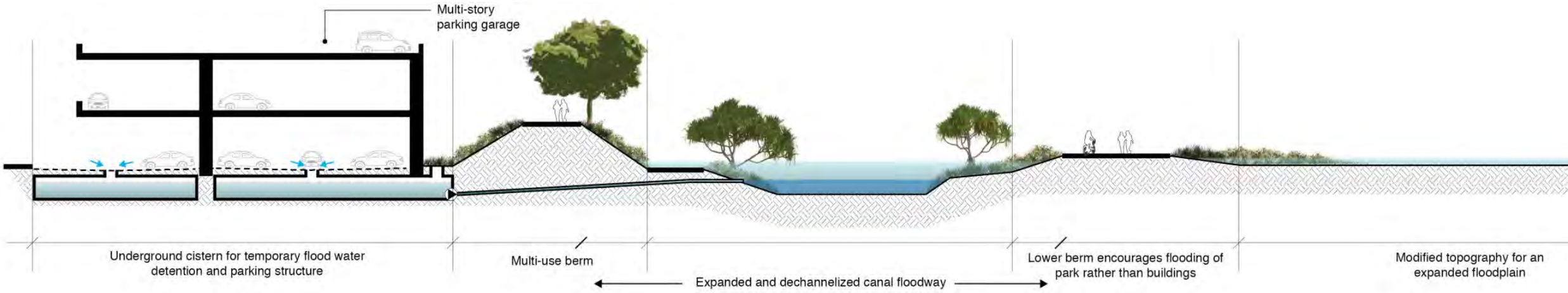
WAIPAHU TOD – SCHEME 2



FLOOD RESILIENCE DESIGN CRITERIA - Sections

PLANNING SCALE RESILIENCE DESIGN CRITERIA

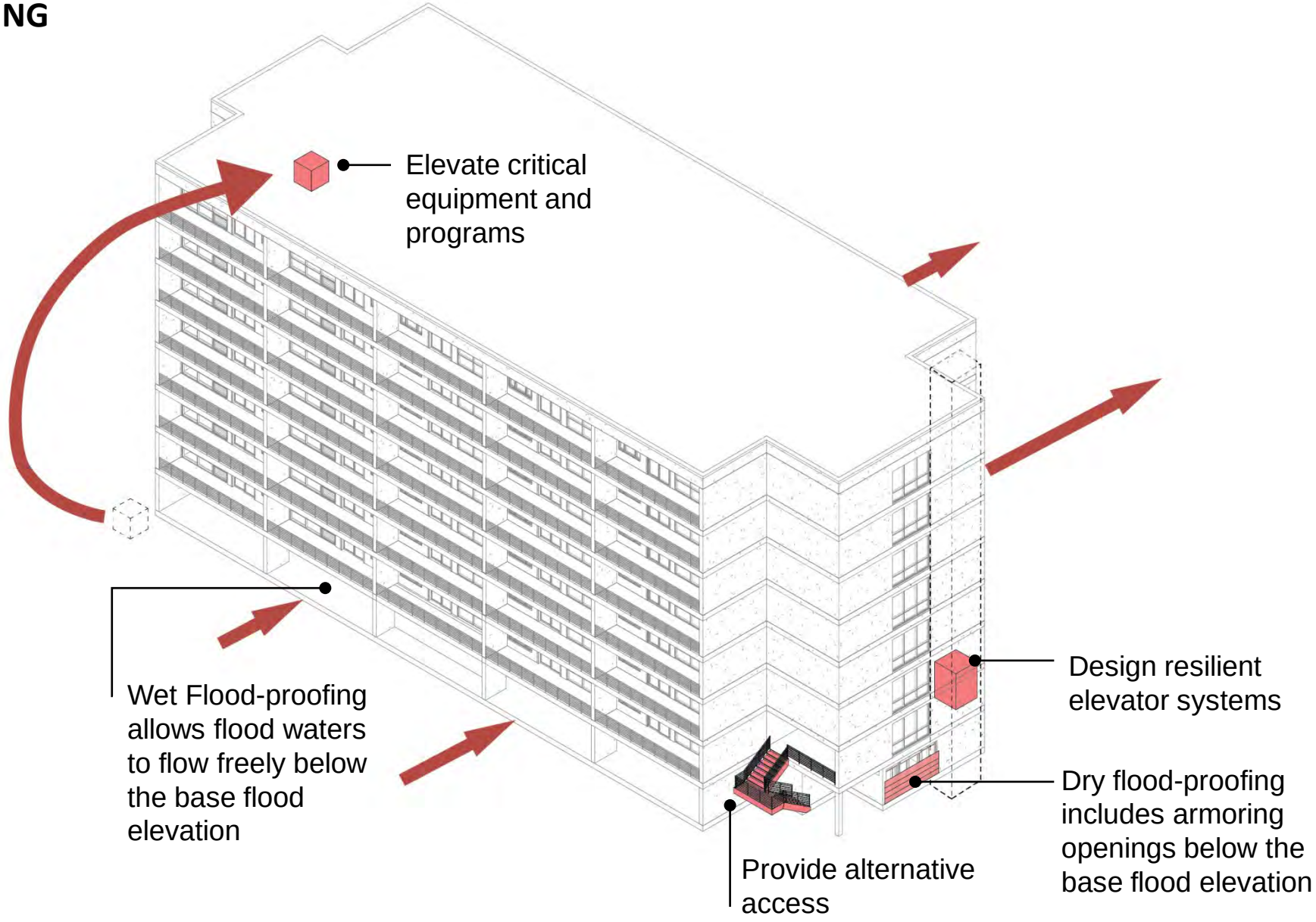
WAIPAHU TOD – SCHEME 3



FLOOD RESILIENCE DESIGN CRITERIA - Sections

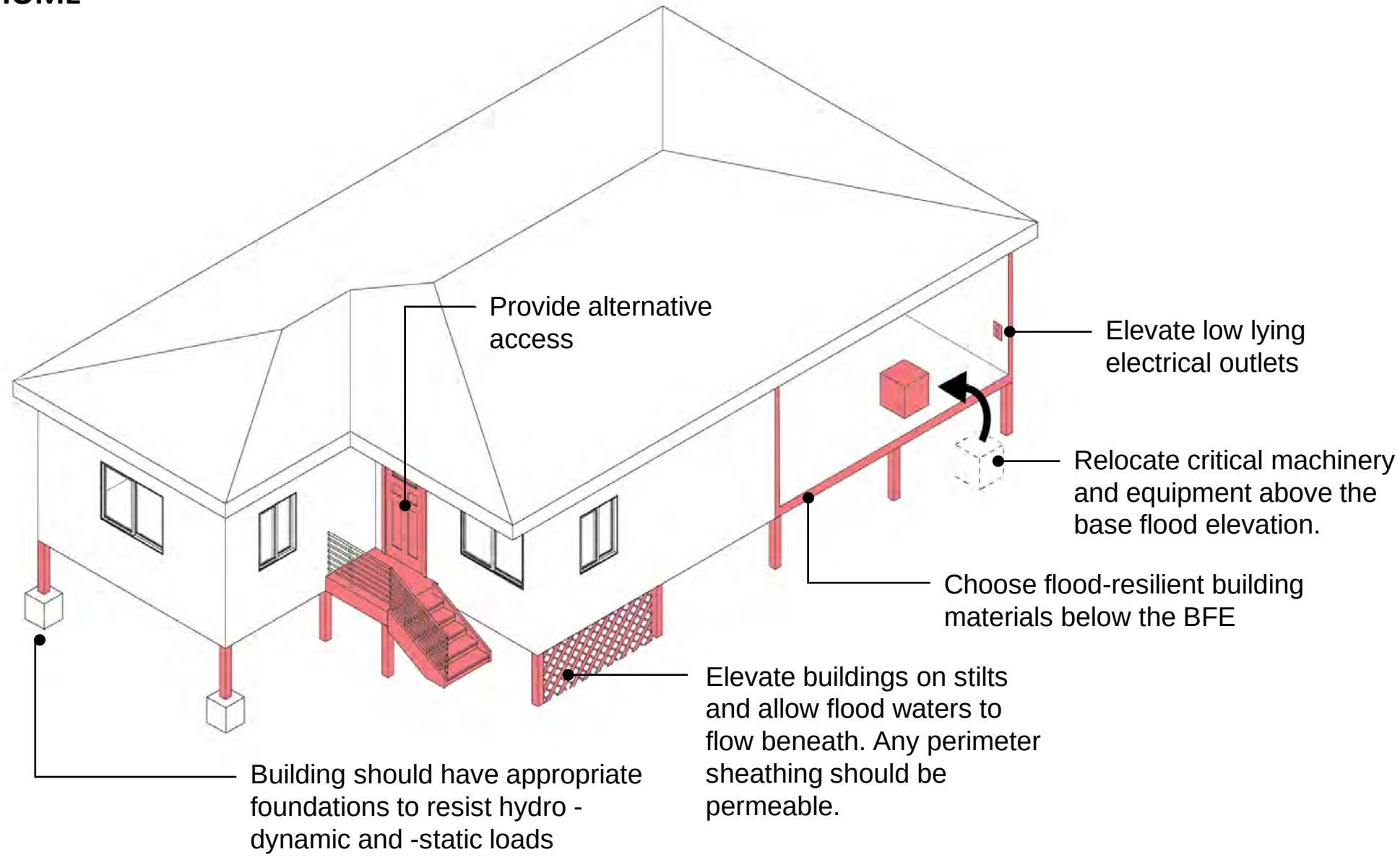
BUILDING SCALE RESILIENCE DESIGN CRITERIA

MULTI-STORY BUILDING



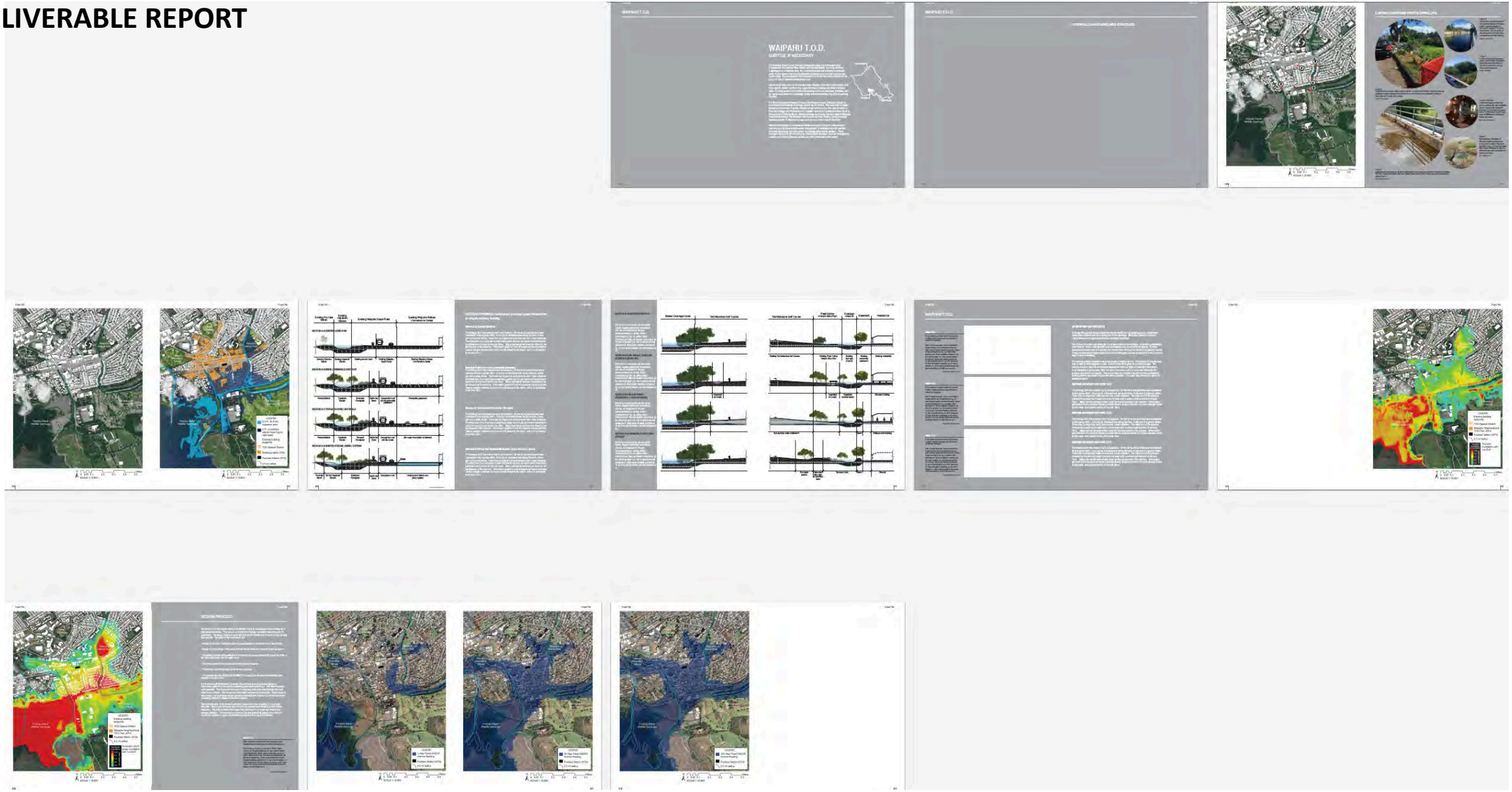
BUILDING SCALE RESILIENCE DESIGN CRITERIA

SINGLE-FAMILY HOME



CONCLUSION

DELIVERABLE REPORT



SITE ANALYSIS – Riverine flooding

WAIPAHU BLOCK STUDY

University of Hawaii Community Design Center

UHCDC
UNIVERSITY OF HAWAI'I
COMMUNITY DESIGN CENTER

PART I BLOCK SUMMARIES

PART II HOUSING BLOCK PRECEDENTS

PART III PARKING PRECEDENTS

PART IV DESIGN OPTIONS

PART I

BLOCK SUMMARY REPORTS

UHCDC
UNIVERSITY OF HAWAI'I
COMMUNITY DESIGN CENTER

BLOCK TYPES

SUBURBAN
town center, community open spaces and residential neighborhoods

CHARACTERISTICS

LAND USE MIX
- mixed of use spaces towards the station
- commercial spaces along the arterials/ main streets

