GUIDANCE ON REVISIONS TO THE REVISED ORDINANCE OF HONOLULU CHAPTER 23, REGARDING SHORELINE SETBACKS
City and County of Honolulu Climate Change Commission
December 23, 2019

PURPOSE

Pursuant to the Revised Charter of Honolulu ("RCH") Section 6-107(h), the City and County of Honolulu ("City") Climate Change Commission ("Commission") is charged with gathering the latest science and information on climate change impacts to Hawai'i and providing advice and recommendations to the Mayor, City Council, and executive departments as they look to draft policy and engage in planning for future climate scenarios and reducing Honolulu's contribution to global greenhouse gas emissions.

The Hawai'i Revised Statutes (HRS), Chapter 205A, authorizes the City to establish and revise as appropriate a coastal setback. Mayor Caldwell, in correspondence dated June 25, 2019, requested that the Commission provide guidance on new shoreline regulations and rules. In response, this document provides recommendations for amending Revised Ordinance of Honolulu (ROH) Chapter 23 "Shoreline Setbacks."

RECOMMENDATIONS

ROH Chapter 23 has not been substantially updated since 2010 and does not incorporate a current understanding of the additional risks associated with sea level rise (SLR) and other aspects of climate change that increase coastal hazards. The Commission recommends that ROH Chapter 23 be revised to be consistent with the ways in which climate change is increasing risk to coastal development, public access, ecosystems, and that it be updated on a regular basis to reflect learning in a continual and adaptive manner.

1. **Include a brief review of the science of climate change and SLR in the "Purpose" (Section 23-1.2) of ROH Chapter 23.** This is important to acknowledge that the coastal zone characterized by dynamic processes and to set the context that the ROH Chapter 23 will be designed in response to and recognition of climate science.
    a. For example, on beaches, SLR drives chronic coastal erosion and shoreline recession. With accelerated SLR, any shoreline hardening of the backshore causes beach narrowing and loss. This decreases open space, damages public access to and along the shoreline, and has a profoundly negative environmental and social impact.[1]
2. **Design a place-appropriate setback regime.** The current shoreline setback of 40 feet is a one-size fits all approach. However, some coastal segments are characterized by sandy beaches, critical habitats and important recreational areas, while others have been previously developed and hardened. There is a fundamental difference between hardened shorelines and otherwise, suggesting that a single setback regime may be inappropriate. Examples of variable setback strategies include, but are not limited to:
    a. Erosion-based setbacks - Maui and Kaua'i Counties have previously adopted erosion-based setbacks that reflect the site-specific nature of the erosion hazard on the basis of empirical measurements (Table 1).
    b. Application of a consistent management approach to geographic areas that share common ecological and physical characteristics.
    c. Use of model results that characterize coastal hazards influenced by climate change. An example is the "red line" that simulates the 80% erosion probability under 3.2 ft (98 cm) of SLR.[2] These approaches are not mutually exclusive.
3. **Consider using multiple criteria to determine the setback, and choose the greater among them.** As shown in Table 1, both Maui and Kaua'i counties employ multiple criteria in their setback rules to identify the setback: lot depth, historical erosion rate, and future erosion hazards. The use

of multiple criteria with a nexus to risk provides increased opportunities to successfully achieve policy objectives.

4. **Carefully review and revise Section 23-1.8 "Criteria for granting a variance."** It is important to acknowledge the established science regarding shoreline hardening. Efforts to stop coastal erosion such as a sea wall or revetment will damage, narrow, and eventually destroy the beach.[3] A wall of any type will also cause flanking (accelerated erosion to a neighboring property), as well as wave reflection (energy transmited seaward by waves that "bounce" off a wall) that disrupts incident waves, benthic ecosystems, and water quality.
5. **Develop criteria guiding the repair and maintenance of existing structures within the setback.** Repair of existing seawalls and revetments continues the practice of shoreline hardening. Shoreline hardening causes beach loss, limits public access to and along the shoreline, increases community exposure to coastal hazards due to SLR, reduces open space, and can lead to degraded water quality and damage to adjacent shallow marine ecosystems. Locations where shoreline hardening should be maintained (e.g., where needed for a public good, in support of clean nearshore waters, to protect major public infrastructure, etc.) can be defined and supported through place-appropriate criteria.
6. **Maintain the buffer zone.** Any seaward shift in the location of the setback should not be allowed, as it violates ROH Chapter 23 objectives. Though there are cases of beach accretion on O'ahu, SLR will undermine this trend in the future. Beach widening is an asset to the public.
7. **Develop a robust process for public outreach.** The City Department of Planning and Permitting (DPP) is tasked to oversee ROH Chapter 23 and its amendments. It is important that DPP have requisite resources to put forth concrete amendments to ROH Chapter 23, including opportunities for public input and education.
8. **Make resources available to revisit and amend ROH Chapter 23 at least every five years.** New information about SLR, climate change, and coastal risk are constantly emerging.

BACKGROUND AND CONTEXT FOR SHORELINE SETBACK GUIDANCE

I. INTRODUCTION

At this writing, surface temperature datasets suggest 2019 will be the second warmest year in the instrumental record (85% probability)[4] and the fifth year in a row more than 1.8° F (1° C) above late 19th century temperature. The five warmest years all occur in the past five years.

Global warming is leading to changes in many Earth systems. Among these is the average level of the ocean surface. Because warming causes melting of glaciers and ice sheets (the resulting meltwater flows into the ocean), and thermal expansion of the marine water column as it absorbs heat from the air, global mean sea level (GMSL) is rising. This guidance provides a review of the problems that are caused by SLR, catalogs national and local "shoreline setback" policies (the shoreline setback is a no-build zone adjacent to the shoreline) for the purposes of providing guidance to the City in amending their setback regulations, ROH Chapter 23.

II. SEA LEVEL RISE AND COASTAL HAZARDS

Global Sea Level - In late 2019, the United Nations Emissions Gap Report projected that global greenhouse gas emissions are on track to warm 5.8° F (3.2° C) above pre-industrial levels by 2100 if relying only on the unconditional Nationally Determined Contributions of the Paris Agreement.[5] This indicates continued and accelerating SLR through this century. Several other sources, such as the July 2019 Global Energy Outlook[6] by Resources for the Future draw similar conclusions.