STREET AND BLOCK PATTERN
- mix of block sizes
- smaller blocks and pedestrian streets near the stations
- best connectivity near the station
- large blocks have mid-block pedestrian passages

BUILDING PLACEMENT AND LOCATION
- consistent entrance orientation to the street
- moderate setbacks
- deep setbacks with parking in front farther away from the station

BUILDING HEIGHTS
- low-mid rise structures
- mid-rise at nodes or along main streets

MOBILITY
- moderate transit use
- balance of rail, bus, bike, and automobile

WAIPAHU
EXISTING CONDITIONS

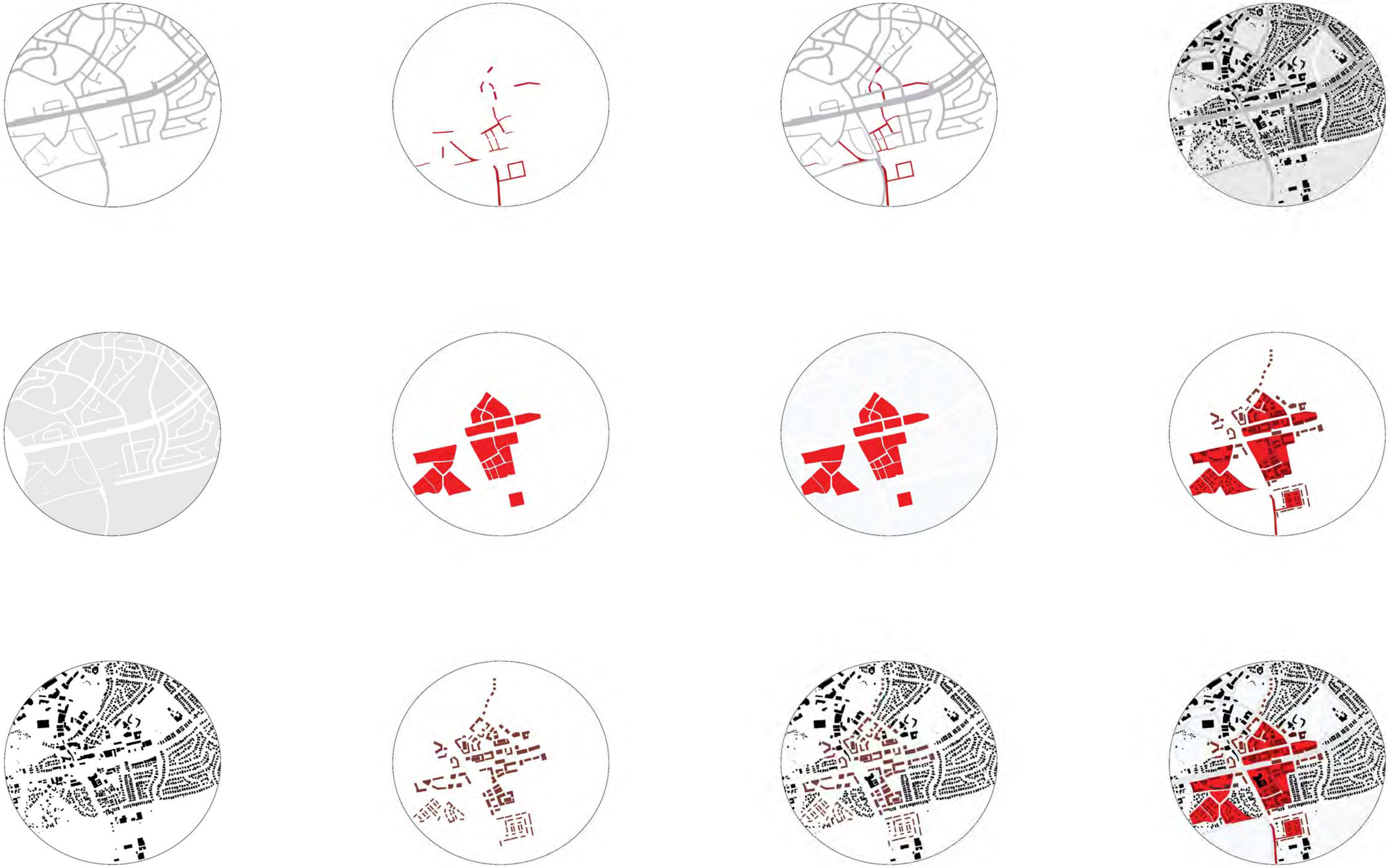
TOD PLAN

PROPERTY OWNERSHIP

STATE CITY TOD ZONE PLAN

EXISTING CONDITIONS

TOD PLAN



WALKABILITY

WALKABLE BLOCKS

IDEAL BLOCK SIZE: 300’ X 400’ (13,000 SF/3 ACRE) MAX: 300,000 SF/7 ACRE

IDEAL BLOCK SIZE

WALKABLE BLOCKS

EXISTING CONDITIONS

TOD PLAN

WALKABILITY

WALKSHED - 1/2 WALK FROM TRANSIT STATION

PARCEL AFFECTED: 622

EXISTING CONDITIONS

PARCEL AFFECTED: 715 (+15%)