In Volume I of the 4th National Climate Assessment (NCA4) Climate Science Special Report (2017),[7] it was found that relative to the year 2000, global mean sea level (GMSL) is very likely (90% -100%

likelihood) to rise by 0.3–0.6 ft (9–18 cm) by 2030, 0.5–1.2 ft (15–38 cm) by 2050, and 1.0–4.3 ft (30–130 cm) by 2100 (very high confidence in lower bounds; medium confidence in upper bounds for 2030 and 2050; low confidence in upper bounds for 2100). It was also found that future greenhouse gas emissions pathways have little effect on projected GMSL rise in the first half of the century, but significantly affect projections for the second half of the century (high confidence).

Emerging science regarding Antarctic ice sheet stability suggests that, for high emission scenarios, a GMSL rise exceeding 8 ft (2.4 m) by 2100 is physically possible, although the probability of such an extreme outcome cannot currently be assessed. Regardless of emissions pathway, it is extremely likely that GMSL rise will continue beyond 2100 (high confidence). In addition, a structured expert judgement published in May 2019 identifies a 10% chance of GMSL exceeding 6.5 ft (2 m) by the end of the century.[8] Accelerating SLR will increase the damage caused by all types of coastal hazards.

Local Impacts - The Honolulu tide station records local mean sea level rising 1.49 +/-0.21 mm/yr.[9] In 2017, the State of Hawai'i Climate Change Mitigation and Adaptation Commission adopted the Hawai'i Sea Level Rise Vulnerability and Adaptation Report.[10] It provides the first state-wide assessment of Hawai'i 's vulnerability to SLR and makes recommendations to reduce exposure and sensitivity to SLR while increasing the capacity of Hawai'i's communities to adapt.

The report provides a statewide assessment of the combined assets that are exposed to coastal hazards as a result of SLR. With 1 ft (30 cm) of SLR, the land and building value on O'ahu that are exposed to erosion, groundwater inundation and storm-drain backflow, and/or high seasonal waves sums to over $4.1 billion, including 5.5 mi (8.8 km) of major roads; approximately 2,000 residents will be displaced. At 3.2 ft (98 cm) of SLR, a total $12.9 billion of land and building value are exposed with over 13,300 residents displaced. The estimate of affected population does not include houseless populations and visitors. In addition, the Hawai'i Department of Transportation has identified 38 mi (61 km) of roadway at risk, with an adaptation cost of $15 billion statewide.[11]

The report recommends that the Sea Level Rise Exposure Area (SLR-XA) with "3.2 feet of SLR be used as a state-wide vulnerability zone for planning at state, county and community levels." The results of the report, and the recommendations, highlight the need to:

1. Incorporate the 3.2SLR-XA in land use planning,
2. Prioritize smart redevelopment outside of the 3.2SLR-XA,
3. Improve flood risk management,
4. Address cultural and environmental vulnerabilities that encourage resilient land and community development, and
5. Create funding sources for research, adaptation, monitoring and collaboration.

At the University of Hawai'i at Mānoa, the PacIOOS[12] program publically serves the Hawai'i Sea Level Rise Viewer[13] which provides maps (downloadable as GIS layers) showing modeled impacts (flooding, erosion, wave run-up) of SLR at increments derived from the 5th Assessment Report (AR5) of the Intergovernmental Panel on Climate Change.[14] These model results were used in the Hawai'i Sea Level Rise Vulnerability and Adaptation Report in their impact assessment.

Coastal Erosion - During SLR, the beach environment, which extends offshore under the surf zone, and onshore across the coastal dune system, retreats landward. In so doing, beachfront land is eroded. If this land has not been altered by landscaping and other forms of development, and if it is sand-rich (such as with a dune field or other types of geologic sand deposits), erosion of this land will supply the migrating beach with sand. Even if a beach is backed by alluvial or volcanic geology, depending on specific coastal processes at the site, a beach may continue to exist through sand delivery from alongshore and/or offshore sources.

Though a widely held view is that coastal erosion can be managed, attempts to stop coastal erosion such as with a wall or revetment will damage, narrow, and eventually destroy the beach.[15] A wall of any type will also cause flanking (accelerated erosion to a neighboring property), as well as wave reflection (energy transmited seaward by waves that "bounce" off a wall), and disrupt incident waves, benthic ecosystems, and water quality. If allowed to migrate landward with the rising ocean levels, beaches can adapt to and survive SLR, as they have for 20,000 yrs since global sea level was over 420 ft (128 m) lower at the culmination of the last ice age. When seawalls and other forms of shoreline hardening are used to protect homes and roads from the effects of erosion it provides a temporary reprieve, but eventually leads to beach narrowing and beach loss.[16]

Beach narrowing and loss represents the destruction of a critical and diverse natural ecosystem essential to a number of endangered, federally protected species (e.g., monk seals and sea turtles), the loss of cultural and intrinsic value, as well as loss of recreational value for residents and tourists alike. From a legal perspective, it is also the loss of a public trust asset.[17]

King Tides - In 2017, the Honolulu Tide Station recorded the highest water levels in its 112 yr record. The scientific term for a king tide is a perigean spring tide. King tides in Hawai'i tend to occur during the summer months (e.g., July and August) and winter months (e.g., December and January) in conjunction with new moons and full moons. Record setting king tides occur when:

1) The moon is at its closest point to Earth in its monthly orbit, so the gravitational pull is stronger.
2) When the sun, the moon, and Earth are in alignment. This means that the sun and moon's individual gravitational pulls work together, producing the highest high tides of the year.
3) Water levels rise an additional amount above the pure tide components and reach unusual heights. Warmer than usual sea surface temperatures, winds, and ocean circulation patterns can add this additional component in some cases.

The timing of these extreme water level events can be anticipated through the use of tidal predictions, yet their impacts (coastal flooding and inundation in low-lying areas) can have devastating consequences for coastal inhabitants, particularly when combined with severe weather or high wave events. With continued SLR, Hawai'i can expect more frequent and more extensive high tide flooding, including monthly and even daily high tides exceeding coastal inundation thresholds.

Typically, intensifying high tide flooding is the first evidence of SLR experienced by a community. Thompson et al. (2019)[18] modelled the occurrence of high tide flooding in Honolulu and found that by the year 2030, the Intermediate and Intermediate-High scenarios proposed by NOAA (2017)[19] may lead to an average 48 and 131 days per year of high tide flooding equivalent to the 2017 episode. By 2040 it is projected there will be 171 and 316 days per year of high tide flooding (respectively). The frequency of flooding more than triples from 75 to 246 days per year on average from the 2030's to the 2040's. By the decade of the 2030's, the NOAA Intermediate scenario (1 m [3.3 ft] of GMSL rise by the year 2100) may lead to more than 169 days of flooding during the worst year of the decade.

Hurricanes - Of great concern for Hawai'i, and Honolulu specifically, is that tropical cyclones are following new pathways[20] that will bring them near island communities more often than has been seen historically.[21] Climate change is projected to cause a northward shift of hurricanes toward the Hawaiian Islands – and this may be already taking place. [22] This shift will increase the chance of landfall, posing severe flood risks to Honolulu communities and infrastructure along the coast as well as further inland. An increasing number of storms have tracked closer to Hawai'i in recent years: Hurricane Iselle in 2014, Hurricane Guillermo in 2015, Hurricanes Celia, Darby and Lester in 2016, and Hurricanes Lane and Olivia in 2018. During the 2015 hurricane season, a record 15 tropical cyclones entered or formed in the North Central Pacific basin. This above-average activity has been attributed in part to the very strong 2014–16 El Niño.

SLR increases the vulnerability of coastal communities to damage related to flooding by intense rainfall and marine storm surge associated with hurricanes. Houses, roads and other assets are exposed to the rising threat of hurricanes through both SLR and new storm tracks.

Seasonal High Waves - On shores facing to the south, high waves produced by storminess in the southern hemisphere arrive every summer, and on shores facing to the north, high waves produced by storminess in the North Pacific arrive every winter. At present, these seasonal high waves lead to occasional flooding of the first row of beachfront homes and certain sections of coastal roads. They also drive changes in beach configuration that can lead to temporary acceleration in erosion trends.

However, SLR is changing this historical pattern. Modeling the characteristics of these annual waves under higher sea levels reveals that between 2 to 3.2 ft (60 to 98 cm) of SLR, wave flooding reaches a critical point, moving from being damaging to catastrophic.[23] It is the sea level height beyond which flooding rapidly accelerates and threatens an entire beachfront community.[24]

Tsunami – The current tsunami evacuation zone is a product of modeling the flooding impact of a 1946-type tsunami and does not take into account future SLR. A future tsunami that may not have caused significant damage in the past, will be able to penetrate further landward, cause greater damage, and poses a more significant threat because of SLR. Public agencies tasked with protecting public health and safety, can begin to address this problem by revising coastal policies so that they decrease exposure to tsunami flooding.

Commission Sea Level Rise Guidance and Directive – Based on the current science, the Commission issued Sea Level Rise Guidance.[25] The Commission recommended that the City set a planning benchmark of 3.2 ft (~1 m; 3.2SLR-XA) of GMSL rise by the end of the century. High-tide flooding will arrive decades earlier and the 3.2SLR-XA will be an area experiencing chronic high tide flooding by mid-century.

In recognition that global emissions are on a warming pathway of over 5.4° F (3.0° C) in the second half of this century, the Commission recommended setting a planning benchmark up to 6 ft (1.8 m) of GMSL for projects with low risk tolerance, potentially with long expected lifespans. The Commission advised that all ordinances related to land development, such as policy, plans, and regulations, should be reviewed and updated, as necessary.

In turn, the Mayor's Directive Number 18-2 says that City departments and agencies are required to use the Commission's guidance for "managing assets, reviewing permitting requests, and assessment of project proposals," as well as "develop place-specific guidance for shoreline policy changes." Revising ROH Chapter 23 to incorporate and reflect management decisions based on the science of climate change and SLR is critically important to meeting the Directive.

III. RELEVANT COASTAL ZONE POLICIES

In 1972, the U.S. Congress passed the Coastal Zone Management Act (CZMA) to "preserve, protect, develop, and where possible, to restore or enhance the resources of the nation's coastal zone" (16 USC 1451 – 1466).[26] After the National CZM Program was established in 1977, several states opted to participate in a federal-local partnership designed to encourage states to create coastal management plans and policies to foster federal, state and local cooperation.

Under this structure, states have established shoreline setbacks using various criteria. These incude methods that are erosion rate-based (the setback is calculated based on the annual rate of coastal erosion), fixed-distance (such as used by the City, determines the setback), or use some other criteria such as distances from coastal landforms (e.g.,dunes), application of multiple criteria depending on site-specific conditions, or guided by existing development. For a summary of shoreline setbacks across coastal U.S. states, see Appendix I.

To manage the coastal zone in Hawai'i, the State created the shoreline setback (HRS Chapter 205A) to be not less than 20 ft (6.1 m) and not more than 40 ft (12.2 m) inland from the shoreline, which is the highest annual reach of the waves.[27] State conservation districts have a setback of 40 ft (12.2 m) + 70 times the average annual coastal erosion rate[28] for structures with average lot depth greater than 200 ft (61 m).[29]

HRS Chapter 205A-45 allows counties to increase their setback beyond 40 ft (12.2 m) from the shoreline. Maui and Kaua'i counties have changed their shoreline setbacks in recognition that 40 ft (12.2 m) does not offer sufficient protection from coastal hazards. Both Kaua'i and Maui have adopted setbacks based on multiple criteria: the rate of historical shoreline change or the average depth of the lot.

On Kaua'i, the shoreline setback[30] is:

- 40 ft (12.2 m) + a distance of 70 times the annual coastal erosion rate + a 20 ft (6.1 m) safety buffer measured from the shoreline for lots with a depth less than 140 ft (42.7 m).
- For lots with average depth of 140 to 220 ft (42.7 to 67.1 m), the greater distance of the two applies: 40 ft (12.2 m) + 70 times the annual coastal erosion rate + 20 ft (6.1 m), or taking the average lot depth, subtracting 100 ft (30.5 m), dividing by 2 + 40 ft (12.2 m).

- For lots with average lot depth over 220 ft (67.1 m), the greater of the two shall apply: 40 ft (12.2 m) + 70 times the annual erosion rate + 20 ft (6.1 m), or a setback line of 100 ft (30.5 m) from the shoreline.