TOD PLAN

FLOOD RESILIENCE

FLOOD RESILIENCE

6 FT SEA LEVEL RISE

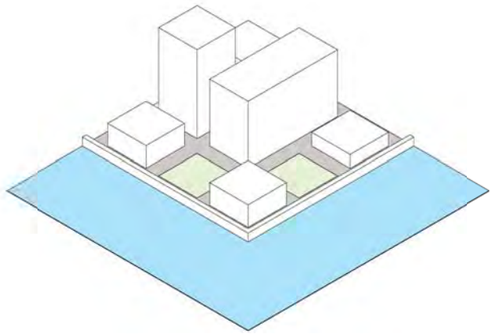
3 FT SEA LEVEL RISE

EXISTING CONDITIONS

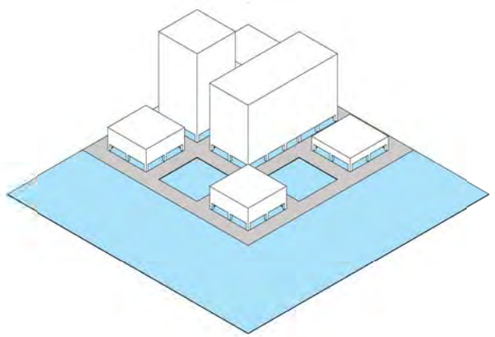
TOD PLAN

FLOOD RESILIENCE STRATEGIES

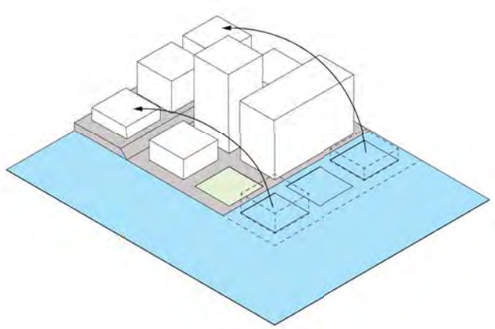
FORTIFY



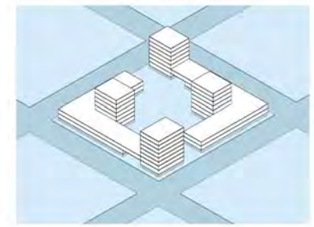
ADAPT

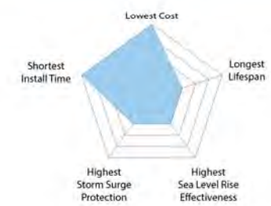


RETREAT

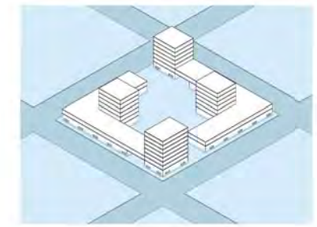


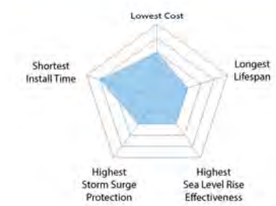
Dry Flood Proofing



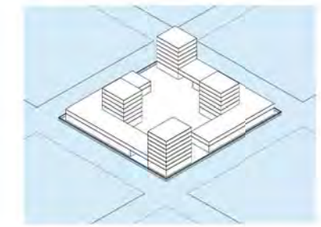


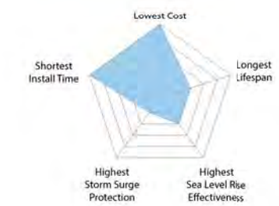
Wet Flood Proofing



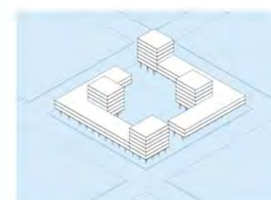


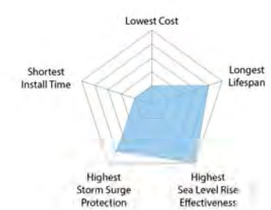
Temporary Flood Walls



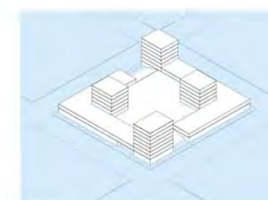


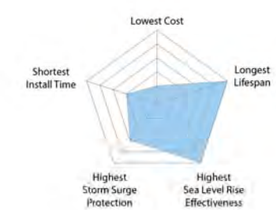
Elevated Stilts



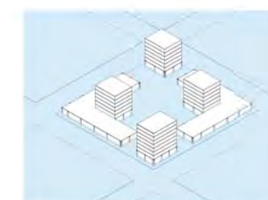


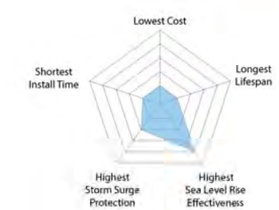
Raised Mounds





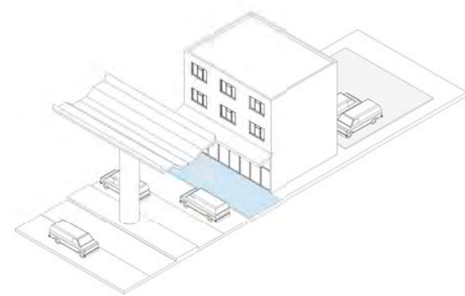
Floatable Buildings

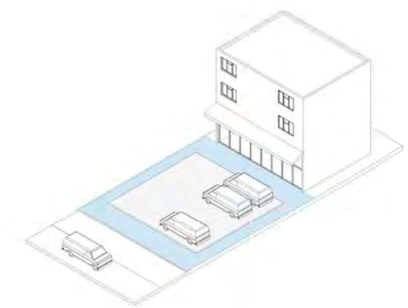




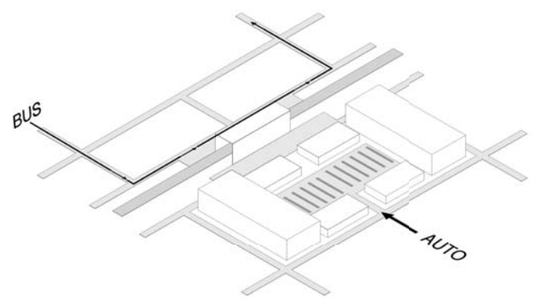
PARKING

STREET ACCESS

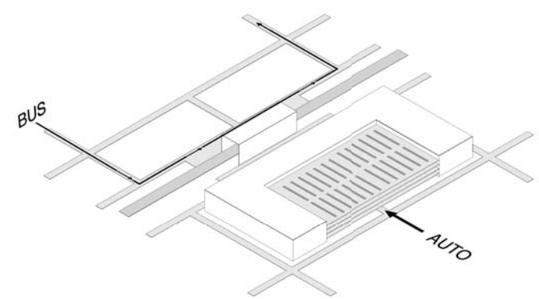




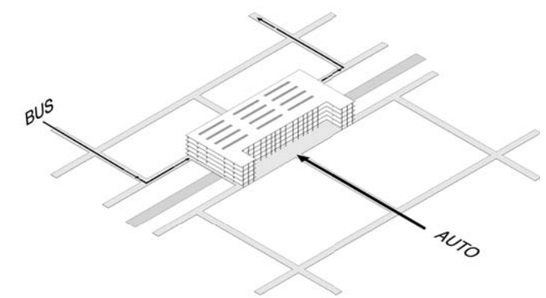
PARKING STRATEGIES



share it



wrap it



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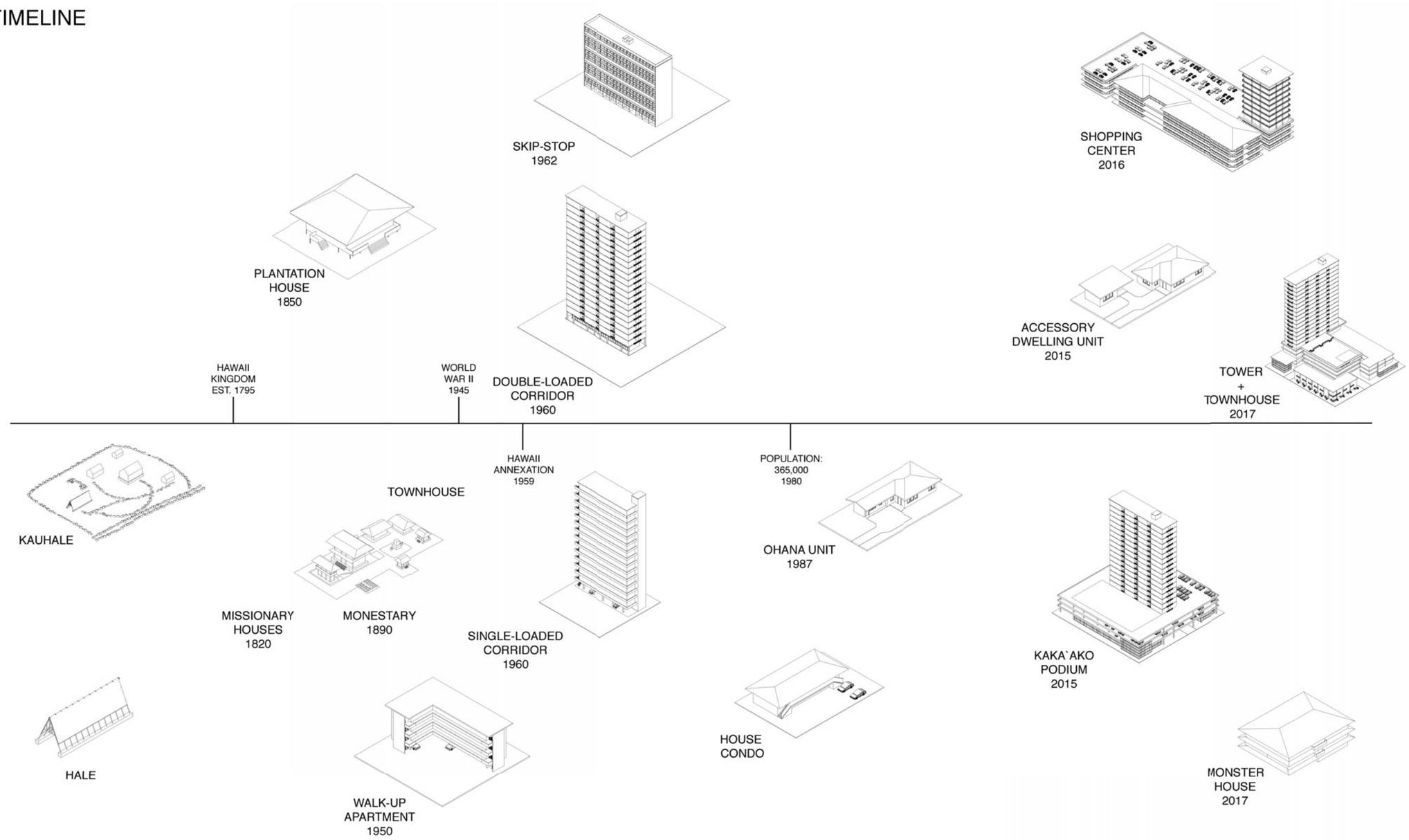
HOUSING TYPES

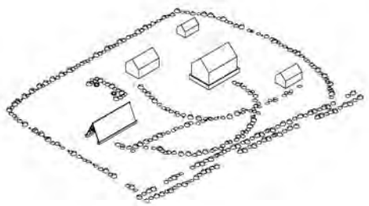
EXISTING HOUSING TYPOLOGIES IN HAWAII

TIMELINE

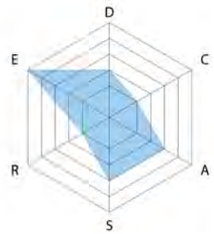


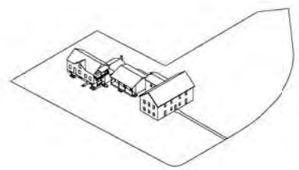
HOUSING TYPES

EXISTING HOUSING TYPOLOGIES IN HAWAII

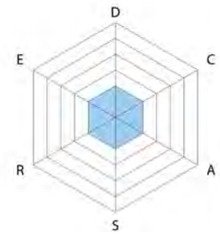


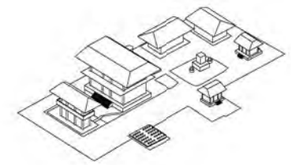
KUAHALE



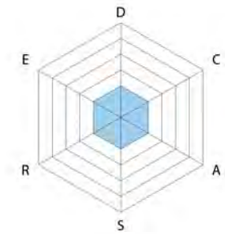


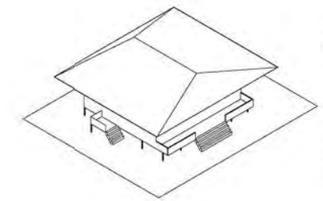
MISSIONARY HOUSE



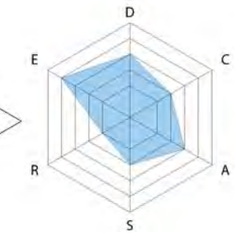


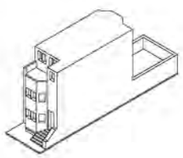
MONESTARY



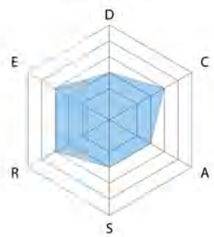


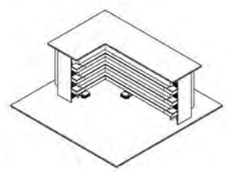
PLANTATION HOUSE



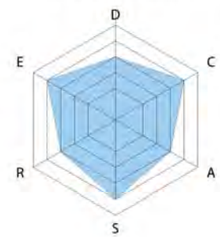


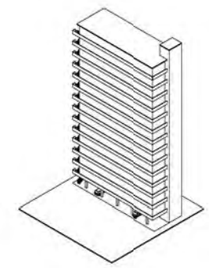
TOWNHOUSE





WALK-UP APARTMENT





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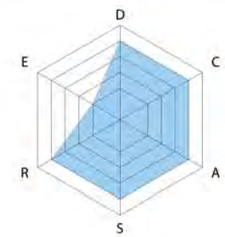

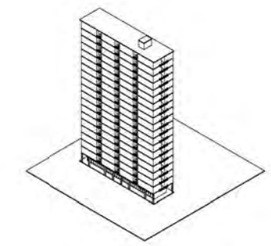

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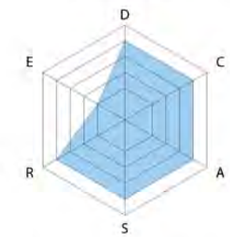
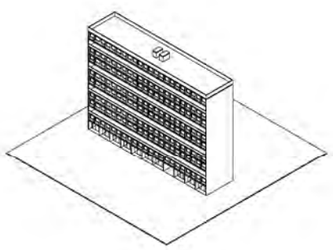
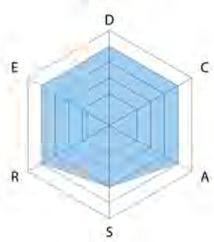
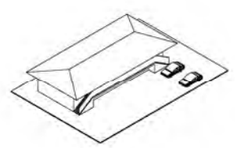


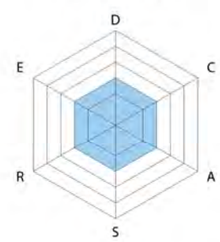


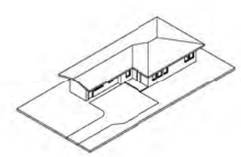
SKIP-STOP



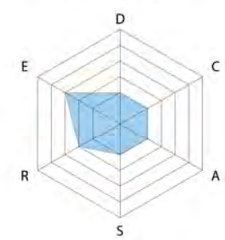


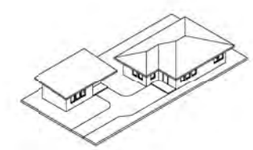
HOUSE CONDO



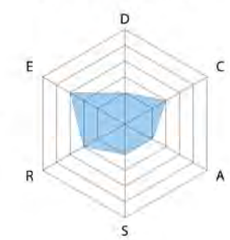


OHANA UNIT

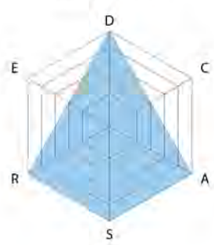


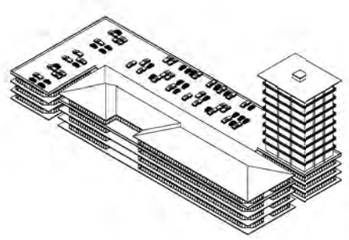


ACCESSORY DWELLING UNIT

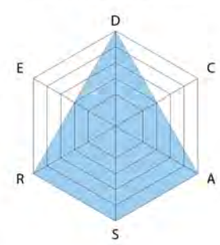


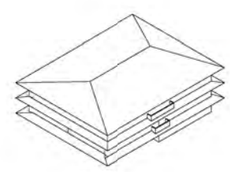
KAKA'AKO PODIUM



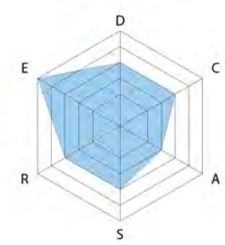


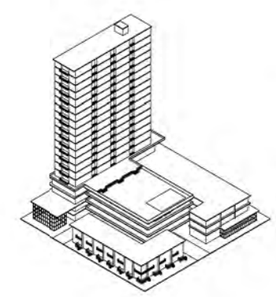
SHOPPING CENTER HYBRID



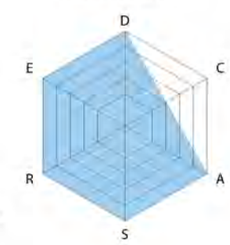


MONSTER HOUSE





TOWER+TOWNHOUSE



STATE OWNED PARCELS

WAIPAHU TRANSIT CENTER STATION AREA

TRANSIT STATION CENTROID

RAIL LINE

STATE

PROPOSED TOD BOUNDARY

0 0.04 0.08 0.16 Miles

PARCEL 1

1	AGENCY	HHFDC
2	STREET ADDRESS	94 830 HIKIMOE ST
3	TMK	9-4-017:051
4	LAND AREA (SF)	35,343
5	FEE OWNER	HAWAII HOUSING FINANCE AND DEV. CORP.
6	LESSEE	WAIPAHU COMM ADULT/DAY CARE CENTER
7	ZONING	BMX-3
8	BUILDING HEIGHT LIMIT (FEET)	60
9	MAX FAR	3.5
10	CURRENT USES	Community Day Care
11	FUTURE PLANS	

PARCEL 2

1	AGENCY	HHFDC
2	STREET ADDRESS	94 333 MOKUOLA ST
3	TMK	9-4-017:062
4	LAND AREA (SF)	60,723
5	FEE OWNER	HAWAII HOUSING FINANCE AND DEV. CORP.
6	LESSEE	MOKUOLA VISTA LP
7	ZONING	R-5
8	BUILDING HEIGHT LIMIT (FEET)	N/A
9	MAX FAR	N/A
10	CURRENT USES	MID-RISE RESIDENTIAL
11	FUTURE PLANS	NO NEW DEVELOPMENT PLANS. BUILDING IS FAIRLY NEW. UNDER 60 YEARS.

PARCEL 3

1	AGENCY	HPHA
2	STREET ADDRESS	94 941 KAUOLU PL
3	TMK	9-4-017:001
4	LAND AREA (SF)	164,787
5	FEE OWNER	HAWAII PUBLIC HOUSING AUTHORITY
6	LESSEE	
7	ZONING	R-5
8	BUILDING HEIGHT LIMIT (FEET)	N/A
9	MAX FAR	N/A
10	CURRENT USES	ELDERLY HOUSING
11	FUTURE PLANS	NO HIGH PRIORITY FOR REDEVELOPMENT. FAIRLY NEW BUILDING. UNDER 60 YEARS OLD.

PARCEL 4

1	AGENCY	HHFDC
2	STREET ADDRESS	
3	TMK	9-4-017:065
4	LAND AREA (SF)	132,335
5	FEE OWNER	HAWAII HOUSING FINANCE AND DEV. CORP. FKA HOUSING & COMM DEV CORP OF HAWAII
6	LESSEE	AOAO OF PLANTATION TOWN APTS
7	ZONING	AMX-3
8	BUILDING HEIGHT LIMIT (FEET)	45
9	MAX FAR	3.36
10	CURRENT USES	SURFACE PARKING
11	FUTURE PLANS	POSSIBLE HOUSING STRUCTURE. CREATE A TOTAL OF 300 HOUSING UNITS