On Maui, all lots have a shoreline setback that is the greater of:

- 25 ft (7.6 m) + a distance of 50 times the annual erosion hazard rate.
- Based on the lot depth:
  - Lots with average depth of 100 ft (30.5 m) or less shall have a setback of 25 ft (7.6 m).
  - Lots with average depth >100 ft (30.5 m) but <160 ft (48.8 m) shall have a setback of 40 ft (12.2 m).
  - Lots with average depth >160 ft (48.8 m), shall have a setback of 25% of the average lot depth, but not >150 ft (45.7 m).
- For irregularly shaped lots, the setback will be equivalent to 25% of the lot depth as determined by the Director of Planning to a maximum of 150 ft (45.7 m).[31]

Table 1 below summarizes the current setback policies for Hawai'i's four counties.

Erosion Hazard Line - Among the model results presented in the Hawai'i Sea Level Rise Vulnerability and Adaptation Report is an Erosion Hazard Line (EHL) representing the 80% probability of erosion with 3.2 ft (1 m) of GMSL rise. The EHL is being proposed by Maui County Planning Department as the basis for a new set-back.[36] Because it is available on the PacIOOS site as a downloadable GIS layer, it is useful for planning and design. It represents the best available science for managing the erosion problem in a future characterized by accelerating SLR. Maui County is proposing the following shoreline rule amendments:

1. In areas where the EHL is mapped, the setback is the EHL+40 ft (12.2 m).
2. In areas without the EHL and with no certified shoreline survey, the setback is 200 ft (61 m) as mapped by the department.
3. In areas without the EHL and with a certified shoreline survey, the setback is based on the lot depth (as in current rules).
4. In areas without the EHL with irregularly shaped lots or cliffs or not mapped by the department, the setback is 25% of the lot depth.

The EHL is determined, in part, by historical rates of shoreline change derived from analysis of orthorectified aerial photogrammetry. This time series begins with imagery collected prior to WWII and is periodically updated.[37]

IV. SUMMARY OF ROH CHAPTER 23

ROH Chapter 23 is the shoreline setback provision for the City. The purpose of ROH Chapter 23 is to "establish standards and to authorize the department of land utilization (now DPP) to adopt rules pursuant to HRS Chapter 91, which generally prohibit within the shoreline area any construction or activity which may adversely affect beach processes, public access along the shoreline, or shoreline open space."

ROH Chapter 23 states that it is the:

> "primary policy of the City to protect and preserve the natural shoreline, especially sandy beaches; to protect and preserve public pedestrian access laterally along the shoreline and to the sea; and to protect and preserve open space along the shoreline. It is also a secondary policy of the city to reduce hazards to property from coastal floods."

ROH Chapter 23 establishes the setback at 40 ft (12.2 m) inland from the shoreline. In the case of shallow lots, where the depth of the buildable area of a lot is less than 30 ft (9.1 m), the setback is "adjusted to allow a minimum depth of buildable area of 30 ft (9.1 m); provided that the adjusted shoreline

<table>
<tr><th colspan="4">TABLE 1 – Hawai'i Counties Setback Delineation</th></tr>
<tr><th>County</th><th>Erosion Rate-Based</th><th>Fixed-Distance</th><th>Area/Other Methods</th></tr>
<tr><td>O'ahu</td><td>Conservation Districts only (DLNR)*</td><td>40 ft (12.2 m) inland from the certified shoreline[32]</td><td>n/a</td></tr>
<tr><td rowspan="3">Maui</td><td colspan="3">The greater of the distances from the shoreline as calculated under the methods listed or the overlay of such distances[33]</td></tr>
<tr><td>25 ft (7.6 m) + distance of 50 times the annual erosion hazard rate from the shoreline</td><td colspan="2">Based on the lot's depth as follows:
1) Lots with average depth of 100 ft (30.5 m) or less shall have a setback 25 ft (7.6 m) from the shoreline
2) Lots with average depth >100 ft (30.5 m) but <160 ft (48.8 m) shall have a setback 40 ft (12.2 m) from the shoreline
3) Lots with average depth >160 ft (48.8 m), shall have a setback equal to 25% of average lot depth, but not >150 ft (45.7 m)
4) For irregular lots, or cliffs, bluffs or other topographic features inhibit safe measurement of boundaries and/or the shoreline, the setback will be equivalent to 25% of the lot depth as determined by Director of the Department of Planning to a maximum of 150 ft (45.7 m) from the shoreline</td></tr>
<tr><td colspan="3">NOTE: Maui Department of Planning introduced a new set-back criteria for Maui island, the erosion hazard line (see PacIOOS SLR Viewer) marking 80% probability of exposure to chronic erosion when sea level has risen 3.2 ft (~1 m).</td></tr>
<tr><td>Kaua'i</td><td>For lots in the Kaua'i Erosion Study[34]
1) For lots with average depth of <140 ft (42.7 m): 40 ft (12.2 m) + distance of 70 times annual coastal erosion rate + 20 ft (6.1 m) safety buffer from certified shoreline
2) For lots with average depth of 140 ft (42.7 m) to 220 ft (67.1 m), the greater setback of the following: 40 ft (12.2 m) + 70 times annual coastal erosion rate + 20 ft (6.1 m), or taking average lot depth, subtracting 100 ft (30.5 m), then dividing by 2 + 40 ft (12.2 m)
3) For lots with average depth greater than 220 ft (67.1 m), the greater setback of the following: 40 ft (12.2 m) + 70 times annual coastal erosion rate + 20 ft (6.1 m), or a setback of 100 ft (30.5 m) from the certified shoreline</td><td>n/a</td><td>For lots <u>not</u> included in the Kaua'i Erosion Study, the setback shall be calculated by the following formula[35]:
Average Lot Depth - 100)/ 2 + 40), subject to the following:
1) For lots with naturally occurring rocky shorelines, the shoreline setback line shall be no less than 40 ft (12.2 m)
2) For all other lots, the shoreline setback line shall be no less than 60 ft (18.3 m)
1) 3) For all lots, the maximum setback that can be required shall be 100 ft (30.5 m)</td></tr>
<tr><td>Hawai'i</td><td>In Conservation Districts only (DLNR)*</td><td>40 ft (12.2 m) inland from the certified shoreline</td><td>n/a</td></tr>
</table>

setback line shall be no less than 20 ft (6.1 m) from the certified shoreline." In the case of a new subdivision or consolidation of land, new lots must accomodate a 60 ft (18.3 m) setback.

Variances - ROH Chapter 23 provides authority to the Director of DPP to grant variances for structures or activities within the setback. For instance, a variance may be awarded for structures or activities that meet a public interest standard (e.g., harbors, airports, etc.), or a hardship standard. The hardship standard is triggered if an applicant would be deprived of reasonable use of the land if required to comply fully with the shoreline setback ordinance and the shoreline setback rules. A key aspect of the hardship standard is determination of "reasonable use of the land." In past practice, reasonable use of the land was found to include improvements such as roads, habitable dwellings, and even the intention of future habitation where no existing improvement was actually threatened.[38]

Under these conditions, discretionary allowances have been made for seawalls, revetments, and other shoreline hardening structures that clearly undermine the primary policy objective. There is an abundant body of published scientific research documenting the negative effects of shoreline hardening, including beach narrowing and beach loss,[39] loss of littoral biodiversity,[40] and other impacts.[41] However, the hardship variance allows land use practices that damage shorelines. Due to the existence of rising sea level and increasing risk from changes in coastal hazards, there is a critical need to limit the granting of variances in order to increase coastal resiliency.

V. CONCLUSIONS

Beaches and coastlines are an integral component of the lives of the people in Hawaiʻi. These are places of cultural practice, food harvesting, and recreation. The existing setback policy was built on the assumption that, within an envelope of variability, the shoreline would largely hold its position through time. However, long-term SLR dramatically undermines this assumption and revising ROH Chapter 23 is a necessary component of adjusting to greater variability within the coastal zone. With climate change, rising sea levels, and increasing intensity of coastal hazards, it is clear that coastal zone management policies need to be updated to accurately reflect current understanding of climate change and its impacts to nearshore environments and public health and safety.

Research has shown that coastal development activity and beach stability are negatively correlated. Within the system of current coastal policies, accelerated SLR triggers a number of consequences: shifts in government jurisdiction and land ownership; erosion and land loss that threaten human communities and their assets; threats to sensitive coastal ecosystems, especially beaches; and increased exposure to hazards such as storms, seasonal high waves, tsunami, and extreme tides. It is on this basis that the Commission recommends revisions to ROH Chapter 23, as summarized in the beginning of this guidance document.

This guidance was unanimously adopted by the Climate Change Commission at its meeting on December 23, 2019.

Makena Coffman, Chair
Climate Change Commission

APPENDIX State No-Build Zone (Setback) Details						
State or Territory	Seaward Reference Feature (SRF)	Landward Boundary (LB)	No-Build Areas (NBA) Delineation	Local Programs	Specifications for NBA Delineation	Regulating Agency
Alabama	Mean High Tide	Construction Control Line (CCL, link in Specifications)	Area/Other Methods: CCL	Some cities/counties delegated permitting, monitoring, & enforcing powers	http://www.adem.state.al.us/alEnviroRegLaws/files/Division8.pdf	Dept. Env. Management, Dept. Consv. & Natural Resources, State Lands Division
American Samoa	Mean High Tide	200 ft from SRF	Fixed-Distance: 200 ft from SRF. Area/Other Methods: Coastal Hazard Areas (floodplains, storm wave, inundation areas, landslide hazard areas, erosion-prone areas).	Office of Development Planning vested with exclusive authority to designate uses subject to land use permit requirements	https://coast.noaa.gov/data/czm/media/nobuildareas.pdf	American Samoa Dept. Commerce
California	Does not explicitly have a No-Build Area or Shoreline Setback Law or Regulation, since the state has local coastal programs and no state mandated setback			Yes, Local Coastal Programs	California Coastal Commission; San Francisco Bay Conservation and Development Commission	
Commonwealth of the Northern Mariana Islands	High Tide Line	Fixed-Distance: A) 0-35 ft: beach/shoreline reservation zone, structures generally not allowed. Non-vertical construction potentially allowed at 35 ft. B) 35-100 ft: Parking areas & vertical construction that obstruct openness not allowed, but pools and terraces are. C) 100-125 ft: Single-story structures, allowed but not exceed 12 ft height measured from natural grade. D) +125 ft: If building height >2 stories, then 150 ft from high tide line is considered property line.		No, Coastal Resource Management Agency. Board approves all permits.	https://dcrm.gov.mp/wp-content/uploads/crm/2018_CRMRegs_FINAL.pdf	CNMI Coastal Resources Management Office
Connecticut	No explicit setback law or regulation		Development of shoreline regulated at local level through municipal planning & zoning boards		Dept. Energy & Environmental Protection, Office of Long Island Sound Programs	
Delaware	Mean High Water Line	Building Line As Defined (link in Specifications)	Fixed Distance: Building Line defined geographically at various coastal communities and	Yes, both state and local governments regulate shorefront	http://regulations.delaware.gov/AdminCode/title7/5000/5102.shtml	Dept. Natural Resources and Environmental Control, Office of the

			natural features (e.g., beaches extending from DEL/MD line to Cape Henlopen, 100 ft landward of the adjusted 9 ft elev. contour, NAVD; Commercial Areas w/ boardwalks and no natural dune, Building Line shall be along west edge of the boardwalk).	development on dry land		Secretary, Delaware Coastal Programs
State or Territory	Seaward Reference Feature (SRF)	Landward Boundary (LB)	No-Build Areas (NBA) Delineation	Local Programs	Specifications for NBA Delineation	Regulating Agency
Florida	Seasonal high water line or mean high water line	Whichever is most seaward: Erosion-Rate Based: Various methods determine location of the 30 yr erosion projection seasonal high water line: http://www.flrules.org/gateway/ruleno.asp?id=62B-33.024&Section=0. Area/Other Methods: Coastal Construction Control Line, landward limit of the beach-dune system subject to 100 yr storm surge, storm waves, or other predictable weather conditions: https://floridadep.gov/sites/default/files/CCCL_FrequentlyAskedQuestions_0.pdf Fixed-Distance: Where there is no CCCL, 50 ft from mean high water line.		Yes, regulated at county level	https://www.lawserver.com/law/state/florida/statutes/florida_statutes_161-052	Dept. Environmental Protection, Bureau of Beaches & Coastal Systems
Georgia	Ordinary low water mark	Line of permanent vegetation	Fixed-Distance: 50 ft for marshlands. Area/Other Methods: Any area between SRF and the LB is not allowed on beaches and eroding sand dune areas.	Yes, county level	https://coast.noaa.gov/data/czm/media/nobuildareas.pdf	Dept. Natural Resources
Guam	Mean high water mark	35 ft or 75 ft of SRF	Fixed Distance: Structures ≤20 ft high: 35 ft from SRF Structures >20 ft high: 75 ft from SRF	No	https://coast.noaa.gov/data/czm/media/nobuildareas.pdf	Guam Bureau Statistics & Plans