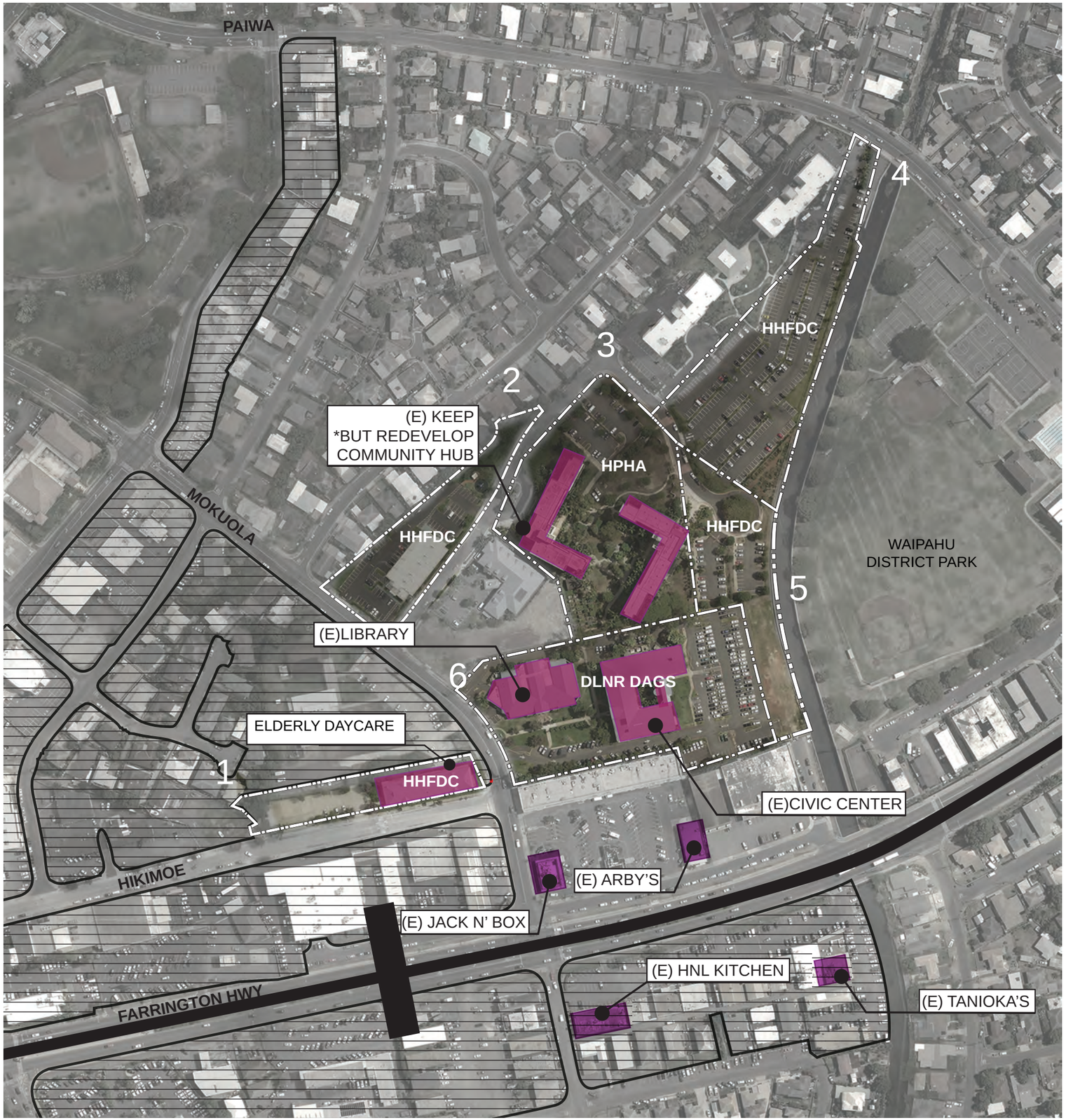
PARCEL 5

1	AGENCY	HHFDC
2	STREET ADDRESS	
3	TMK	9-4-017:051
4	LAND AREA (SF)	35,343
5	FEE OWNER	HAWAII HOUSING FINANCE AND DEV. CORP.
6	LESSEE	
7	ZONING	BMX-3
8	BUILDING HEIGHT LIMIT (FEET)	60
9	MAX FAR	3.5
10	CURRENT USES	SURFACE PARKING
11	FUTURE PLANS	COORDINATE WITH DAGS AND DOE

PARCEL 6

1	AGENCY	DLNR/DAGS
2	STREET ADDRESS	94 275 MOKUOLA ST
3	TMK	9-4-017:052
4	LAND AREA (SF)	196,511
5	FEE OWNER	STATE OF HAWAII
6	LESSEE	
7	ZONING	BMX-3
8	BUILDING HEIGHT LIMIT (FEET)	60
9	MAX FAR	3.5
10	CURRENT USES	LIBRARY AND SOCIAL SERVICE- CIVIC CENTER
11	FUTURE PLANS	DOE - WAIPAHU IS NOT A HIGH PRIORITY DAGS - OPEN TO DISCUSSION

EXISTING PROGRAM



PROPOSED PROGRAMMING

Food
Common Eating Area
Hangout Spot
Riverwalk Restaurant
Restaurants
Coffee
Boba Cafe
Ice Cream Parlor
Bakery
Pub/Sports Bar

Retail/Commercial
Shopping Center
Shoe Store
Convenience
Bike Shop
Gym/Boxing/MMA
Yoga/Dance Studio
Office Space

Entertainment
Stage
Drive-In Theater
Arena
Exploratorium

Recreational
Soccer field
Stadium
Park
Playground
Basketball Court
Square/Plaza
Film Maker Space
Multi-Use Community

Plaza
Splash Pad

Public Service/ Community
Police Substation
Bike Lane
Better Transit
Restrooms
Community Hub
Community Garden
Public Library
Adaptable Parking

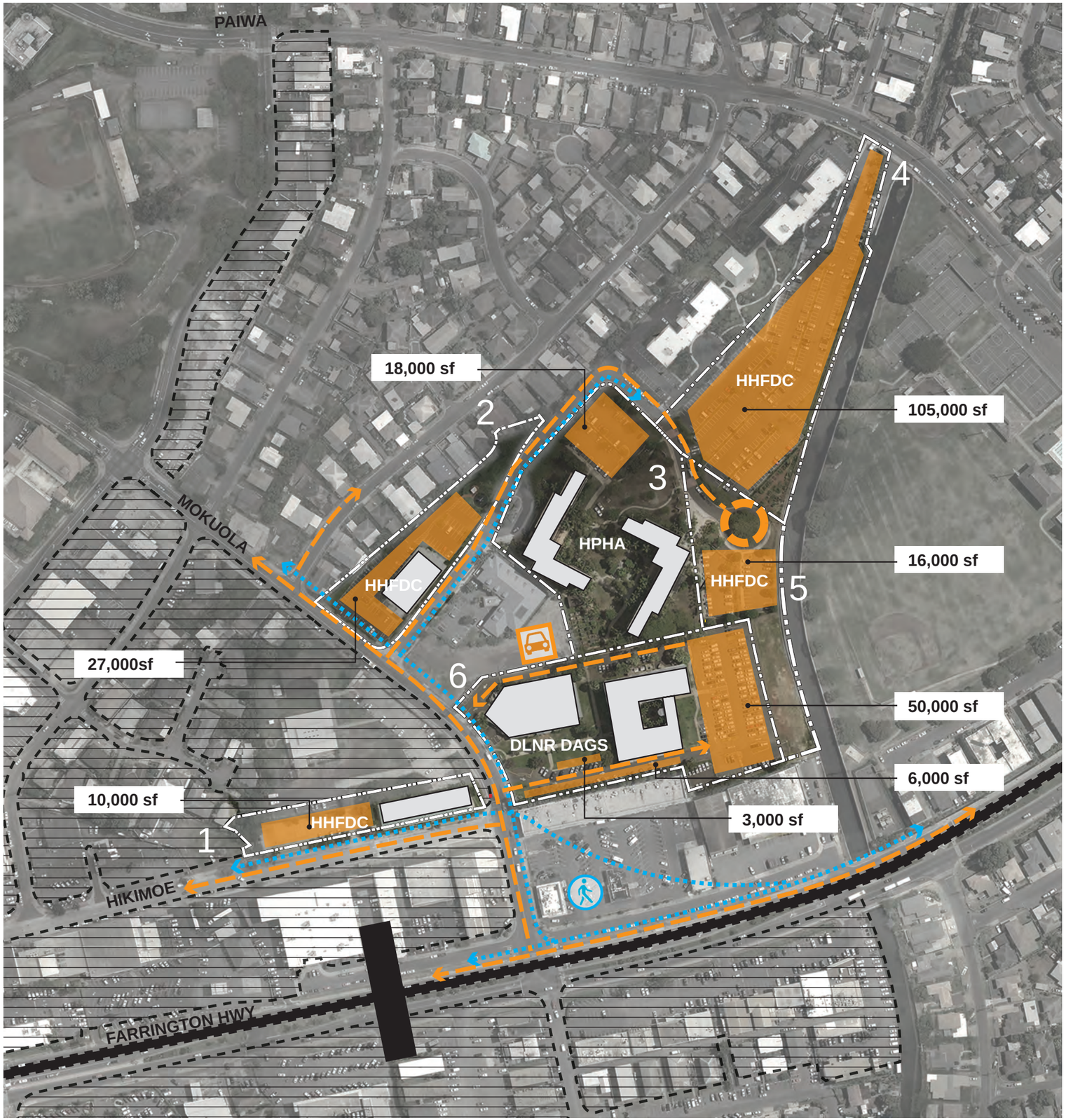
Garage
Bank/Insurance
Medical Services
Free Parking on State

Land for Kids+Ride
Afterschool Programs
Adult/Child Daycare
Parking

Housing
Mixed-Use
Studio Apartments
Affordable Housing
Senior Housing

Beautification
Better Security
Shade
Crosswalks
Better Lighting
Throughway
Floodable Spaces
Floodable Fountain
Greenery
Shade
Widen Sidewalks

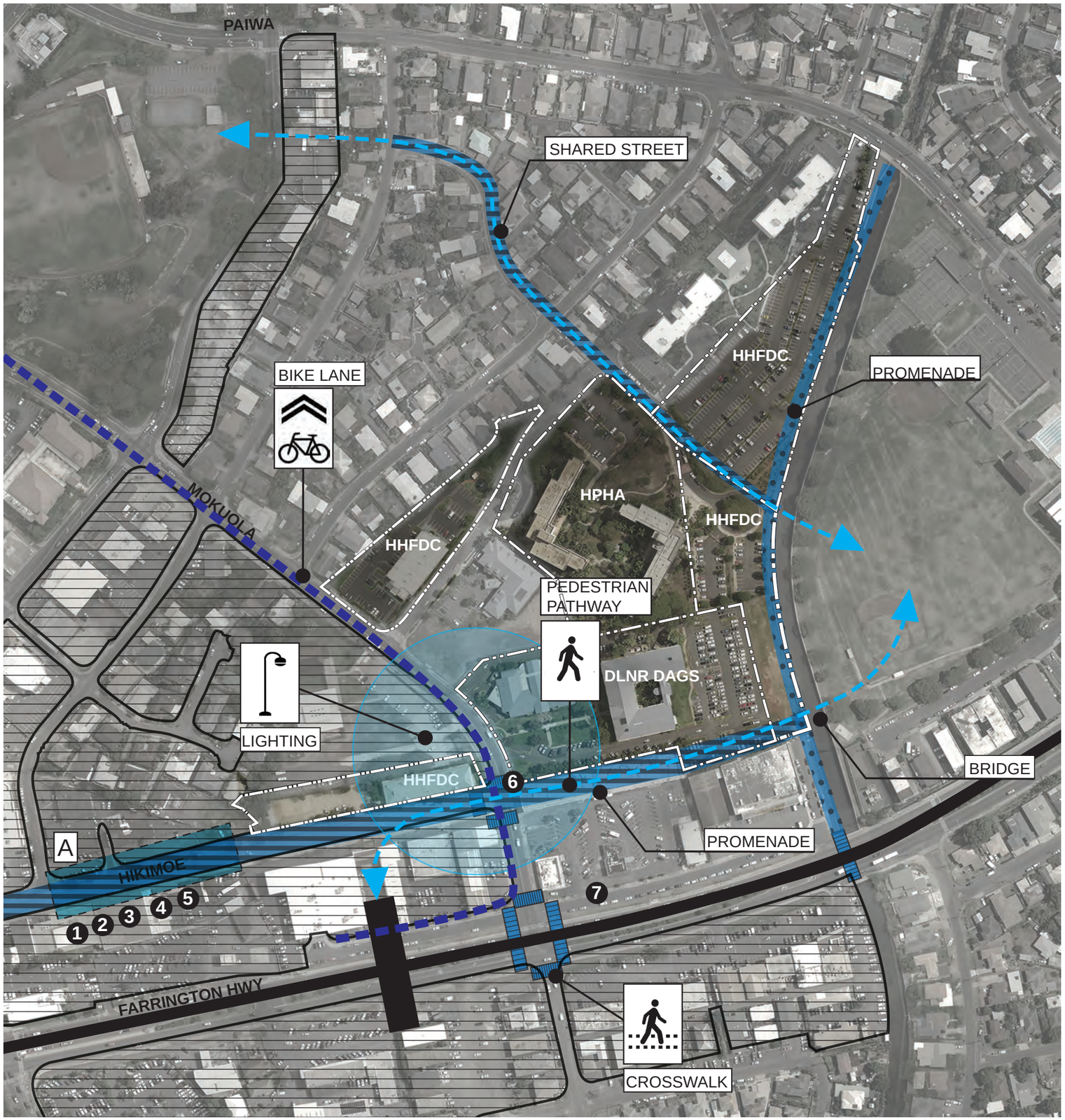
EXISTING PARKING AND CIRCULATION



PARCEL	PARKING SF	PARKING STALLS
1	10,000	33
2	27,000	90
3	18,000	60
4	105,000	350
5	16,000	53
6	59,000	196
TOTAL	235,000	782

PEDESTRIAN CIRCULATION

VEHICLE CIRCULATION



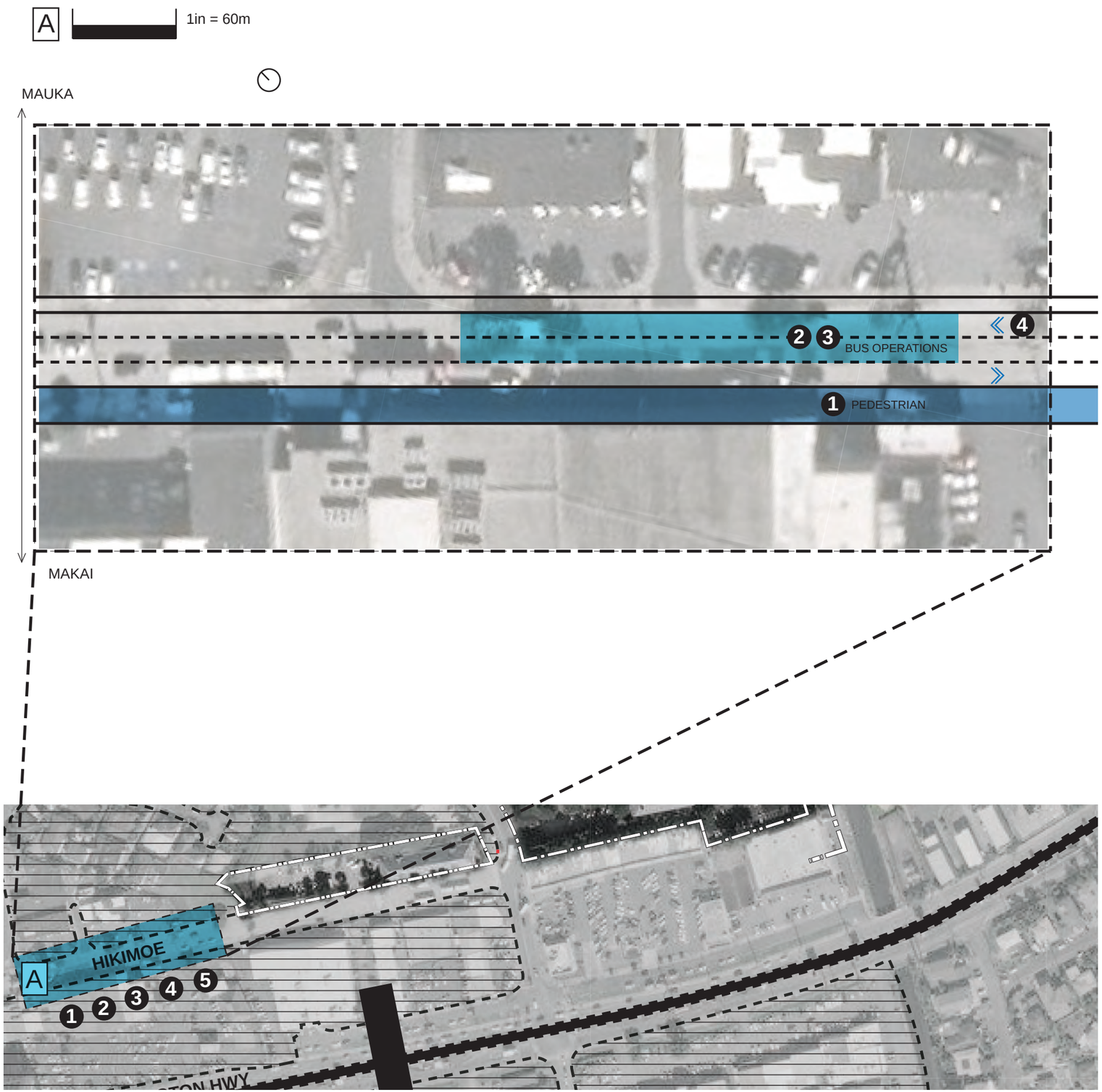
CIRCULATION & SAFETY RECOMMENDATIONS

1 – 5 SEE HIKIMOE DETAIL PLAN

6 DELINEATE A NEW CROSSWALK ON THE MAKAI SIDE OF THE HIKIMOE STREET / MOKUOLA STREET INTERSECTION AND INSTALL APPROPRIATE PEDESTRIAN SIGNAL HEADS, PAVEMENT STRIPING, AND ADA-COMPLIANT RAMPS AS NEEDED

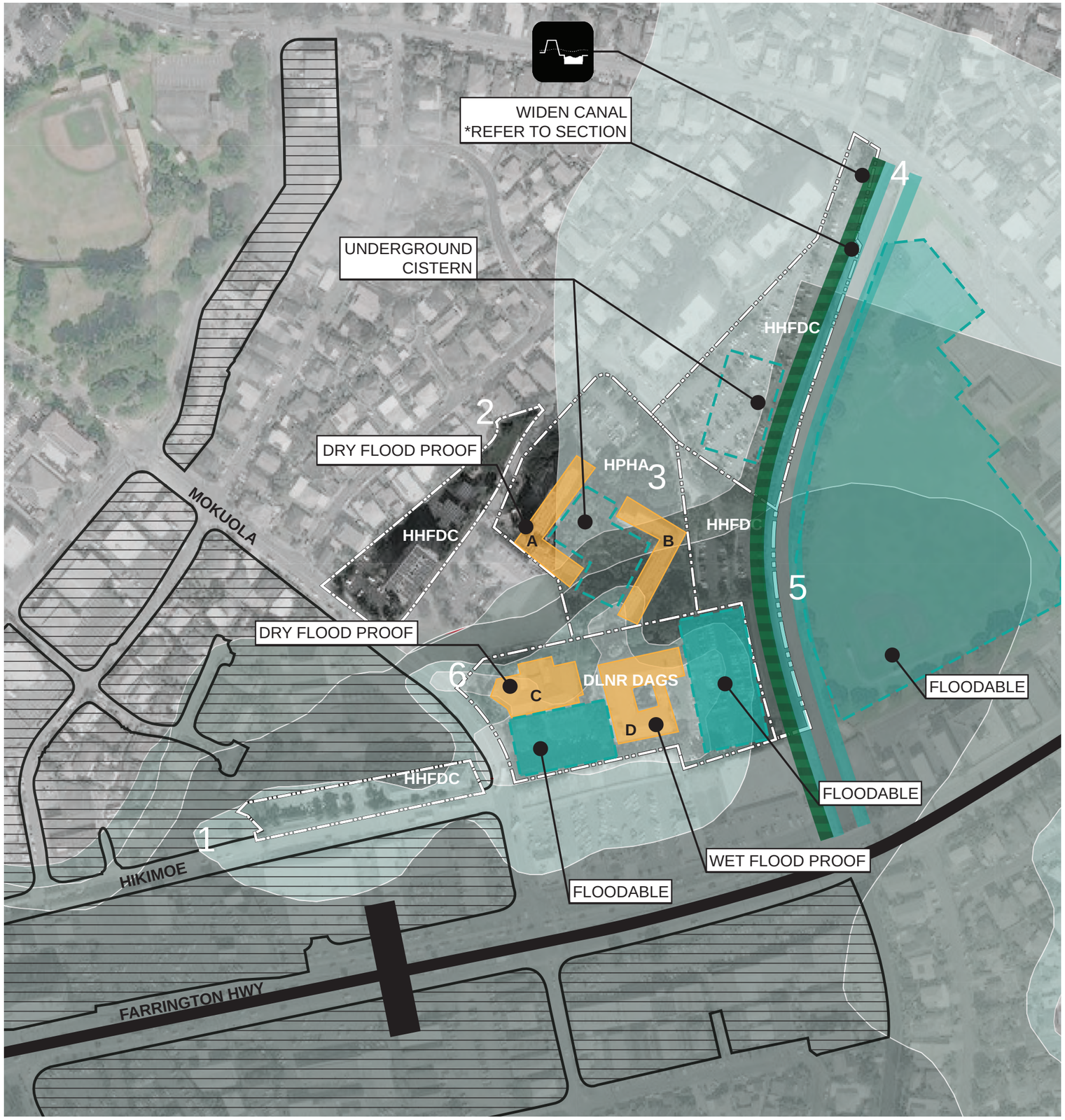
7 INSTALL A NEW RAISED CROSSWALK ON MOLOALO STREET MAKAI OF THE FUTURE HART STATION THAT WILL PROVIDE A DIRECT PEDESTRIAN CONNECTION

HIKIMOE STREET



1. WIDEN THE MAKAI SIDEWALK ON HIKIMOE STREET FROM 10 FEET TO 15 FEET ALONG THE ENTIRE LENGTH FROM WAIPAHU DEPOT STREET TO MOKUOLA STREET
2. RE-STRIPE THE DIAMOND HEAD HALF OF HIKIMOE STREET FOR BUS OPERATIONS
3. RE-STRIPE THE EWA HALF OF HIKIMOE STREET TO A DEDICATED BUS LAYOVER SPACE
4. INSTALL SHARROWS IN BOTH DIRECTIONS ON HIKIMOE STREET TO INCREASE DRIVER AWARENESS OF CYCLISTS
5. INSTALL SIGNAGE TO DISCOURAGE THROUGH TRAFFIC FROM USING EWA-BOUND HIKIMOE STREET

FLOODING MITIGATION



A

LESS FLOOD RISK: 1 IN 500 YEAR STORM
ELDERLY HOUSING MUST MAINTAIN OPERATIONS DURING FLOODING
ELEVATE EQUIPMENT
DRY FLOOD PROOF ELEVATOR PIT

B

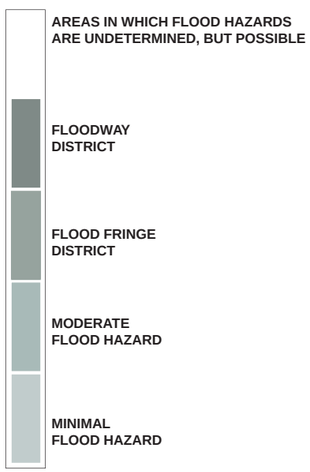
MORE FLOOD RISK: 1 IN 100 YEAR STORM
ALTERNATE ACCESS (IF GROUND FLOOR IS FLOODED)
GROUND FLOOR PROGRAMS SHOULD NOT REQUIRE 24/7 FUNCTIONALITY;
SUSPENSION OPTIONAL
ASSESS IF WET OR DRY FLOOD PROOFING IS APPROPRIATE

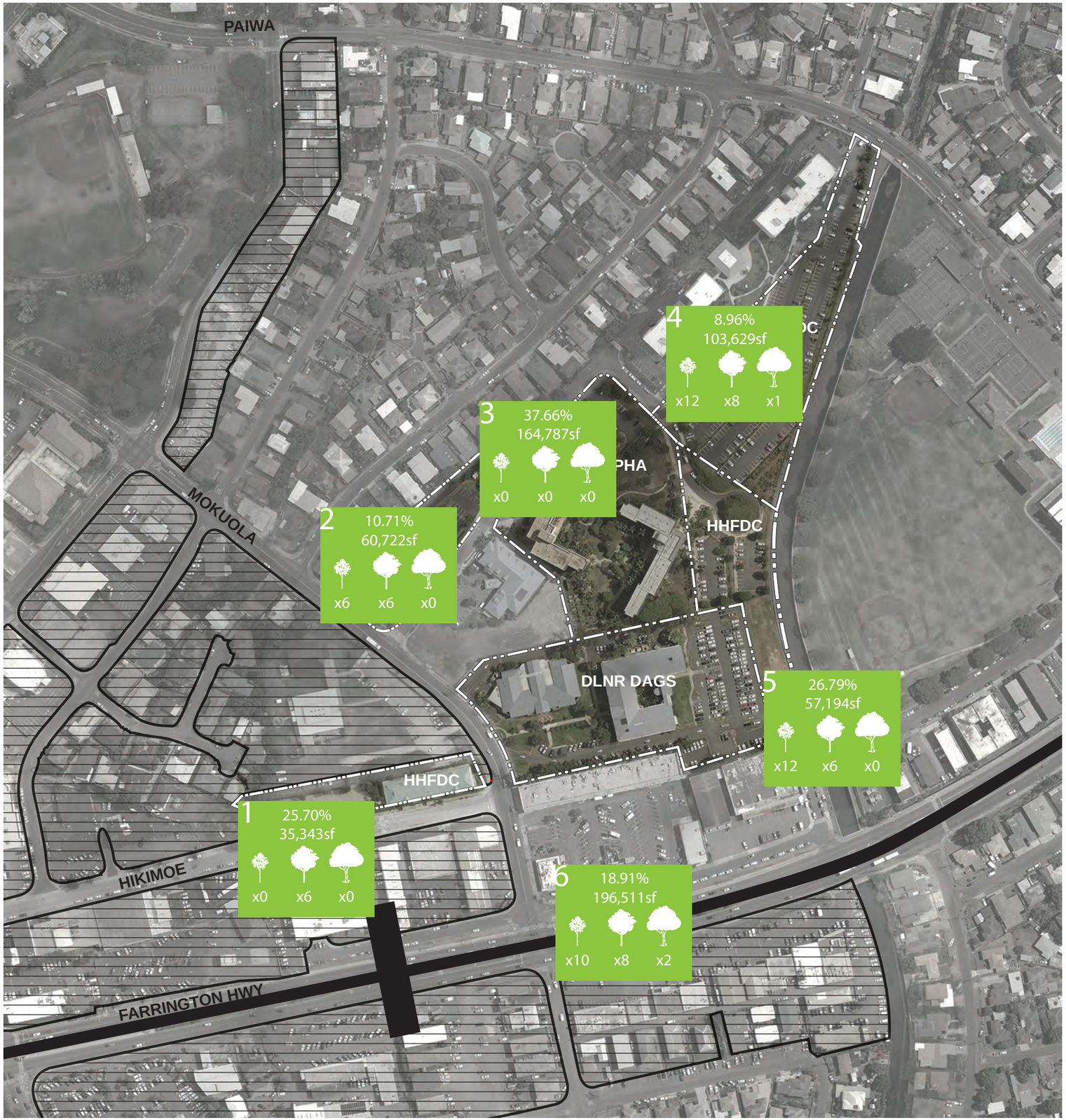
C

DRY FLOOD PROOF
NOT OPERATIONAL IN A FLOOD
ELEVATE EQUIPMENT

D

1 IN 500 YEAR FLOOD
WET FLOOD PROOF
WATER MOVES THROUGH GF
POTENTIAL TO REMAIN OPERATIONAL WHEN NEARBY AREAS FLOOD
COULD PROGRAM CRITICAL CONTINUOUS FUNCTIONS ON HIGHER FLOORS
- CLINIC = APPROPRIATE PROGRAM