Hawai'i	Shoreline –Upper wash of waves at high tide	20-40 ft from SRF	Erosion-Rate Based: Maui & Kauai w/ erosion rates. Fixed-Distance: Hawai'i & O'ahu w/ 40 ft. Area/Other Methods: Conservation District where structures setback from shoreline (upper wash of waves at high tide) 40 ft + 70 times avg. annual coastal erosion rate.	Yes, at the county level	https://coast.noaa.gov/data/czm/media/nobuildareas.pdf	HI DBEDT, Office Planning & HI DLNR, Office Conservation & Coastal Lands
Louisiana	No explicit setback			Some parishes have CZM programs.		Dept. Natural Resources Office of Coastal Management
Maine	Atlantic shoreline: highest annual tide elev. or top of unstable bluff	Atlantic Shoreline: 75 ft from SRF or General Development I Districts: 25 ft from SRF.	Fixed-Distance: Shoreline Zone (General): 75 ft from SRF. Area/Other Methods: General Development I Districts: 25 ft from SRF.	Municipalities develop & administer zoning ordinances	https://coast.noaa.gov/data/czm/media/nobuildareas.pdf	Dept. Environmental Protection
Maryland	Ocean	Ocean City Building Limit Line as defined	Area/Other Methods: State-Ocean City Building Limit Line defined by Army Corps based on control points.	Local jurisdictions establish shoreline buffers & minimum setbacks	https://coast.noaa.gov/data/czm/media/nobuildareas.pdf	Dept. Natural Resources
Massachusetts	No explicit setback or regulation			Municipalities administer regulations		Executive Office Energy & Environmental Affairs
Mississippi	No explicit setback or regulation					Dept. of Marine Resources
State or Territory	Seaward Reference Feature (SRF)	Landward Boundary (LB)	No-Build Areas (NBA) Delineation	Local Programs	Specifications for NBA Delineation	Regulating Agency
New Hampshire	Highest observable astronomical tide line	Primary Building Line	Fixed-Distance: Primary Building Line is primary setback: 50 ft from SRF. Area/Other Methods: Construction in 100	Municipalities	https://coast.noaa.gov/data/czm/media/nobuildareas.pdf	Dept. Env. Services, Wetlands Bureau, Shoreland Program

			ft tidal zone buffer prohibited			
New Jersey	Beaches: Mean high water line	Beaches: most seaward of Manmade feature parallel to sea or Seaward foot dunes	Erosion Rate-Based: 30 times erosion rate for 1-4 unit dwelling structures & 60 times erosion rate for others. Fixed-Distance: Depends on situation, can include flood haz. areas (100 ft setback) & coastal bluffs (25 ft setback). Area/Other Methods: Depends on situation, can include beaches, dunes, coastal bluffs, overwash areas, coastal high hazards.	Yes, development must meet most stringent standards (whether that is state or local standards)	https://coast.noaa.gov/data/czm/media/nobuildareas.pdf	Dept. Environmental Protection
New York	Beaches: Bluff or dune: Mean low water line. or whatever most seaward of marked change in physiographic form or line of permanent vegetation	Beaches: Bluff or dune, whichever most seaward: - Seaward toe of dune - Seaward toe of bluff No bluff or dune: 100 ft landward of SRF	Erosion-Rate Based & Area/Other Methods: structural hazard areas, 40 X erosion rate from SRF. Fixed-Distance: natural protective feature areas, depends on situation; for beaches, 100 ft landward if no bluff or dune; for bluffs, 25 ft landward of bluff's receding edge/point of inflection; for primary dunes, 25 ft landward of primary dune's landward toe.	Yes, local governments	https://coast.noaa.gov/data/czm/media/nobuildareas.pdf	Dept. Environmental Conservation

North Carolina	First line of stable natural vegetation	Development must be landward of primary dune crest or the frontal dune (if primary dune absent) or in accordance with the Ocean Hazard Setback, whichever is most landward.	Erosion-Rate Based & Fixed-Distance: depends on size of structure and a setback factor based on shoreline position change rate. Area/Other Methods: Ocean Erodible Area of Environmental Concern. See link under Specifications for NBA Delineation.	Yes, county level	https://deq.nc.gov/about/divisions/coastal-management/coastal-management-oceanfront-shorelines/oceanfront-construction-setback-erosion-rate	Dept. Environment and Natural Resources
Oregon	Ocean shores: extreme low tide	Ocean shores: most landward of Statutory Vegetation Line or line of established upland shore vegetation	Area/Other Methods: Development not allowed between extreme low tide and LB. For more information see link.	Yes, local governments	https://coast.noaa.gov/data/czm/media/nobuildareas.pdf	Parks & Rec. Dept. & Oregon Dept. Land Conservation & Development
Puerto Rico	High tide line	Greater of: 50 m from SRF or 2.5 X building height	Fixed-Distance: Greater of: 50 m from seaward reference feature or 2.5 X building height for buildings constructed within 400 m of Maritime Terrestrial Zone. Area/Other Methods: urban zoning districts, additional calculations required to establish setback and building height limits.		https://coast.noaa.gov/data/czm/media/nobuildareas.pdf	Dept. Natural & Environmental Resources & Planning Board
State or Territory	Seaward Reference Feature (SRF)	Landward Boundary (LB)	No-Build Areas (NBA) Delineation	Local Programs	Specifications for NBA Delineation	Regulating Agency
Rhode Island	Inland boundary of most landward coastal feature (beach, dune, wetland, rocky shore, manmade shoreline,	Greater of: Residential, 30 X erosion rate from SRF Commercial, industrial, larger residential (4+ units): 60 X erosion rate from SRF 50 ft from SRF 25 ft from edge	Erosion-Rate Based: Residential, commercial and industrial structures. Fixed-Distance: Minimum setback 50 ft from coastal feature or 25 ft from edge of coastal buffer zone, whichever further landward. Area/Other	No, regulated by state	https://coast.noaa.gov/data/czm/media/nobuildareas.pdf	Coastal Resources Management Council