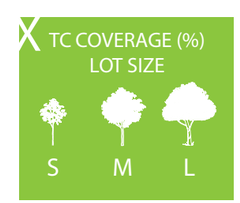
TREE CANOPY COVERAGE

EXISTING TREE CANOPY COVERAGE

PARCEL	LOT SIZE	TC COVERAGE (%)	TC COVEAGE (SF)	30% (SF)	NEEDED COVERAGE (SF)
1	35,343	25.7	9,083	10,603	1,520
2	60,722	10.7	6,503	18,217	11,713
3	164,787	37.7	62,059	49,436	0
4	103,629	9.0	9,285	31,089	21,804
5	57,194	26.8	15,322	17,158	1,836
6	196,511	18.9	37,160	58,953	21,793
Total	618,186	21.5	139,413	58,953	46,043

AMOUNT OF TREES NEEDED TO REACH 30%

PARCEL	LARGE	MEDIUM	SMALL	TREE AREA (SF)
1	0	6	0	4,242
2	0	6	6	5,448
3	1	8	12	13,094
4	0	6	10	6,252
5	0	0	0	0
6	2	8	10	17,718
TOTAL	3	34	38	46,754

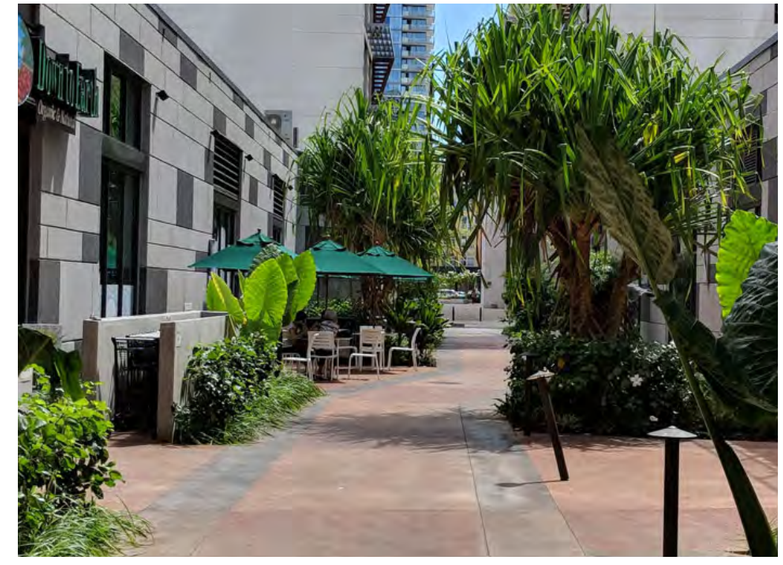


PART II

HOUSING BLOCK PRECEDENTS

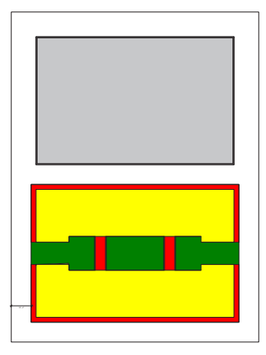
UHCDC
UNIVERSITY OF HAWAI'I
COMMUNITY DESIGN CENTER

INTERIOR LANE

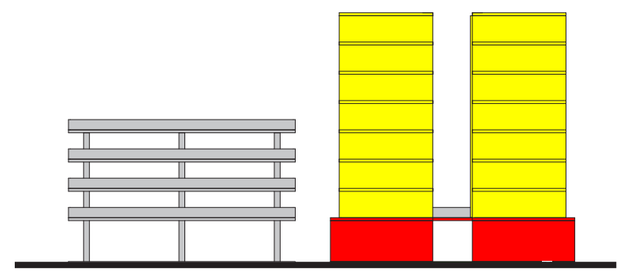


PROJECT	Keauhou Lane
LOCATION	Honolulu, Hawai'i
FIRM	Hierarchy LLP
CLIENT	Gerding Edlen
YEAR	2017
SIZE	17,918 sqft/1.57 acre
UNITS	209
COMMERCIAL	30,000 SF

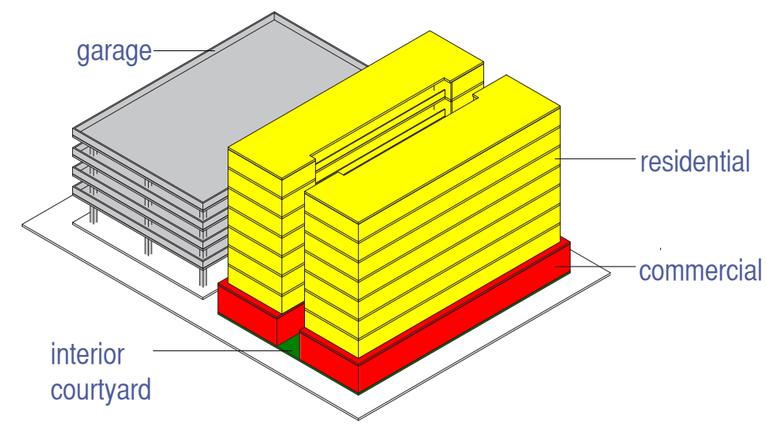
The Keauhou Lane Mixed-Use Development project is a 6-story affordable housing project with five levels of residences over 30,000 sf of street level commercial retail space.



Plan



Elevation

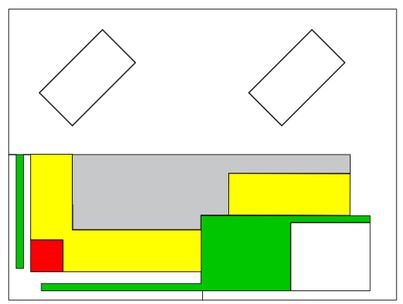


3D View

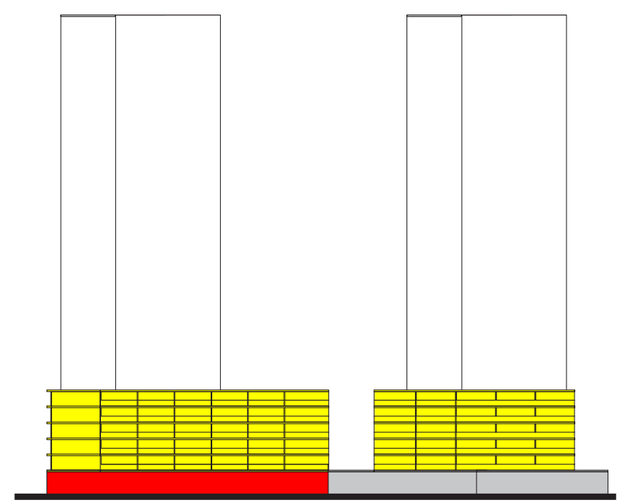
PARKING WRAP

PROJECT	400 Keawe St
LOCATION	Honolulu, Hawai'i
FIRM	Design Partners Inc
CLIENT	Castle & Cooke Hawaii
YEAR	2016
SIZE	1.52 acres
UNITS	95
COMMERCIAL	9,680 SF

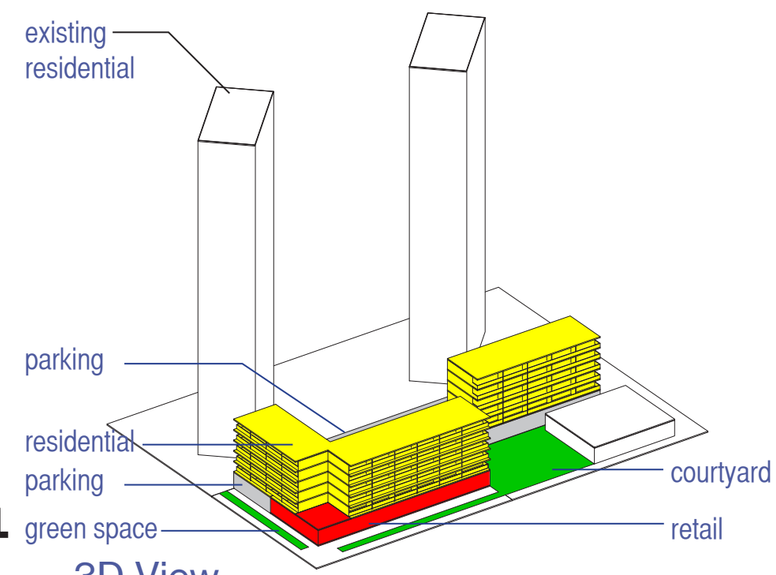
400 Keawe is a 133,000 sf six story complex with 9,680 sf of commercial space on the ground floor, unifying the pedestrian experience which connects the future Civic Center Honolulu Area Rapid Transit station to the Salt commercial center. The remainig five stories of the building include a mixture of one, two and three bedroom units ranging from 550 sf to 1,500 sf with 150 parking stalls available.



Plan



Elevation



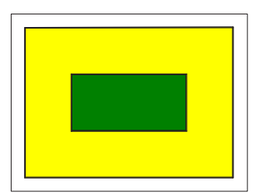
3D View

COMMERCIAL ARCADE & INTERIOR COURTYARD

PROJECT	Trellis House
LOCATION	Washington, DC
FIRM	Niles Bolton Assoc
CLIENT	RISE Real Estate Co
YEAR	2018
SIZE	1.1 acre
UNITS	319
COMMERCIAL	8,600 SF

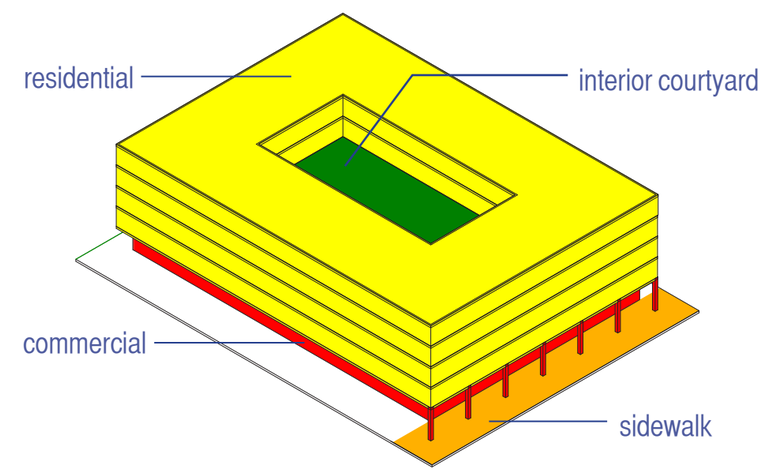
Designed to provide a communal node for young professionals and diverse social atmosphere. A mixed-use development activating the street edge with retail and engages the neighboring park with walk-up townhouses.

1.1 acre- 319 units- 7,600 sf retail space; 1,000 sqft office space-2 level podium parking deck w/143 stalls



Plan

Front Elevation



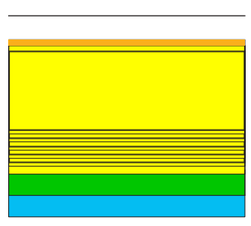
3D View

PRECEDENT STUDY

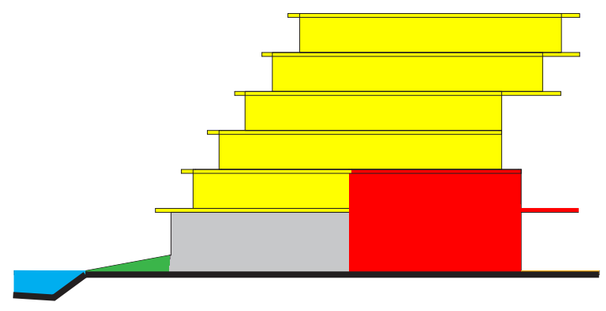
TERRACED

PROJECT	Klencke
LOCATION	Amsterdam, Netherlands
FIRM	NL Architects
CLIENT	NL Development
YEAR	2017
SIZE	N/A
UNITS	50

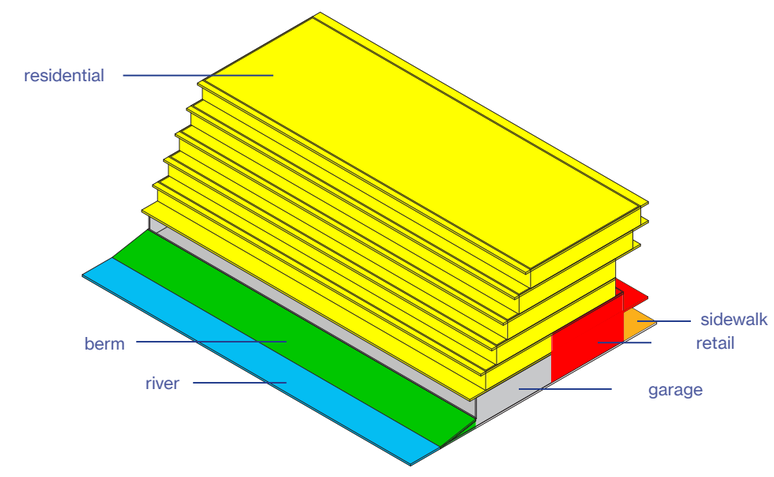
Klencke (or “terras op zuid”), is a 50-unit residential complex with a stepped profile acting as a mediator between the urban financial district and the greenery of the canal. The dwellings, apartments and lofts have a gross iternal size ranging from 517-1798 sf.