	or headland/ bluff/cliff)	coastal buffer zone	Methods: barrier islands, no new development on moderately developed or undeveloped barrier islands + new infrastructure & utilities generally prohibited on all barriers. New construction not allowed on developed barriers on which only roads, utility lines, and other forms of public infrastructure were present as of 1985.			
South Carolina	Ocean	Most seaward of: escarpment, first line stable natural vegetation	Area/Other Methods: no new construction, additions, or reconstruction on active beach, which is the area seaward of escarpment or first line of stable natural vegetation, whichever is most seaward, and on primary oceanfront sand dunes	Yes, local agencies	https://coast.noaa.gov/data/czm/media/nobuildareas.pdf	Dept. Health & Environmental Control
Texas	Public beach: Mean low tide	Public beach: Line of vegetation	Fixed-Distance: In dunes, mean high tide is seaward reference feature and landward is up to 1,000 ft from SRF. Area/Other Methods: At public beaches, line of vegetation is landward boundary.		https://coast.noaa.gov/data/czm/media/nobuildareas.pdf	Texas General Land Office
U.S. Virgin Islands	Line of low tide	Whichever is most seaward: 50 ft from seaward ref. feature or first line of vegetation or natural barrier	Fixed-Distance: Development not allowed between line of low tide & line measured 50 ft inland or Area/Other Methods: extreme seaward boundary of natural vegetation or the natural barrier		https://coast.noaa.gov/data/czm/media/nobuildareas.pdf	

Virginia	Beaches: Low water line	Beaches: Marked change in material composition or physiographic form, line of woody vegetation, or nearest impermeable manmade structure	Erosion-Rate Based: Structures on barrier islands, setback from dune crest 20x 100 yr long-term annual erosion rate. Area/Other Methods:_law does not allow construction on beaches and primary sand dunes that impairs natural functions, physically alter the feature, or destroy vegetation	Yes, local agencies	https://coast.noaa.gov/data/czm/media/nobuildareas.pdf	Virginia Marine Resources Commission
State or Territory	Seaward Reference Feature (SRF)	Landward Boundary (LB)	No-Build Areas (NBA) Delineation	Local Programs	Specifications for NBA Delineation	Regulating Agency
Washington	No explicit setback law or regulation, instead uses Shoreline Management Act Law & implementing codes. Structural setbacks and vegetative buffers required on shorefront but depend on existing development patterns and ecological condition. There is to be "no net loss of ecological functions" which applies to all shoreline areas in Washington.			Yes, Shoreline Master Programs	https://ecology.wa.gov/Water-Shorelines/Shoreline-coastal-management/Shoreline-coastal-planning/Shoreline-Management-Act-SMA	Dept. of Ecology

[1] Summers, Alisha, et al. "Failure to Protect Beaches under Slowly Rising Sea Level." Climatic Change, vol. 151, no. 3-4, 2018, pp. 427–443., doi:10.1007/s10584-018-2327-7.

[2] Found at the Hawai'i Sea Level Rise Viewer served online by the University of Hawai'i PacIOOS Program: https://www.pacioos.hawaii.edu/shoreline/slr-hawaii/ or hawaiisealevelriseviewer.org

[3] Summers et al. (2018)

[4] "Data.GISS: GISS Surface Temperature Analysis (GISTEMP v4)." NASA, NASA, https://data.giss.nasa.gov/gistemp/.

[5] Emissions Gap Report 2019 | UNEP - UN Environment Programme. https://www.unenvironment.org/resources/emissions-gap-report-2019.

[6] "Global Energy Outlook 2019: The Next Generation of Energy." Resources for the Future, https://www.rff.org/publications/reports/global-energy-outlook-2019/.

[7] Sweet, W.V., et al. "Chapter 12: Sea Level Rise. Climate Science Special Report: Fourth National Climate Assessment, Volume I." U.S. Global Change Research Program, 2017, pp. 333–363, https://science2017.globalchange.gov/chapter/12/.

[8] Bamber, Jonathan L., et al. "Ice Sheet Contributions to Future Sea-Level Rise from Structured Expert Judgment." Proceedings of the National Academy of Sciences, vol. 116, no. 23, 2019, pp. 11195–11200., doi:10.1073/pnas.1817205116.

[9] "Sea Level Trends - NOAA Tides & Currents." Tides & Currents, https://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?id=1612340.

[10] "Hawai'i Sea Level Rise Vulnerability and Adaptation Report." *Hawai'i Climate Change Mitigation and Adaptation Commission.* Prepared by Tetra Tech, Inc. and the State of Hawai'i Department of Land and Natural Resources,

Office of Conservation and Coastal Lands, under the State of Hawai'i Department of Land and Natural Resources Contract No: 64064, 2017.

[11] Dredske, Logan. "" Anticipating the Costly Impacts of Climate Change in Hawai'i SSTI." SSTI Anticipating the Costly Impacts of Climate Change in Hawai'i Comments, 16 Aug. 2018, https://www.ssti.us/2018/04/anticipating-the-costly-impacts-of-climate-change-in-hawaii/. or https://www.civilbeat.org/2018/04/a-15-billion-price-tag-to-protect-hawaii-highways-from-climate-change/

[12] The Pacific Islands Ocean Observing System (PacIOOS: https://www.pacioos.hawaii.edu) is a federally funded ocean data and information program, hosted by the University of Hawai'i at Mānoa School of Ocean and Earth Science and Technology. PacIOOS collects real-time data on ocean conditions, forecasts future events, and develops user-friendly tools to access this information.

[13] "Hawai'i Sea Level Rise Viewer: PacIOOS." Pacific Islands Ocean Observing System (PacIOOS), http://www.pacioos.hawaii.edu/shoreline/slr-hawaii/.

[14] Pachauri, R.K., and L.A. Meyer . "AR5 Synthesis Report: Climate Change 2014." Fifth Assessment Report of the Intergovernmental Panel on Climate Change , IPCC, https://www.ipcc.ch/report/ar5/syr/.

[15] Summers et al. (2018)

[16] Fletcher, Charles H., et al. "Beach Loss Along Armored Shorelines on O'ahu, Hawaiian Islands." Journal of Coastal Research, vol. 13, no. 1, 30 May 1996, pp. 209–215., http://www.soest.hawaii.edu/coasts/publications/JCRBeachLoss.pdf.

[17] Summers et al. (2018)

[18] Thompson, Philip R., et al. "A Statistical Model for Frequency of Coastal Flooding in Honolulu, Hawai'i, During the 21st Century." AGU Journals, John Wiley & Sons, Ltd, 24 Apr. 2019, https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1029/2018JC014741.