Plan



Section

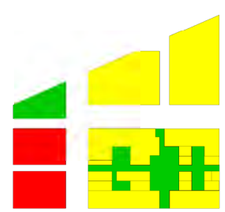


3D View

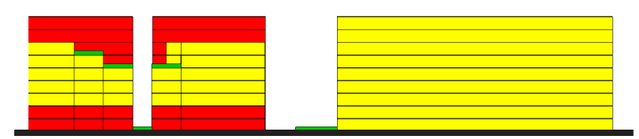
PUBLIC PLAZA

PROJECT	City Center DC
LOCATION	Washington, DC
FIRM	Foster and Partners
CLIENT	Hines Archstone
YEAR	2014
SIZE	12 acres
UNITS	1,000
COMMERCIAL	550,000 SF

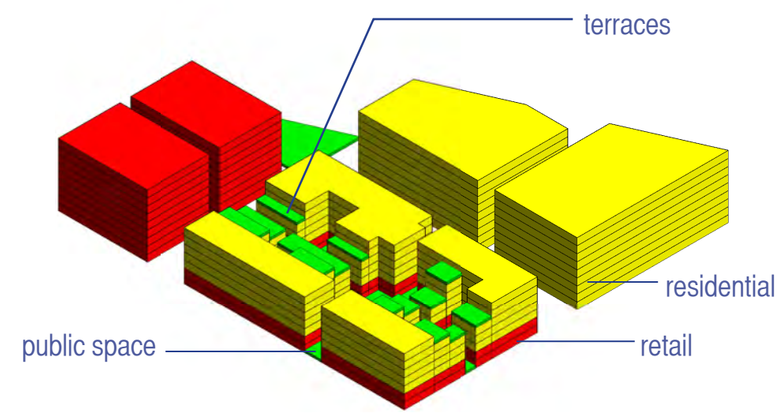
This mixed-use scheme combining office, condominiums, restaurants and shops on a 12-acre site of the former Washington Convention Center.



Plan



Front Elevation

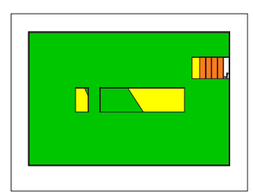


3D View

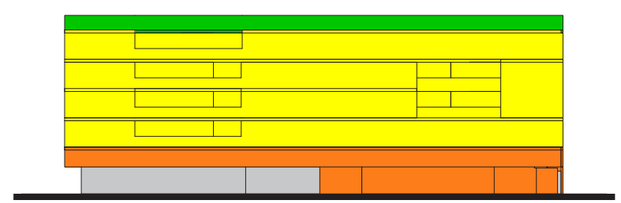
RAISED COURTYARD OPEN TO STREET

PROJECT	The SIX
LOCATION	Los Angeles, California
FIRM	Brooks + Scarpa
YEAR	2016
SIZE	40,250 SF
UNITS	52

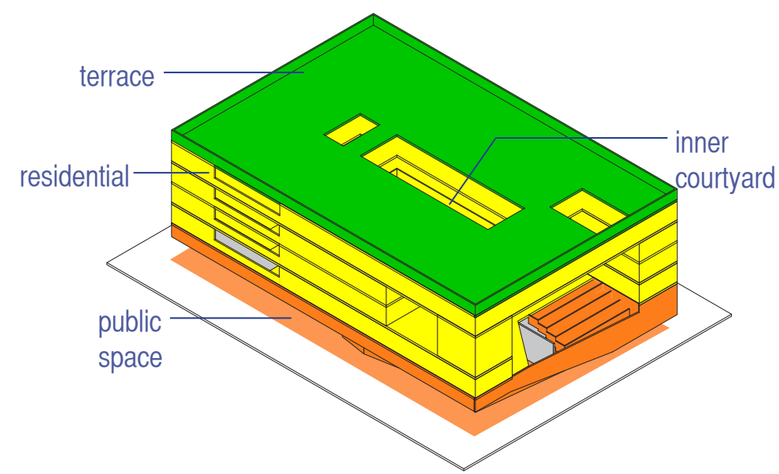
The SIX is a 52-unit affordable housing project with five habitable floors and an interior court. The project creates public and private zones in which private space is deemphasized. This is to introduce a community-oriented and interactive space.



Plan



Front Elevation

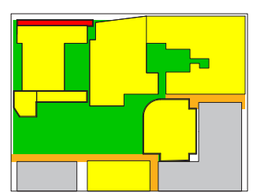


3D View

MINI PARK

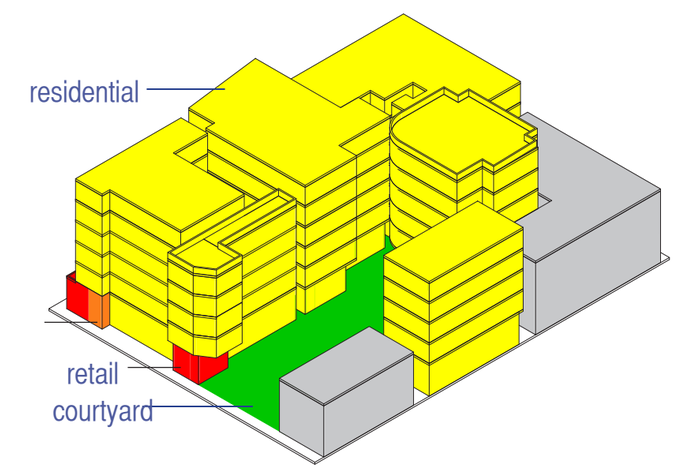
PROJECT	Brady Block
LOCATION	San Francisco, California
FIRM	David Baker
SIZE	501,000 SF
UNITS	579
COMMERCIAL	13,000 SF

The project features six buildings, including 579 new market-rate and affordable residences. There is 20,000 sf of new public space which was primarily used for parking lot space. The urban design of the two-acre site aims to maximize porosity, opening it up for circulation.



Plan

Back Elevation



3D View (Back)

PART III

PARKING PRECEDENTS

UHCDC
UNIVERSITY OF HAWAI'I
COMMUNITY DESIGN CENTER

PARK N' PLAY

PROJECT	P-HUS LUDERS
LOCATION	Copenhagen, Denmark
FIRM	JAJA Architects
CLIENT	Nordhavn
YEAR	2016
SIZE	2,400.0 m2

Conventional parking house structure, with an attractive green facade and a concept to encourage people to use the rooftop.

PARK N' SHOP

PROJECT	THE PARK AT SOUTH MARKET
FIRM	Eskew+Dumez+Ripple
LOCATION	New Orleans, Louisiana
CLIENT	N/A
YEAR	2014
SIZE	205,000 sf

The Park at South Market District is a 6-story, 441-space parking garage that features 27,000 sf of ground floor retail and diverse amenities.

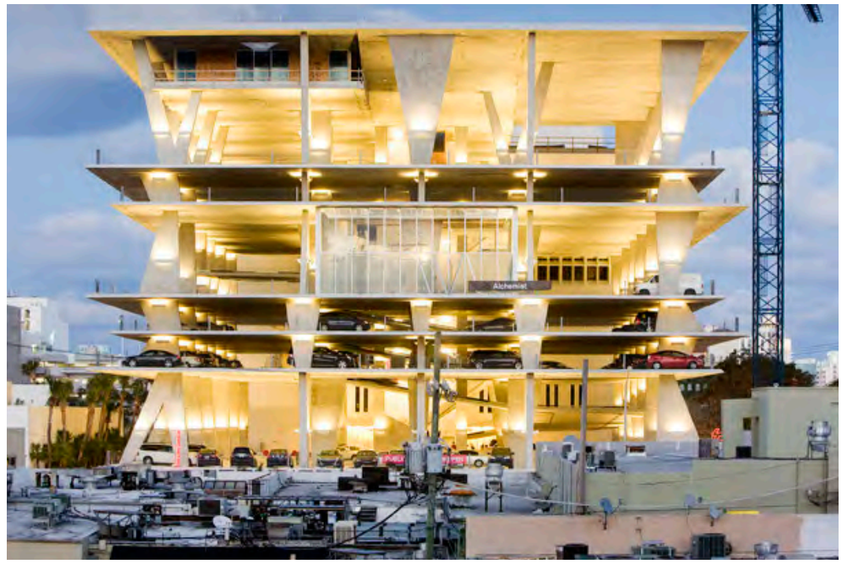
This non-traditional parking structure adapts to an evolving hub of urban activity.

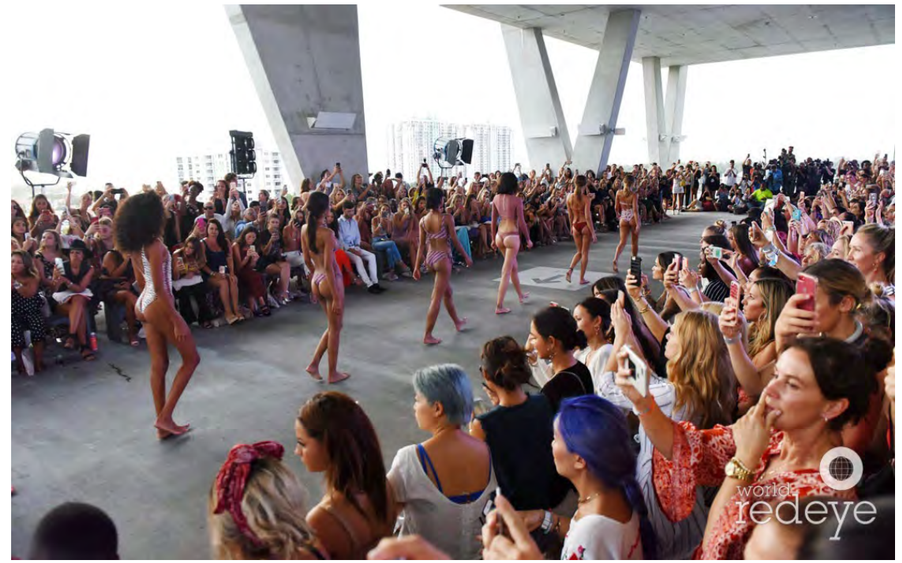
PRECEDENT STUDY

UHCDC
UNIVERSITY OF HAWAI'I
COMMUNITY DESIGN CENTER

Miami Beach, Florida

SHOWCASE-MULTI-HEIGHT





PROJECT	1111 LINCOLN ROAD
FIRM	Herzog & de Meuron
CLIENT	Nippon Steel Engineering Co.,Ltd.
YEAR	2010
SIZE	9,500sqm

The project includes 300 parking stalls, including 11 shops and 3 restaurants at ground level, with further shopping on the 5h floor, another restaurant and luxury residences.

Exaggerated ceiling eights, wide open 360-degree views and no exterior walls. Rather than hiding cars, it openly celebrates them.

PRECEDENT STUDY

UHCDC
UNIVERSITY OF HAWAI'I
COMMUNITY DESIGN CENTER

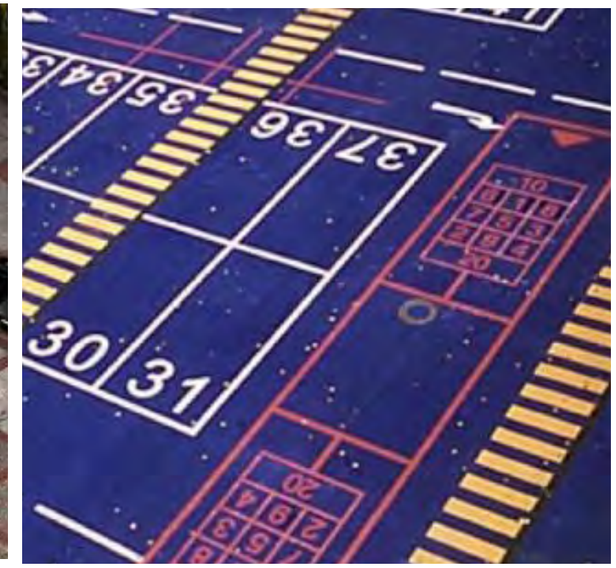
LOW-IMPACT DESIGN

PROJECT NSE KITAKYUSHU TECHNOLOGY CENTER
LOCATION Fukuoka, Japan
FIRM PLATdesign
CLIENT Nippon Steel Engineering Co.,Ltd.
YEAR 2011
SIZE 9,500 sqm

The goal was to provide more than just a functional space, by creating a front garden that incorporated landscaping. A mound of grass hides cars in the lot from the field of view.

This simple spatial structure combined both function and landscape, resulting in the welcoming scene of a garden which also works as a drainage system.

MULTI-PARKING PLAZAS



UHCDC
UNIVERSITY OF HAWAI'I
COMMUNITY DESIGN CENTER

PART IV

DESIGN OPTIONS

UHCDC
UNIVERSITY OF HAWAI'I
COMMUNITY DESIGN CENTER

OPTION 1
Surface

SUMMARY OF FINDINGS

COMMUNITY OUTREACH SURVEY
- Widen Makai Sidewalk on Hikimoe Street
- Re-Stripe the Diamond Head Half of Hikimoe St for bus layover
- Install sharrows in both directions on Hikimore St
- Install signage to discourage traffic from Ewa-bound
- Delineate a new crosswalk on the makai side of the Hikimoe St/Mokoula St intersection
- Install a new raised crosswalk on Moloala St for future Hart Rail
- Lighting on Hikimoe and Moloalu intersection
- Pedestrian access through Waiphau District Park
- Promenade along Ewa Side of Canal
- Promenade on Civic Center parcel

TREE CANOPY STUDY
- Medium trees along pedestrian pathways to increase walkability
- Small trees planted at drypond parking stalls
- Added trees along Mokuola St, a main street, to connect to Han L'Orange Park
- Trees along proposed bike lane
- 30% tree canopy coverage for all six parcels
- 30% tree canopy coverage for Parcel 1
- 30% tree canopy coverage for Parcel 2
- 30% tree canopy coverage for Parcel 3
- 30% tree canopy coverage for Parcel 4
- 30% tree canopy coverage for Parcel 5
- 30% tree canopy coverage for Parcel 6

FLOOD AND STORM MITIGATION
- Widen Canal
- Natural Berm/Levee on Ewa side of Waipahu Canal
- Underground cistern on HPHA elderly housing and HHFCDC surface parking lots
- Dry flood proofing for the Elderly housing and Library
- Wet flood proofing for the civic center
- Dry pond on civic center surface parking
- Permeable pavement on pedestrian walkway

WAIPAHU ACTION PLAN
- Implement a connected bicycle facility
- Upgrade Waipahu Transit Center
- Redesign Moloalo Street
- Upgrade Street Lighting
- Connect Hawaii's Plantation Village to Waipahu Town Core
- Implement Placemaking Strategies
- Connect Waipahu District Park to Waipahu Town Core
- Develop a Master Plan for Han L'Orange Park
- Address Areawide Flooding
- Establish Areawide Wayfinding
- Develop Pouhala Marsh Educational Signage

OPTION 1 SITE PLAN

DLNR/DAGS

	EXISTING	NEW
CIVIC AREA:	68,000 SF	—
PROMENADE AND BRIDGE:	—	33,000 SF
PARKING:	59,000 SF (160 PARKING STALLS)	

OPTION 2
House & Park

SUMMARY OF FINDINGS

COMMUNITY OUTREACH SURVEY
- Widen Makai Sidewalk on Hikimoe Street
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OPTION 2 SITE PLAN

DLNR/DAGS

	EXISTING	NEW
CIVIC AREA:	68,000 SF	—
COMMERCIAL:	—	15,000 SF
PROMENADE:	—	33,000 SF
PARKING:	—	100,000 SF (330 PARKING STALLS)

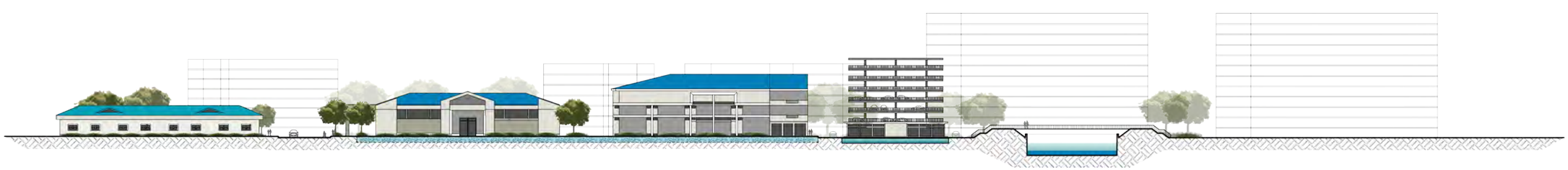
75 NEW JOBS (200 SF/FOOD SERVICE WORKER)

HHFDC

MID RISE HOUSING:	—	66,000 SF (80 DU @ 800SF/UNIT)
LOW RISE HOUSING:	—	27,000 SF (33 DU @ 800SF/UNIT)
TOTAL HOUSING:	—	93,000 SF (113 DU @ 800SF/UNIT)
PARKING:	—	54,000 SF (180 PARKING STALLS)
PUBLIC PARK:	—	20,000 SF

HPHA

PARKING:	—	81,600 SF (272 PARKING STALLS)



OPTION 3

Vertical School

SUMMARY OF FINDINGS

COMMUNITY OUTREACH SURVEY

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- Upgrade Street Lighting
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- Implement Placemaking Strategies
- Connect Waipahu District Park to Waipahu Town Core
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- Address Areawide Flooding
- Establish Areawide Wayfinding
- Develop Pouhala Marsh Educational Signage

OPTION 3 SITE PLAN

DLNR/DAGS/DOE - VERTICAL SCHOOL AND CIVIC CENTER

	EXISTING	NEW
VERTICAL SCHOOL:	—	230,000 SF
CIVIC AREA:	—	68,000 SF
COMMERCIAL:	—	16,700 SF
URBAN PLAZA:	—	10,000 SF
PROMENADE:	—	33,000 SF
PARKING:	—	160,000 SF (530 PARKING STALLS)

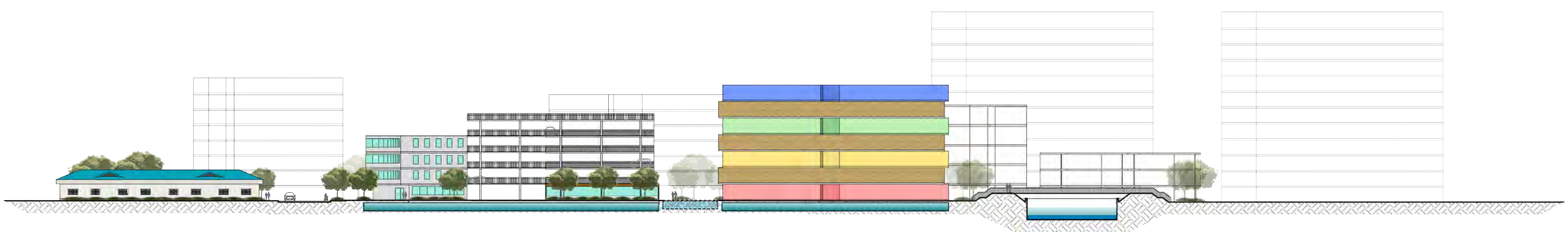
80 NEW JOBS (200 SF/ FOOD SERVICE WORKER)

HHFDC

MID RISE HOUSING:	—	66,000 SF (80 DU @ 800SF/UNIT)
LOW RISE HOUSING:	—	27,000 SF (33 DU @ 800SF/UNIT)
TOTAL HOUSING:	—	93,000 SF (113 DU @ 800SF/UNIT)
PARKING:	—	54,000 SF (180 PARKING STALLS)
PUBLIC PARK:	—	20,000 SF

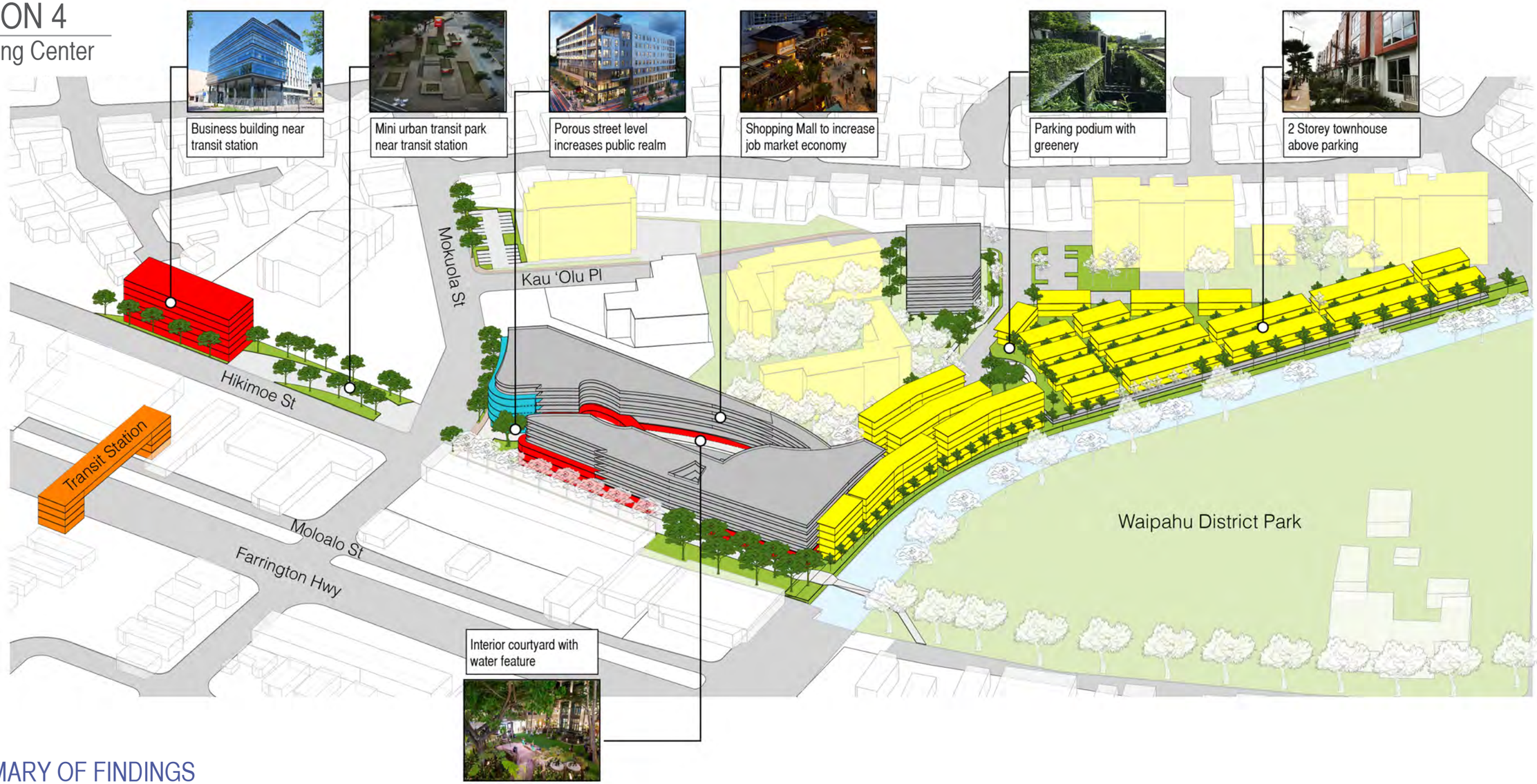
HPHA

PARKING:	—	81,600 SF (272 PARKING STALLS)



OPTION 4

Shopping Center



SUMMARY OF FINDINGS

COMMUNITY OUTREACH SURVEY

- Widen Makai Sidewalk on Hikimoe Street
- Re-Stripe the Diamond Head Half of Hikimoe St for bus layover
- Install sharrows in both directions on Hikimore St
- Install signage to discourage traffic from Ewa-bound
- Delineate a new crosswalk on the makai side of the Hikimoe St/Mokoula St intersection
- Install a new raised crosswalk on Moloala St for future Hart Rail
- Lighting on Hikimoe and Moloalu intersection
- Pedestrian access through Waiphau District Park
- Promenade along Ewa Side of Canal
- Promenade on Civic Center parcel

TREE CANOPY STUDY

- Medium trees along pedestrian pathways to increase walkability
- Small trees planted at drypond parking stalls
- Added trees along Mokuola St, a main street, to connect to Han L'Orange Park
- Trees along proposed bike lane
- 30% tree canopy coverage for all six parcels
- 30% tree canopy coverage for Parcel 1
- 30% tree canopy coverage for Parcel 2
- 30% tree canopy coverage for Parcel 3
- 30% tree canopy coverage for Parcel 4
- 30% tree canopy coverage for Parcel 5
- 30% tree canopy coverage for Parcel 6

FLOOD AND STORM MITIGATION

- Widen Canal
- Natural Berm/Levee on Ewa side of Waipahu Canal
- Underground cistern on HPHA elderly housing and HHFCDC surface parking lots
- Dry flood proofing for the Elderly housing and Library
- Wet flood proofing for the civic center
- Dry pond on civic center surface parking
- Permeable pavement on pedestrian walkway

WAIPAHU ACTION PLAN

- Implement a connected bicycle facility
- Upgrade Waipahu Transit Center
- Redesign Moloalo Street
- Upgrade Street Lighting
- Connect Hawaii's Plantation Village to Waipahu Town Core
- Implement Placemaking Strategies
- Connect Waipahu District Park to Waipahu Town Core
- Develop a Master Plan for Han L'Orange Park
- Address Areawide Flooding
- Establish Areawide Wayfinding
- Develop Pouhala Marsh Educational Signage

OPTION 4 SITE PLAN

DLNR/DAGS - SHOPPING CENTER RETAIL:

	EXISTING	NEW
COMMERCIAL AREA:	—	230,000 SF
CIVIC AREA:	—	68,000 SF
URBAN PLAZA:	—	10,000 SF
PROMENADE:	—	33,000 SF
PARKING:	—	365,000 SF (1040 PARKING STALLS)

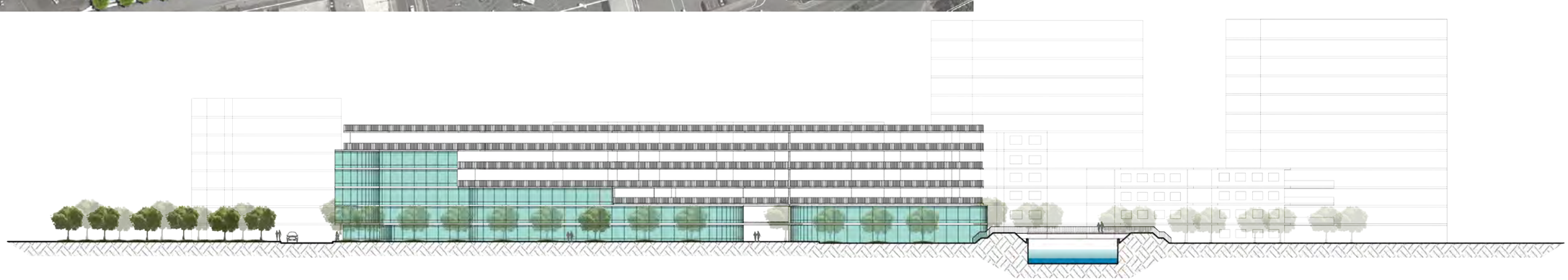
320 NEW JOBS (700 SF/WORKER)
575 PARKING STALL DEMAND (172,000 SF)

HHFDC

MID RISE HOUSING:	—	133,500 SF (160 DU @ 800SF/UNIT)
TOWNHOUSE:	—	125,000 SF (150 DU @ 800SF/UNIT)
TOTAL HOUSING:	—	258,500 SF (310 DU @ 800SF/UNIT)
PARKING:	—	206,000 SF (686 PARKING STALLS)

HPHA

PARKING:	—	81,600 SF (272 PARKING STALLS)



UHCDC
UNIVERSITY OF HAWAI'I
COMMUNITY DESIGN CENTER

Hawaii Interagency Council for Transit-Oriented Development
January 8, 2018, 9:00 AM
Hawaii Community Development Authority, Community Room

Name (Optional): _____

Department (Optional): _____

ECOLOGICAL CONDITIONS STUDY (TREE CANOPY)	FLOOD MITIGATION MEASURES	HOUSING BLOCK STUDY	DESIGN FUTURES DIGITAL OPTIMIZATION STUDY

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