[19] Sweet, William V., et al. Global and Regional Sea Level Rise Scenarios for the United States. National Oceanic and Atmospheric Administration, 2017, Global and Regional Sea Level Rise Scenarios for the United States, https://tidesandcurrents.noaa.gov/publications/techrpt83_Global_and_Regional_SLR_Scenarios_for_the_US_final.pdf.

[20] Kossin, James P., et al. "The Poleward Migration of the Location of Tropical Cyclone Maximum Intensity." Nature, vol. 509, no. 7500, 14 May 2014, pp. 349–352., doi:10.1038/nature13278.

[21] Murakami, Hiroyuki, et al. "Projected Increase in Tropical Cyclones near Hawai'i." Nature Climate Change, vol. 3, no. 8, May 2013, pp. 749–754., doi:10.1038/nclimate1890.

[22] Li, Ning, et al. "Probabilistic Mapping of Storm-Induced Coastal Inundation for Climate Change Adaptation." Coastal Engineering, vol. 133, 2018, pp. 126–141., doi:10.1016/j.coastaleng.2017.12.013.

[23] Kane, Haunani H., et al. "Critical Elevation Levels for Flooding Due to Sea-Level Rise in Hawai'i." Regional Environmental Change, vol. 15, no. 8, 2014, pp. 1679–1687., doi:10.1007/s10113-014-0725-6.

[24] Anderson, Robert S., et al. "Climate Driven Coevolution of Weathering Profiles and Hillslope Topography Generates Dramatic Differences in Critical Zone Architecture." Hydrological Processes, vol. 33, no. 1, Apr. 2018, pp. 4–19., doi:10.1002/hyp.13307.

[25] "Sea Level Rise Guidance." City and County of Honolulu Climate Change Commission, 2018. https://static1.squarespace.com/static/59af5d3cd7bdce7aa5c3e11f/t/5bef1aa688251b73aaaeff92/1542396587587/Sea+Level+Rise+Guidance.pdf

[26] NOAA Office for Coastal Management ADS Group. "OFFICE FOR COASTAL MANAGEMENT." NOAA Office for Coastal Management | About the Office, https://coast.noaa.gov/czm/act/.

[27] "Hawai'i Revised Statutes, Chapter 205A, Coastal Zone Management." https://dlnr.hawaii.gov/occl/files/2013/07/205a.pdf

[28] Data on the rate of sandy shoreline change have been calculated for Maui, Kaua'i, and O'ahu islands by the Coastal Geology Group at the University of Hawai'i at Mānoa, School of Ocean and Earth Science and Technology (http://www.soest.hawaii.edu/coasts/publications/)

[29] "Protecting the Public Interest through the National Coastal Zone Management Program: How Coastal States and Territories Use No-Build Areas along Ocean and Great Lake Shorefronts." National Oceanic and Atmospheric Administration (NOAA), 2012. NOAA Office of Ocean and Coastal Resource Management. http://coastalmanagement.noaa.gov/ resources/publications.html

[30] Kaua'i County Code 1987, Ordinance No. 979, Bill No. 2461, Draft 5. https://www.kauai.gov/Portals/0/Planning/Ordinance_979_Shoreline_Setback_Amends%20887%2012-05-14.pdf?ver=2017-07-06-153242-393

[31] Maui County, Department of Planning, Maui Planning Commission, Chapter 203, Shoreline Rules for the Maui Planning Commission. https://www.mauicounty.gov/DocumentCenter/View/8412/Chpt-203--MPC-Shoreline-Procedure-Rules?bidId=

[32] City and County of Honolulu, Revised Ordinances of Honolulu, Chapter 23, Shoreline Setbacks. https://www.honolulu.gov/rep/site/ocs/roh/ROH_Chapter_23__.pdf.pdf

[33] Maui County, Department of Planning, Maui Planning Commission, Chapter 203, Shoreline Rules for the Maui Planning Commission. https://www.mauicounty.gov/DocumentCenter/View/8412/Chpt-203--MPC-Shoreline-Procedure-Rules?bidId=

[34] Genz, Ayesha, and Charles Fletcher. "Data." Kaua'i Shoreline Study Erosion Maps, 5 Jan. 2005, http://www.soest.hawaii.edu/coasts/kauaicounty/KCounty.html.
[35] Kaua'i County Code 1987, Ordinance No. 979, Bill No. 2461, Draft 5. https://www.kauai.gov/Portals/0/Planning/Ordinance_979_Shoreline_Setback_Amends%20887%2012-05-14.pdf?ver=2017-07-06-153242-393
[36] "Proposed Amendments to the Maui Planning Commission's Special Management Area & Shoreline Rules". Kihei Community Informational Meeting, 14 Nov 2019, https://www.mauicounty.gov/DocumentCenter/View/120280/2019-Community-Meetings-SMAShoreline-Rules-Presentation
[37] Fletcher, C.H., Romine, B.M., Genz, A.S., Barbee, M.M., Dyer, Matthew, Anderson, T.R., Lim, S.C., Vitousek, Sean, Bochicchio, Christopher, and Richmond, B.M., 2012, National assessment of shoreline change: Historical shoreline change in the Hawaiian Islands: U.S. Geological Survey Open-File Report 2011–1051, 55 p. https://pubs.usgs.gov/of/2011/1051/ (Also available at https://pubs.usgs.gov/of/2011/1051.)
[38] Summers et al. (2018)
[39] Romine BM, Fletcher CH (2012a) Hardening on eroding coasts leads to beach narrowing and loss on Oahu, Hawaii. In: Cooper JAG, Andrew G, Pilkey OH (eds) Coastal research Library 3Pitfalls of Shoreline Stabilization: Selected Case Studies. Springer Science and Business Media, Dordrecht, Netherlands. https://doi.org/10.1007/978-94-007-4123-2_10
[40] Barbier EB, Hacker SD, Kennedy C, Koch EW, Stier AC, Silliman BR (2011) The value of estuarine and coastal ecosystem services. Ecol Monogr 81:169–193. https://doi.org/10.1890/10-1510.1
[41] Crosset K, Ache B, Pacheco P, Haber K (2013). National Coastal Population Report: Population Trends from 1970 to 2020. Rep. N.p.: National Oceanic and Atmospheric Administration, Print. NOAA State of the Coast Report